The nutritional and economic effects of palm oil trade liberalisation in India: A policy analysis

Soledad Cuevas García-Dorado

Thesis submitted in accordance with the requirements for the degree of

Doctor of Philosophy

University of London

June 2018

Department of Global Health and Development

Faculty of Public Health and Policy

LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE

Funded by the Leverhulme Centre For Integrative Research on Agriculture and Health (LCIRAH)

Declaration of the candidate's own role in the thesis

I, Soledad Cuevas García-Dorado, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm this has been indicated in the thesis. The entire thesis was designed, conceptualised, analysed and written by myself while I was pursuing the doctoral degree at the Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine (LSHTM). The contributions of co-authors have been acknowledged in the cover sheets at the beginning of the relevant chapters. The protocol for this thesis has been approved by the LSHTM ethics committee and by the Institutional Ethics Committee of the Public Health Foundation of India. This thesis has been supervised by Dr. Marcus Keogh-Brown, Professor Bhavani Shankar and Dr. Henning Tarp-Jensen, and advised by Dr. Sanjay Basu as a member of the advisory committee.

Soledad Cuevas García-Dorado

I confirm the accuracy of the above statement

20 May 2018

Principal supervisor: Dr Marcus Keogh-Brown

Abstract

Introduction

The liberalisation of the Indian edible oils sector in 1994 was followed by important increases in palm oil consumption, which is high in saturated fats compared to the oils traditionally consumed in Indian diets, potentially contributing to rising burdens of cardiovascular disease. Taxation, import substitution and other interventions to promote healthier oil consumption have been proposed. Additionally, Indian dependence on palm oil imports has been identified as a challenge for sustainability, contributing to environmental impacts in supplying countries. The main aim of this thesis is to prospectively assess potential policy interventions aimed at promoting healthy, sustainable oil consumption in India.

Methods

This thesis uses a mixed methods approach. We combine qualitative analysis of vegetable oils value chains for sustainable nutrition with an analysis of the policy space for the promotion of healthy, sustainable oil consumption. Subsequently, using a macroeconomic model of India, we analyse the economic and nutritional impacts of palm oil tariff changes.

Results

We have identified structural characteristics along the value chain that both drive unhealthy oil consumption patterns and create barriers for improved sustainability. These factors concern agricultural constraints, processing industry structure, marketing, branding, distribution and use patterns of palm oil, often driven by competition in an increasingly concentrated sector.

There are substantial opportunities to promote healthier, sustainable oil consumption, as well as challenges, given by changing policy priorities, and the involvement of non-state actors. The space for intervention is shaped by the alignment of proposals with policy goals related to self-sufficiency and food security, as well as with the economic interests of key stakeholders, including a corporate sector in rapid transformation whose role is becoming increasingly pivotal.

Increased tariffs on palm oil can lead to modest reductions in saturated fat intakes, replacement towards unsaturated fats, small reductions in overall energy from fats and processed foods, and small increases in trans fat intakes. Tariff protection is also associated with aggregate economic losses, as well as sector-specific impacts. The combination of palm oil tariffs with revenue-neutral subsidies on healthier oils slightly reinforces the shift away from saturated fats, without increasing trans fat intakes, and mitigating aggregate and sectoral economic impacts.

Conclusion

Differential tariffs on palm oil could potentially be used as an intervention to promote healthier, sustainable oil consumption, as part of a sectoral agenda for sustainable nutrition. However, this approach can involve trade-offs in terms of economic impacts and nutritional side-effects. Adequate compensatory measures could reinforce nutritional benefits, while mitigating some undesirable impacts. This thesis illustrates an approach to food policy analysis which can be applied in other settings, where trade-offs and synergies across economic outcomes and sustainable nutrition need to be considered.

Frequently used acronyms

ASI: Annual Survey of Industries (India)

ASEAN: Association of South East Asian Nations

AIFTA: ASEAN-India Free Trade Area

CES: Constant Elasticity of Substitution function

CGE: Computable General Equilibrium

DFPD: Department of Food and Public Distribution (India)

FA: Fatty Acid, SFA: Saturated Fatty Acids, UFA: Unsaturated Fatty Acids, TFA: Trans Fatty Acids, MUFA/PUFA: Mono/Polyunsaturated fatty acids

FDI: Foreign Direct Investment

FSSAI: Food Safety and Standards Authority of India

HFSS: High Fat, Salt or Sugar

NMOOP: National Mission on Oilseeds and Oil Palm

NSSO: National Sample Survey Organisation (India)

NCD: Non-Communicable Disease

PDS: Public Distribution System

PHVO: Partially Hydrogenated Vegetable oil

SAM: Social Accounting Matrix

USDA ps&d: United States Department of Agriculture production, supply and distribution database

WTO: World Trade Organisation

Contents table

Abstract 3
Acknowledgements 5
Frequently used acronyms 6
Contents table 7
Figures 12
Tables 15
Boxes 17
Chapter 1. Introduction 18
1.1 Introduction 18
1.2 The health impacts of fatty acid consumption. Scientific evidence 20
1.2.1 The health impacts of fatty acid consumption: Scientific evidence 20
1.2.2 The saturated fat debate: influence of vested interests 22
1.3 Main characteristics of palm oil as a global commodity 23
1.4 Aim and objectives of the study 25
1.5 Mixed-methods research strategy 25
1.6 Structure of the thesis 26
Chapter 2. Economic globalisation, nutrition and health: evidence from the literature .. 29
2.1 Introduction 30
2.2 Theoretical framework 31
2.2.1 International trade and food environments 32
2.2.2 Foreign direct investment in agriculture, food processing and retail 33
2.2.3 Global flows of information 33
2.2.4 Policy and regulatory space 34
2.2.5 Interaction with socioeconomic drivers of nutrition 34
2.3 Methods 35
2.3.1 Methodological approach 35
2.3.2 Search 35

2.3.3 Inclusion criteria 37

2.3.4 Information extraction and analysis 38

2.4 Results 39

2.4.1 Economic globalisation: trade and investment 39

2.4.2 Trade 40

2.4.3 Foreign direct investment 41

2.4.4 Increased flows of information 43

2.4.5 Trade and investment policy and regulatory environments 43

2.4.6 Socioeconomic and demographic factors as mediators of impact 44

2.5 Discussion and interpretation 44

2.6 Conclusion and implications for policy and research 48

Chapter 3. Background to this study: Historical overview and nutritional impacts of trade liberalisation in the Indian food sector 58

3.1 Introduction 58

3.2 India's agricultural trade liberalisation 58

3.2.1 Structural adjustment and the WTO 58

3.2.2 Preferential regional and bilateral trade agreements (PTA) 61

3.3 Foreign direct investment in Indian food supply chains: selective liberalisation and promotion of food processing 62

3.4 Liberalisation in the edible oils sector 64

3.5 Changing dietary patterns and the role of liberalisation 66

3.6 Conclusion 73

Chapter 4. Qualitative methodology for this study 74

4.1 Introduction 74

4.2 Methodology 75

4.2.1 Theoretical framework 75

4.2.2 Sampling and data collection procedure 84

4.2.3 Information extraction and analysis 88

4.3 Summary 89

Chapter 5. The Value Chain for edible oils in India: Characteristics, incentives and areas of intervention for sustainable nutrition 91
5.1 Introduction 91
5.2 Characteristics and incentives of the value chain 92
5.2.1 Domestic agricultural sector: constraints, incentives and policy 93
5.2.2 International trade 96
5.2.3 Edible oil processing industry 98
5.2.4 Marketing and distribution 102
5.2.5 Food processing 107
5.2.6 Household demand patterns 108
5.3 Impacts on nutrition, sustainability and mediating factors 112
5.4 Discussion: Potential areas of intervention for sustainable nutrition 115
5.5 Conclusion 119
Chapter 6. Analysing the policy space for the promotion of healthy, sustainable edible oils in India 122
6.1 Introduction 122
6.2 Context 125
6.3 Policy process and circumstance 126
6.3.1 Main institutions 126
6.3.2 Main priorities and processes driving sectoral policy 127
6.3.3 Influence of non-state actors on nutrition-related policy 129
6.3.4 Influence of non-state actors on sustainability-related policy 132
6.4 Policy characteristics 134
6.4.1 Explicit inclusion of nutrition or sustainability criteria 134
6.4.2 Distribution of impacts and costs 136
6.5 Policy instruments and goals in the sectoral portfolio: The Tinbergen principle and beyond 138
6.6 Conclusions 145
Chapter 7. Quantitative methodology in context: The use of CGE models for research on diets and nutrition 148

7.1 Introduction 148

7.2 Main characteristics, advantages and limitations of CGE applications to diet and nutrition topics: theoretical discussion 148

7.3 Search strategy, inclusion and exclusion criteria for quick review of CGE applications to nutrition 151

7.4 Results 151

7.4.1 Studies analysing the impacts of macroeconomic factors and policies on nutrition 152

7.4.2 Studies analysing the impacts of climate change on nutritional indicators.. 153

7.4.3 Models analysing the economic impacts of dietary changes 153

7.5 Discussion: CGE models for food policy; towards nutrition-sensitive analysis.. 153

7.6 Conclusion 156

Chapter 8. The Social Accounting Matrix of India and nutritional coefficients 157

8.1 Introduction 157

8.2 What is a Social Accounting Matrix? 158

8.3 Description of the India Social Accounting Matrix for 2007/08 161

8.3.1 Household food expenditure patterns in the SAM 164

8.4 SAM adaptation and disaggregation procedure 165

8.4.1 Adapting the IEG SAM for use with the IFPRI standard model 165

8.4.2 Disaggregation of the edible oils sector 166

8.5 Nutritional Coefficients 175

8.6 Summary and limitations of the data 181

Chapter 9. The CGE model structure and equations 184

9.1 Introduction 184

9.2 Impact pathways and transmission mechanisms of food policy in a multi-sector macroeconomic modelling framework 186

9.3 Model description 188

9.3.1 Production 188

9.3.2 Household income, expenditure and saving behaviour 192

9.3.3 Enterprises 196

9.3.4 Government revenue, expenditure and investment behaviour 197
9.3.5 Factor Markets 198
9.3.6 Commodity Markets 198
9.3.7 Prices.. 201
9.3.8 Model Closure and system-level constraints.. 202
9.3.9 Nutritional content and nutritional intake 203
9.3.10 Structure of the edible oil sector in the model 207
9.3.11 Calibration and parameters 210
9.4 Conclusion 219
Chapter 10. Scenarios and results: Nutritional and economic impacts of palm oil liberalisation in India 221
10.1 Introduction.. 221
10.2 Design of scenarios for policy interventions in the edible oil sector in India 222
10.2.1 Motivation and strategy for the design of policy scenarios 222
10.2.2 Design and implementation of policy shocks and sensitivity analysis 224
10.3 Nutritional outcomes... 227
10.3.1 Saturated fatty acids.. 227
10.3.2 Trans fats.. 230
10.3.3 Energy from fats and processed foods 233
10.4 Economic impacts... 235
10.4.1 Household expenditure 235
10.4.2 Government revenues 236
10.4.3 Sectoral value added 237
10.4.4 Domestic absorption 241
10.5 Summary and interpretation of results 243
Chapter 11. Summary, discussion of main findings and contributions and conclusion .. 249
11.1 Introduction.. 249
11.2 Main findings and contributions 249
11.2.1 Methodological contributions 258

11.3 Limitations and further research ... 261
11.3.1 Qualitative analysis ... 261
11.3.2 Quantitative analysis ... 262
11.4 Policy recommendations ... 265
11.5 Conclusion ... 267
References ... 268
Appendix 1: Qualitative policy analysis ... 285
A 1.1 Figures and tables ... 285
A 1.2 Interview guideline ... 299
A 1.3 Themes for analysis of interviews and documents ... 300
Appendix 2: Results from quick review: the use of CGE models in nutrition ... 302
Appendix 3: Data for modelling ... 305
A 3.1 Splitting commodity and activity accounts and disaggregating IEG Indirect Taxes based on GTAP9.1 SAM ... 305
A 3.1.1 Distributing indirect sales taxes and tariffs across commodities ... 306
A 3.1.2 Splitting each payment from institutional accounts to the indirect tax account into different producer and commodity taxes ... 308
A 3.1.3 Additional Adjustments ... 309
A 3.2 Data sources: Brief description. Access, advantages and limitations ... 316
A 3.3 Additional tables and figures ... 319
Appendix 4: Simulation results summary tables ... 334
Appendix 5: Specification and calibration of the nested demand model ... 348

Figures

Figure 1-1. Fatty Acid profiles of common fats and oils ... 22
Figure 1-2. Mixed methods research design ... 26
Figure 2-1. Conceptual framework of the relationship between globalisation, nutrition and related health outcomes ... 32
Figure 2-2 Document flow diagram ... 36
Figure 3-1 Historical tariff rates ... 65
Figure 3-2. Imports and production of edible oils in India ... 66

Figure 3-3. Average composition of Indian diets: Consumption of main food groups 67
Figure 3-4. Per capita availability for domestic food consumption in India, main food groups 67
Figure 3-5. Daily fat intake per consumer unit 2011-12. Socioeconomic gradient. 69
Figure 3-6. Availability of edible oils for consumption in India 69
Figure 3-7. Trends in consumption of vegetable oils and animal fats in India 70
Figure 3-8. Regional patterns of consumption of major edible oils in India 70
Figure 3-9.Regional consumption of animal fats in India... 71
Figure 3-10. Increased sales in packaged processed food (2012-2016)................................ 72
Figure 3-11. Pattern of processed food expenditure by household type in India 2009/2010. 72
Figure 3-12. Pattern of expenditure on processed foods in India, 2011-2012 72
Figure 4-1. Sustainable nutrition security in the Indian edible oils sector. Dimensions of interest. Simplified diagram 77
Figure 4-2. Integrated value chains and policy space analysis: Synergistic nutrition and nutrition policy interventions 78
Figure 4-3. Value chain analysis for sustainable nutrition. Theoretical framework 81
Figure 5-1. Simplified diagram showing the main steps in the supply chain for palm oil in India 92
Figure 5-2. Import dependence for edible oils 97
Figure 5-3. Edible oil imports and public distribution before liberalisation 106
Figure 6-1. Policy coordination in the edible oils sector. 128
Figure 8-1. Main steps in the disaggregation and re-balancing process 168
Figure 8-2. Consumption of animal fats and vegetable oils across household categories in our model 180
Figure 9-1. Impact pathways and transmission of food policy shocks in a multi-sector macroeconomic model. 188
Figure 9-2. Nested Production technology 192
Figure 9-3. Household nested demand structure 193
Figure 9-5. Flow of nutrients within the model. Fatty acids content and intake 203
Figure 9-6. Flow of marketed commodities in the edible oil sector commodities in the model. Simplified representation 209
Figure 10-1. SFA consumption as a response to policy interventions. CF, A, B, C, C+S1, C+S2 228
Figure 10-2. SFA intake in response to palm oil tariffs. Sensitivity analysis on key elasticity parameters 229
Figure 10-3. Changes in SFA intake in response to a 60% tariff increase. Scenario C. Sensitivity analysis on key elasticity parameters, by household category 230

Figure 10-4. Trans fat intake levels under the main tariff and subsidy scenarios. Scenarios CF, A, B, C, C+S1, C+S2. 231
Figure 10-5. Changes in trans fat consumption as a response to palm oil tariffs in the absence of effective regulation. Sccenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters 232
Figure 10-6. Changes in trans fat consumption as a response to a 60% increase in palm oil tariffs in the absence of effective regulation.Scenario C. Sensitivity analysis on key behavioural parameters 232
Figure 10-7. Changes in trans fat intake in response to a 60% increase in tariffs. Scenario C. Sensitivity analysis pre-and post- trans fat regulation. Reference elasticity values 233
Figure 10-8. Changes in daily fat intake in response to tariffs. Scenarios A, B, C. Sensitivity analysis 234
Figure 10-9. Changes in energy intake from processed foods as a result of palm oil tariffs. Scenarios CF, A, B, C, D. 234
Figure 10-10. Change in expenditure on edible oils in response to palm oil tariffs. Scenarios CF, A, B, C, D 235
Figure 10-11. Expenditure on edible oils as a proportion of total food expenditure in response to a 60% tariff increase (Scenario C) 236
Figure 10-12. Changes in government revenues in response to palm oil tariffs. Scenarios CF, A, B, C, D 237
Figure 10-13. Changes in sectoral value added as a result of changes in palm oil tariffs. Scenarios A, B, C, C+S1, C+S2 238
Figure 10-14. Changes in value added in the processed food sector in response to palm oil tariffs. Scenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters 239
Figure 10-15. Changes in value added in the PHVO industry as a result of palm oil tariffs. Scenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters 240
Figure 10-16. Changes in value added in the oilseed sector in response to palm oil tariffs. Scenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters 240
Figure 10-17. Changes in domestic absorption and components as a result of palm oil tariffs and revenue-neutral subsidies. Scenarios A, B, C, C+S1, C+S2 241
Figure 10-18. Sensitivity analysis, changes in domestic absorption as a result of palm oil tariffs. Scenario C 241
Figure A1-1 Value Chain of edible oils. Organisational Characteristics 285
Figure A1-2 Value Chain for edible oils: Policy mapping 286
Figure A1-2 Value Chain for edible oils: Policy mapping 286

Tables

Table 2-1. Inclusion criteria 38
Table 2-2. Included articles 50
Table 3-1. Average composition of Indian diets: Macronutrient intakes (1983-2011) 67
Table 4-1 Context, study characteristics and choice of value chain framework 80
Table 5-1. Scheme for public distribution of edible oils 106
Table 5-2. Value chain key characteristics and incentives 110
Table 5-3. Impacts of key characteristics on mediating variables and on nutrition and sustainability outcomes 111
Table 5-4. Potential areas of intervention for sustainable nutrition 115
Table 5-5. Key policies and corresponding documents. Policy mapping 118
Table 6-1. Policy context, process and characteristics 124
Table 6-2 Explicit inclusion of sustainable nutrition goals in current policy 135
Table 6-3. Matching policies and goals in the sectoral portfolio. The Tinbergen principle and beyond 144
Table 7-1. Search terms 151
Table 8-1. Basic SAM structure 160
Table 8-2. Macro SAM of India 161
Table 8-3 SAM structure summary table 164
Table 8-4. Household expenditure on main food groups 165
Table 8-5. Imports and exports from the edible oils sector in India (2007/08). Value shares 169
Table 8-6. Edible oil inputs into food processing 170
Table 8-7. Household consumption expenditure shares 171
Table 8-8. Household direct expenditure on edible oils 172
Table 8-9. Domestic production of edible oils and oil cake, value shares 174
Table 8-10. Oilseed Crush. Physical quantities. 2007/08 175
Table 8-11 Contribution of major food groups to nutrient intakes (grams) 177
Table 8-12 Contribution of major food groups to daily KCal intake across household categories 177
Table 9-1. Key points. Model description 185
Table 9-2. Elasticity parameters for model calibration 211
Table 9-3. elasticity parameters for input demand from food processing industry 214
Table 9-4 Elasticity parameters for consumer demand. Reference case 215
Table 9-5. Elasticity parameters for consumer demand. Sensitivity analysis 216
Table 9-6. Elasticity parameters for consumer demand. Sensitivity analysis 217

Table 10-1. Summary of policy scenarios 226
Table 10-2. Parameters for sensitivity analysis... 227
Table 10-3. Results Summary table (C), (C+S1) 248
Table 11-1. Methodological contributions... 258
Table A1-1 Policy documents... 287
Table A1-2 Value chain for edible oils: Policy mapping... 288
Table A1-3 Framing sustainability and nutrition outcomes in the edible oils sector: Dimensions of Sustainable Nutrition Security.. 289
Table A1-4 Actors.. 291
Table A1-5 Document search. For typology of documents see Mogalakwe 2006 297
Table A2-1 The use of CGE models in nutrition. Results from quick review..................... 302
Table A3-1 Correspondence table IEG, ASI/NIC2004 input output classification NSSO .. 311
Table A3-2 SAM classification 312
Table A3-3 Correspondence table NSSO SAM ASICC04 314
Table A3-4 Data sources and use summary table. 319
Table A3-5 SAM sectors and correspondence.. 322
Table A3-6 Correspondence between SAM edible oil commodities and HS commodity codes, as used by the Government of India Export and Import Data Bank 325
Table A3-7 Nutritional Coefficients 327
Table A3-8 Shares for household disaggregation 331
Table A3-9 Adjusted nutritional weights. Nutritional weights per INR in baseline............ 333
Table A4-1 Changes in palm oil tariffs. Scenario (A), 20% reduction (tariff removal), Scenario (B) 25% increase with respect to baseline (ASEAN limit)... 334
Table A4-2 Results summary. Scenarios (C), (C + S2), 60% increase in palm oil tariffs (Historical levels); 60% increase and revenue-neutral subside on soybean......................... 335
Table A4-3 Results summary. Scenarios (C), (C + S1), 60% increase in palm oil tariffs (Historical levels); 60% increase and revenue-neutral subside on soybean......................... 336
Table A4-4 Sensitivity analysis Scenario (C): 60%increase in palm oil tariffs (Historical levels): Elasticity EFP, EVP=reference, EHD= High... 337
Table A4-5 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP = low, EHD = high.. 338
Table A4-6 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP = high, EHD = low.. 339
Table A4-7 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP, EHD = low... 340
Table A4-8 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD = High, EVP = low... 341

Table A4-9 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP=reference, EHD=high. 342
Table A4-10 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD=reference, EVP=high. 343
Table A4-11 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); elasticity EVP, EHD=reference, EFP=high 344
Table A4-12 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels) Elasticity EFP, EVP = reference, EHD = low 345
Table A4-13 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD = reference, EVP = low 346
Table A4-14 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EVP, EHD = reference, EFP = low 347

Boxes

Box 2-1 Search Strategy 57
Box 3-1 Simplified timeline. Edible oil policy in India 64
Box 5-2.. The links between trans fat, and palm oil in India 102
Box 10-1. Key findings 243
Box 11-1. Policy recommendations 265

Chapter 1. Introduction

1.1 Introduction

Traditionally considered a problem of Western societies, the burden of Non-Communicable Diseases (NCD) has greatly increased in low and middle income countries, which already account for more than 80% of deaths from NCD worldwide (Alwan, 2011).

Additionally, in many of these countries, due to the lack of resources and health care infrastructures, deaths from NCD occur at a younger age, contributing to high disease burdens. Among all NCD, cardiovascular disease is the largest contributor to premature deaths. In India, cardiovascular disease mortality among those aged 30 to 59 is twice that of the USA (Narain et al., 2011).

The World Health Organization, identifies unhealthy diets amongst the main risk factors contributing to NCD (Alwan, 2011), alongside others including tobacco and alcohol consumption or sedentary lifestyles.

India, in particular, is experimenting a fast and unequal nutrition transition, with rapidly changing food environments, associated to a wider process of trade liberalisation, urbanization and demographic change (Popkin, 2003), (Popkin, 2006a). Increased prevalence of overnutrition and NCD, however, coexist with a persistent problem of stunting and undernutrition (Meenakshi, 2016), (Kumar 2017). Food policy interventions, therefore, increasingly have to balance food security concerns with concerns about growing burdens of diet-related chronic disease (Thow et al. 2016). (Panda and Ganesh-Kumar, 2009), for example, estimated that reduction of tariffs across the main economic sectors as proposed in the Doha round of trade negotiations was associated to increases in fat consumption across socioeconomic groups, even as calorie and protein intakes fell for the poorest households.

The transition to a "Westernized" diet in developing countries is usually accompanied with rapid increases in the consumption of vegetable edible oils, rather than in animal fat consumption (Popkin, 2003). In the case of India, following the liberalisation of the edible oils sector in 1994, consumption of imported oils rose rapidly. In particular, the consumption of palm oil, which is not used in traditional Indian cooking, went from practically zero to almost 10 million tonnes (USDA, psd). This makes India the largest importer worldwide and the second largest consumer, only after Indonesia.

Edible oil consumption in India has experienced an increase of around 75% over the last ten years. Imported oils (mainly palm and soybean) currently make up around

70% of available edible oil, compared to around 33% in 2005/06 (USDA, psd), (4th Advance Estimates (dated 17.08.2015), Ministry of Agriculture, DGCIS).

Other dietary changes include increases in energy consumption from milk products, sugar, salt, highly processed foods and foods consumed out of the house (Popkin, 2003), (Vepa, 2004), (Misra et al. 2011), (Kumar, 2017).

From a nutritional point of view, palm oil is an affordable source of calories, but is also high in saturated fats compared to the oils traditionally consumed in Indian diets (Downs, 2014). Saturated fats (as well as trans fats) have been linked to increased risk of cardiovascular disease (Mensink et al., 2003), (Micha and Mozaffarian, 2010), (Sun et al., 2015).

The picture is further complicated if we consider sustainability concerns. Given India's position as a global import leader, the dynamics in the palm oil sector in India can have important environmental implications in the supplying countries, mainly Malaysia and Indonesia (Schleifer, 2016). Moreover, sustainability and climate adaptation concerns are also relevant in the domestic oilseed sector (Jha et al., 2012), which is vulnerable to changes in temperature and rainfall (Mall et al., 2006).

This thesis focusses on the Indian edible oil markets, adopting a national scope. Environmental sustainability is not the main focus of our study, and our quantitative analysis focusses exclusively on nutritional and economic aspects. However, we address the interaction between nutrition and environmental priorities in the palm oil sector in our qualitative analysis, from a sustainable nutrition security approach (Gustafson et al., 2016).

Using a qualitative value chains approach (Hawkes, 2009), Downs et al. (2014a), (2015) analyse supply side policies to support the consumption of healthier oils in India. These studies find that long-term improvements in the quality of oil consumed would require investment and supply-side (mainly agricultural) interventions to address constraints to domestic production, reducing import dependence. Downs et al. (2014a), (2015) focus on domestic oils, as a replacement to palm oil, but do not specifically address palm oil value chains or related sustainability issues. We address this gap in the literature by focussing on palm oil, in the wider context of the edible oils sector, while also assessing introducing sustainability into the analysis, as a fundamental challenge in palm oil value chains.

Additionally, we analyse the policy space (Grindle and Thomas, 1991), (Thow et al., 2016) for the promotion of sustainable, healthy oil consumption in India. This analysis attempts to explain how the space for intervention is shaped by the policy context, sectoral policy processes or agenda-setting circumstances, as well as the characteristics of key current policy interventions in the edible oils sector.

Basu et al. (2013) estimated the health the impact of a proposed 20% tax on palm oil. The authors report that this tax could lead to modest reductions in saturated fat intakes, avoiding up to 421 000 from cardiovascular disease. However, this study does not consider the potential economic impacts of this tax (which would fall mainly on imports, given that palm oil is mainly an imported commodity) on related productive sectors or at an aggregate level. Using a multi-sectoral macroeconomic model, we incorporate economic impacts of taxation, both at an aggregate level and on specific sectors. Moreover, Basu et al. (2013) focus on household demand for cooking oil, while our approach allows us to consider palm oil use in food processing as well as direct household consumption. In this sense, our results complement the findings from the latter study, highlighting additional transmission mechanisms and potential side-effects of palm oil import policy. Given the difference in approaches, however, our results are not directly comparable to those of Basu et al. (2013).

The rest of the introduction is structured as follows: Sections 1.2 and 1.3 briefly outline the evidence and current debates around the health impacts of fatty acid consumption and the characteristics of palm oil as a commodity. This serves the purpose of framing our topic of study within the wider literature and related debates. Section 1.4 summarizes the aim and objectives of this thesis. Section 1.5 discusses our mixed-methods research design and Section 1.6 outlines the structure of the thesis.

1.2 The health impacts of fatty acid consumption. Scientific evidence

1.2.1 The health impacts of fatty acid consumption: Scientific evidence

The main sources of saturated fatty acid (SFA) consumption in the diet are animal source products (meat, dairy) and vegetable oils. Palm oil has one of the highest contents in saturated fats among vegetable oils and fats (Figure 1-1).

Since the late sixties, multiple studies have found an association between intakes of saturated fatty acids and biomarkers for cardiovascular disease or related health outcomes (Keys and Parlin, 1966), (Mensink and Katan 1990), (Mensink and Katan, 1992), (Wang et al., 2016) including some studies in the Indian context (Singh et al., 1996), (Ghosh, 2007). Negative associations with health outcomes or biomarkers have also been found for palm oil specifically (Uusitalo et al. 1996), (Vega-López et al., 2006), (Micha and Mozaffarian, 2010), (Chen et al. 2011) (country-level associations), (Sun et al., 2015).

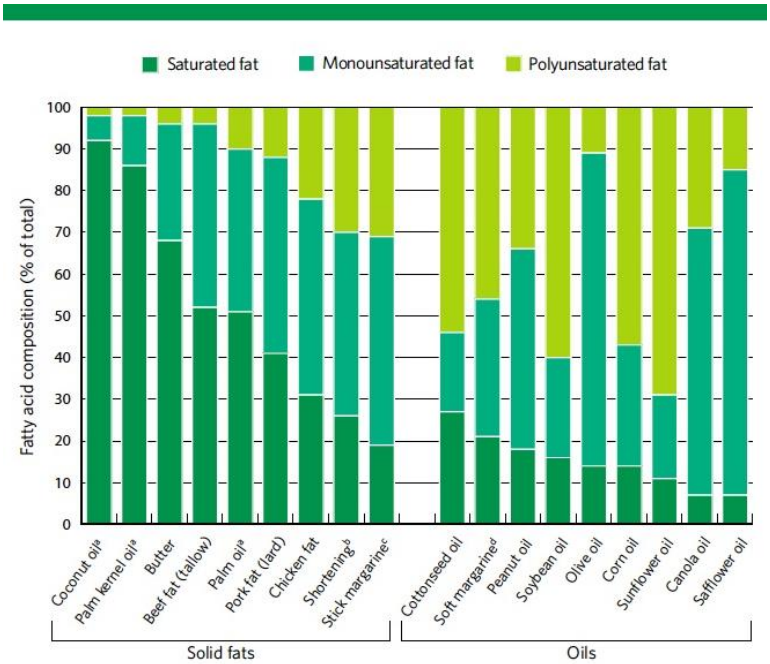
The consensus around the health impacts of SFA has been reflected in the World Health Organization Status Report on Non Communicable Diseases (Alwan, 2011), as well as in dietary recommendations provided by the WHO, the USDA in the US (USDA, 2010) and NHS in UK (NHS, 2016).

However, this evidence has been recently questioned by some, leading to an ongoing controversy. Based on current evidence, experts have argued for a shift from total levels of SFA towards replacement of SFA for unsaturated fatty acids, or have recommended an increased focus on specific fatty acids (Mensink et al., 2003), Mozaffarian (2011).

Low levels of trans fatty acids (TFA) appear naturally in products of animal origin, such as milk. They also appear in vegetable oils that are artificially partially hydrogenated (PHVO) to produce more solid, thermally stable fats which are used in cooking and industrial processing (Lefevre et al., 2012). Trans fats have been found to have negative health effects at any level of consumption (Mensink et al., 2003). They increase both total serum cholesterol and total/HDL cholesterol ratio, leading to higher rates of cardiovascular disease.

In this study we adopt the established consensus and focus on saturated and trans fatty acids, highlighting substitution across saturated and unsaturated fatty acids.

Figure 1-1. Fatty Acid profiles of common fats and oils



Source: USDA Dietary Guidelines for Americans (USDA, 2010).

1.2.2 The saturated fat debate: influence of vested interests

The controversy around saturated fat cannot be understood purely as a scientific debate. As consumers in western countries shifted away from animal fat consumption and became increasingly aware of the health effects of vegetable oils, the producers of major edible oils and, to a certain extent, the corresponding governments, became engaged in a battle for the public's opinion. The origins of this "battle" can be traced back to 1986, when the American Soybean Association (ASA) and the Malaysian Palm oil Council (MPOC) mounted respective campaigns to publicise the negative impacts of their competitors' product (the ASA focussing on saturated fat, while the MPOC focussed on trans fat, since soybean oil was frequently hydrogenated (Sims, 1998)). Since 1990, the oil industry switched towards the promotion of the health impacts of their own products. The MPOC has recently focussed on highlighting the existing controversy around SFA (MPOC, n.d.), while promoting palm oil as a non-GMO alternative (Danielson, 2015). The promotion efforts of the ASA, on the other hand, have been somewhat constrained, at least within the US, by the approval of more stringent regulation on health claims (Caswell et al., 2003). The FDA, however, recently approved the health claims about soybean oil and cardiovascular health, in a move that was celebrated by the ASA (ASA, 2017).

In addition to the efforts to influence public opinion through marketing and dietary recommendations, producer associations have funded research on nutrition and health impacts of edible oils. For example, Fattore et al. (2014) carried out a systematic review of the evidence on palm oil impacts on blood lipid-related biomarkers of cardiovascular health. The authors report that 19 out of 50 studies were conducted with the support of the Malaysian Palm Oil Board and another 12 had funding from various private companies, with funding source having a significant impact on findings.

Although a thorough analysis of the influence of industry involvement in research is beyond the scope of our study, it is worth taking into account the political dimension and the potential influence of vested interests in the debate.

1.3 Main characteristics of palm oil as a global commodity

Oil palm (*Eleais Guineensis*) is a perennial tree crop whose fruits produce a dense edible oil, whose derived products have multiple food and industrial uses. Palm oil is a highly profitable although controversial product, often viewed with suspicion by consumers, and is frequently the subject of opposition from social actors (Alonso-Fradejas et al., 2016).

Oil palm grows almost exclusively on tropical humid low-lands, coinciding with the zone of adaptation of tropical forests and peatland, which are crucial environmental resources, both in terms of biodiversity and as carbon sinks (Byerlee et al., 2017). The main global producing countries, Malaysia and Indonesia, have experienced rapid processes of deforestation, in a context influenced by post-colonial conflicts over land tenure (McCarthy and Cramb, 2009).

In these countries, the expansion of oil palm plantations has been linked to large-scale deforestation (Agus et al., 2013), (Carlson et al., 2013) as well as peat-land fires, although the precise figures and the extent to which environmental degradation and forest fires can be directly or indirectly attributed to palm oil remain contested.

The yield per hectare of oil palm is higher than other major oils, making it a highly profitable crop (Byerlee et al., 2017). National governments in Malaysia and Indonesia, along with the World Bank, have promoted oil palm to foster agricultural growth and development (McCarthy and Cramb, 2009). Additionally, some studies have estimated that, thanks to the higher yields, a shift from soybean production to palm oil could reduce global deforestation (Lapola et al., 2010). However, others have argued that yield increases tend to attract investment, and can reduce the profitability of forest uses with respect to agriculture, encouraging deforestation (Villoria et al., 2013).

Area expansion, rather than yield improvements, has been the main driver of increased global output of palm oil. The establishment of a new commercially viable plantation, however, requires large up-front investment, which is not accessible to small-holders or peasant farmers (Byerlee et al., 2017). In order to face the barriers posed by these initial costs, and create the necessary economies of scale, oil palm development has generally resorted either to direct state investment or, since the 1980s, to corporate investment. The efforts to provide incentives for private investors have historically led to land-grabbing. Even in the cases when some form of small-holder ownership has been retained, farmers have often been locked into disadvantageous contracts with millers, creating a situation of effective monopsony, or demand-side monopoly (McCarthy and Cramb, 2009). In the discourse of social actors (and occasionally foreign state actors), these features have made oil palm a synonym for the commercialization and financialization of agriculture, and the shift towards export-oriented cash-crop monocultures.

Palm oil has multiple uses, including as an affordable cooking oil, an ingredient in processed products, a chemical product or, increasingly, a cheap biofuel (Byerlee et al., 2017). A small amount of oil is extracted from the fruit kernel, generally used for industrial purposes. In this thesis we focus on food uses of palm oil, which represent the main use in India.

Highly visible global consumer brands are directly involved and invested in all the segments and stages of production, from the supply of inputs into palm plantation to processing and branding of consumer goods (Borras Jr et al., 2016), (Cramb and McCarthy, 2016). These consumer brands provide a visible target for campaigners seeking to exert pressure through consumer awareness (Alonso-Fradejas et al., 2016).

Perhaps for this reason, international efforts towards improved sustainability have been driven to a large extent in the form of private industry standards, agreed in the context of a multi-stakeholder platform including industry and social actors, which is known as the Roundtable on Sustainable Palm oil (RSPO) (RSPO, 2013).

Relevance to this study

Although our study is restricted to India, and the focus of our quantitative analysis is on nutrition outcomes, the global environmental dimensions of palm oil cannot be ignored when discussing policy options for the major global importer. In our study, sustainability aspects are considered as a dimension of sustainable nutrition security, in terms of their interaction with nutrition and food-security policy options in the context of sectoral policy space. We mainly focus on the incentives to reduce reliance on unsustainable imports, either through a switch towards imports of sustainable certified palm oil or overall reductions in imports and substitution towards potentially more sustainable domestic products. Other methodologies would be required to fully assess global dimensions, including multi-country modelling or the use of a global value chains/global production networks framework (Gereffi, 2001).

1.4 Aim and objectives of the study

The main aim of this study is to analyse the role of palm oil in the Indian food systems following liberalisation of the edible oils sector and prospectively assess potential policy interventions aimed at promoting healthy, sustainable oil consumption in India.

Specific objectives of this thesis are:

1. To critically review the literature on the links between trade liberalisation and nutrition from an international perspective, before discussing the case of India.
2. To qualitatively analyse the main characteristics and incentives in the Indian palm oil value chain as they affect key nutrition and sustainability outcomes and identify potential areas for intervention to address sustainable nutrition challenges.
3. To analyse the policy space for the promotion of sustainable, healthy oil consumption in the sector, highlighting barriers and opportunities for synergistic intervention.
4. To quantitatively analyse the economic and nutritional impacts of tariff changes on palm oil using a multi-sectoral static CGE model of India.

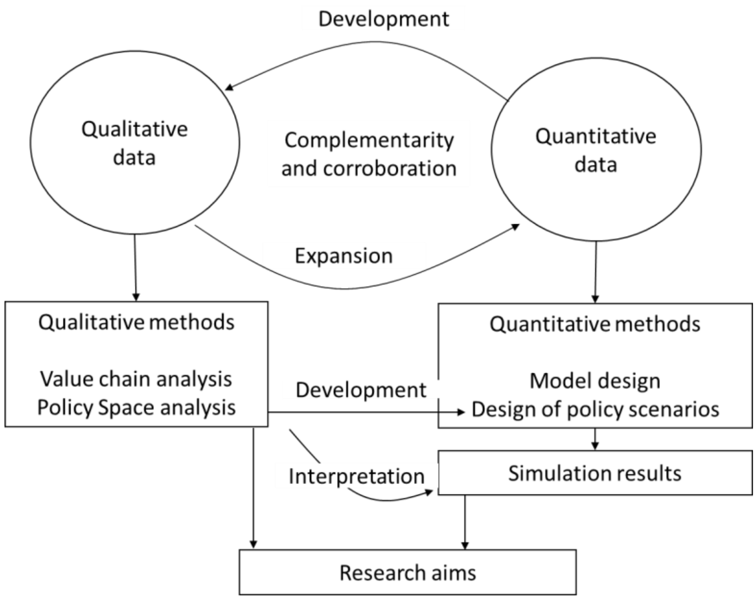
Our focus, therefore, is not so much on liberalisation as a causal factor, but on the analysis of policy options to address challenges which are partly raised by liberalisation, in a context that is shaped by this same process.

1.5 Mixed-methods research strategy

Greene et al. (1989) identify five main purposes for mixed-methods research: triangulation or corroboration, complementarity (in terms of enhancement or clarification of understanding), initiation or re-framing of a research question, development (in the sense that qualitative research and data can inform the development of quantitative methods and vice-versa) and expansion of the research scope.

Johnson and Onwuegbuzie (2004) single out complementarity as a *"fundamental principle"* of mixed methods research, but highlight pragmatism, flexibility and creativity as the defining features in the mixed-methods research process. Following Johnson and Onwuegbuzie (2004), we have pragmatically chosen the combination of methods that would best contribute to answering our research question. The figure below illustrates how the qualitative and quantitative parts of this thesis complement and feed into each other. We have attempted to keep the figure descriptive and simple, while differentiating the major functions identified by Greene et al. (1989).

Figure 1-2. Mixed methods research design



In the first place, quantitative and qualitative data are compared for corroboration and triangulation. In addition, quantitative data helped understand the context and evolution of the oils sector and supported the development of the qualitative data collection. At the same time, qualitative data expand the scope of quantitative analysis, allowing us to incorporate dimensions of sustainability and interpret quantitative data. Moreover, qualitative research supported the design of policy scenarios and the interpretation of simulation results. Both quantitative and qualitative research contribute to answering our research questions, however, and we do not consider a hierarchy of methods.

1.6 Structure of the thesis

This thesis is structured as follows:

Chapter 1 has justified the interest of the study, set the context and specified our aims and objectives.

In Chapter 2 we review the quantitative evidence on the impacts of trade and investment liberalisation on nutrition outcomes, setting our study within the broader debate around the role of economic globalisation as a driver of the nutrition transition (Popkin, 2006a). We use a methodology for "rigorous review" (Hagen-Zanker and Mallett, 2013), which maintains transparency and unbiasedness in the review process while allowing for the flexibility and critical interpretation required in the context of social science. We include only ex-post statistical analysis, given that our focus here is on the trends and empirical associations between relevant variables, and not on the methodology of the studies.

Chapter 3 provides a brief historical overview of trade liberalisation in the Indian agricultural and food sector, with emphasis on the oils sector. It also provides a description of dietary patterns and the nutrition transition in India.

Chapters 4 to 6 include the qualitative part of the analysis, describing respectively the methods, value chain and policy space analysis. The final section in Chapter 6 provides a more normative discussion of the sectoral policy portfolio, combining concepts from the seminal work of Tinbergen (1952) and more recent contributions to the area of the analysis of complex policy mixes (Del Rio and Howlett, 2013).

Chapter 7 provides a quick review and discussion of CGE models applied to nutrition, setting our quantitative methodology in context.

Chapters 8 to 10 include the quantitative part of the analysis, describing the SAM database, model equations policy scenarios and results.

Chapter 11 summarizes the main findings and contributions, policy implications and limitations and concludes.

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
www.lshtm.ac.uk

Registry
T: +44(0)20 7299 4646
F: +44(0)20 7299 4656
E: registry@lshtm.ac.uk

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Soledad Cuevas Garcia-Dorado
Principal Supervisor	Marcus Keogh-Brown
Thesis Title	The nutritional and economic effects of palm oil trade liberalisation in India: A policy analysis

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
When was the work published?			
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*		Was the work subject to academic peer review?	

**If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.*

SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Food Policy
Please list the paper's authors in the intended authorship order:	Soledad Cuevas, Laura Cornelsen, Richard Smith, Helen Walls
Stage of publication	Under review

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	SC is the main contributor and has carried out the review and written the manuscript.LC and HW have assisted in screening the articles for inclusion. All authors have contributed to the design of the review and to the final manuscript.

Student Signature: [redacted] **Date:** 20/May/2018

Supervisor Signature: [redacted] **Date:** 25/05/2018

Chapter 2. Economic globalisation, nutrition and health: evidence from the literature

Soledad Cuevas[1 2], Laura Cornselsen[1 2], Richard Smith[1 2], Helen Walls[1 2]

[1] London School of Hygiene and Tropical Medicine, Department of Global Health and Development, Tavistock Place, London, WC1H 9SH, United Kingdom.

[2] Leverhulme Centre for Integrate Research on Agriculture and Health, 36 Gordon Square, London WC1H 0PD, United Kingdom.

*Corresponding author: soledad.cuevas@lshtm.ac.uk

Key words
Globalisation, trade liberalisation, FDI, nutrition transition.

2.1 Introduction

International trade as a proportion of GDP has almost doubled since the beginning of the 1970s, and now represents almost 60% of world GDP (World Bank, accessed 03/2017). This increased exchange of goods and services has occurred as part of a wider process of globalisation, encompassing inter-related economic, social and cultural components (Labonté and Schrecker, 2007). Trade policies and globalisation processes are significantly transforming societies, affecting political institutions, economic and social relationships, modes of production, consumption patterns and lifestyles. These structural factors are increasingly recognized as important drivers of nutrition and health outcomes (Labonte et al., 2011), (Blouin et al., 2009). In particular, trade reforms and liberalisation have often been linked to both under-nutrition and the rapid rise in overweight and obesity and spread of diet-related non-communicable diseases (NCD) in low- and middle-income countries (LMICs) (Hawkes 2006), (Popkin, 2006b). Traditionally considered a problem of high-income countries, the burden of overweight, obesity and diet-related NCDs has greatly increased in LMICs, which already account for more than 80% of deaths from NCD worldwide (Alwan, 2011). Increased prevalence of overweight, obesity and NCD, however, often coexists with persistent undernutrition, leading to what is known as a "double burden of malnutrition" (Wahlqvist, 2006).

Debate on the links between trade liberalisation and nutrition can be traced back to the controversial implementation of structural adjustment programmes by the World Bank and IMF in the 1980s (Panagariya, 2002), (Thomas, 2006) . Following the international food crisis in 2008 and in the context of the growing obesity "epidemic", however, this issue has gained renewed attention from researchers and policy-makers. This has led to the recent surge of publications that approach the issue, and increasingly so from different angles, providing new and updated evidence on the subject.

Several recent reviews have mapped the pathways between trade agreements and food-related aspects of public health, including those related to food environments (Friel et al. 2013), and the nutrition transition (Thow, 2009). Studies have synthesized existing evidence of the impacts of agricultural trade liberalisation on food security in LMICs (McCorriston et al. 2013), and analysed the effect of trade and investment liberalisation in non-communicable disease prevalence in Asia (Phillip Baker et al., 2014). There is a wide variation in terms of quality and design of the studies included in these reviews, ranging from case-studies to quantitative multi-country and natural experimental designs. In addition, Barlow et al. (2017) recently published a more general review of quantitative studies analysing the impact of regional trade agreements on major health risk factors and outcomes, including some evidence on nutrition-related outcomes.

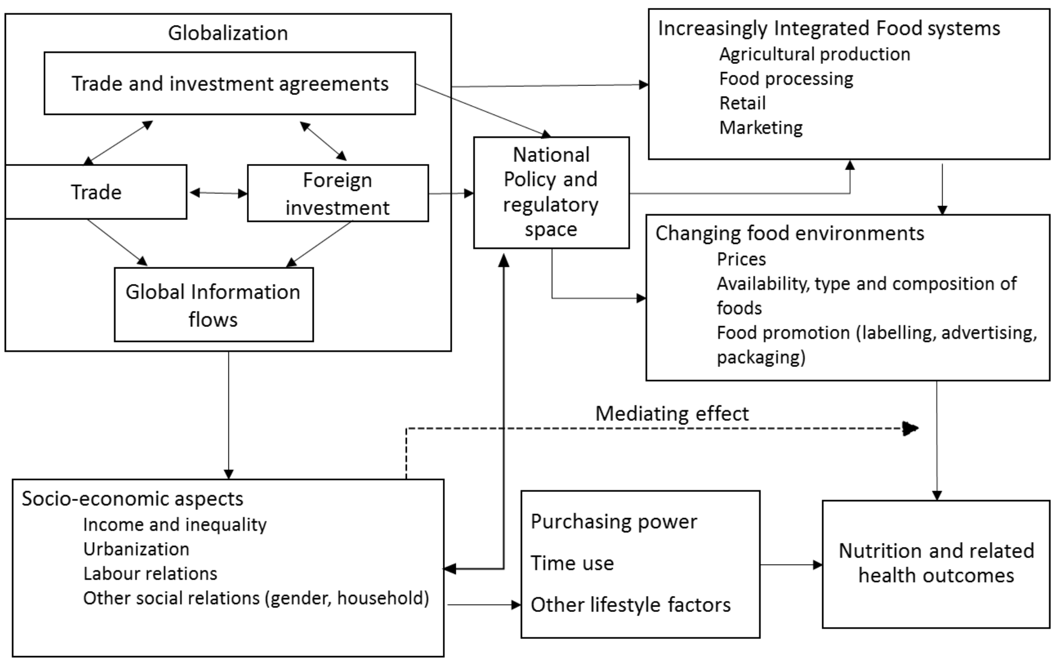
To our knowledge, however, no-one has systematically analysed and synthesized the empirical evidence on the associations between economic globalisation and liberalisation processes and nutrition outcomes. This review complements the existing evidence, through the use of a 'rigorous review' methodology as proposed by Hagen-Zanker and Mallett (2013) to undertake analysis of studies quantifying the relationship between economic globalisation and nutritional outcomes including under and overnutrition and incorporating new, relevant evidence not covered by previous reviews. The specific focus on malnutrition in all its forms is in line with recent literature calling for integrated approaches to address the growing double-burden of malnutrition (Thow et al., 2016), (Walls et al., 2016). This approach allows us also to explore evidence of the overlapping processes of dietary convergence-divergence that take place as food systems become increasingly integrated (Hawkes 2006).

2.2 Theoretical framework

Jenkins (2004) describes globalisation as "a process of greater integration within the world economy, through movements of goods and services, capital, technology and (to a lesser extent) labour, which leads increasingly to economic decisions being influenced by global conditions" (Jenkins, 2004). This definition focuses on economic globalisation, concerned with changes taking place to world trade and investment, but adopting the view that economic forces underlie and shape the overall globalisation process, connecting what are sometimes described as different aspects of globalisation, including socio-cultural changes and information flows (Labonté and Schrecker, 2007).

We have developed a framework, shown in Figure 2-1, to conceptualise the relationships between globalisation, nutrition and related health outcomes. The framework, informed by existing theoretical works and published conceptual frameworks, ((Woodward et al., 2001), (C. Hawkes, 2006) (Blouin et al., 2009), (Labonté and Schrecker, 2007), (Friel et al. 2013) , includes the main sub-components of globalisation and the trade and investment policies underpinning the process. It depicts the impact of globalisation processes on nutrition outcomes as linked through changes in food systems and food environments, as well as through impacts on national policy and regulatory space, and through the transformation of broader socio-economic factors. Socio-economic factors also play an important role as mediators of the effect of food environment changes, resulting in heterogeneous effects across population sub-groups. Before proceeding to a description of the method used and our study findings, we will briefly describe each of the domains in Figure 2-1, as they relate to the wider framework.

Figure 2-1. Conceptual framework of the relationship between globalisation, nutrition and related health outcomes



Source: Synthesised based on the frameworks of (S. Friel et al., 2013), (Labonté and Schrecker, 2007), (McCorriston et al., 2013)

2.2.1 International trade and food environments

This pathway is shown at the top and to the right in our conceptual framework. The creation of a global market for food products has important effects on the availability and prices of food commodities. On the production side, global markets encourage specialization in export crops, which tends to create economies of scale in agricultural and food production, leading to increased global output, but also to homogenization in the availability of food products (Popkin, 2006b), (Ogundari and Ito, 2015), (Khoury et al., 2014). On the demand side, countries can increase their access to a variety of goods through imports, including essential foodstuffs (Haggblade, 2008) and healthy foods (Huang, 2004) as well as potentially unhealthy processed and ultra-processed products (Thow et al., 2010), (Baker et al., 2016). The relationship between international trade and food prices is complex. Access to international commodity markets can reduce food price volatility by diminishing the effect of local shocks. However, it increases the exposure to global demand instability, as well as to volatility in the "terms of trade" for highly specialized countries (Jacks et al., 2011). On average, trade openness has been found to lower the relative price of calorie-dense foods and animal feed (Drewnowski et al., 2010).

2.2.2 Foreign direct investment in agriculture, food processing and retail

Foreign direct investment (FDI) is also thought to play an important role in transforming food systems. It is FDI, rather than trade, that is considered to be the currently preferred method for Transnational Food Companies (TFC) to enter new markets for processed foods, allowing multinationals to advertise and market their products more efficiently, creating a demand while, simultaneously, adapting to consumer characteristics (Stuckler and Nestle, 2012) .

Both FDI and advertising are also thought to lead to indirect effects on nutrition; increasing competition among local firms and increasing the demand not only for the marketed brand, but for the whole category, be it snacks, ice-cream or "diet" and "wellness" products (C. Hawkes, 2006). Additionally, retail and marketing strategies contribute to market segmentation, which is believed to lead to a divergence in dietary patterns within countries, even as diets converge across countries. (C. Hawkes, 2006), (Dixon et al., 2007), (Monteiro et al., 2010).

2.2.3 Global flows of information

Increased global flows of information can transform cultural norms, social relations, and consumption patterns. The spread of communication technology and infrastructure makes it possible for information to be shared more widely and faster, but it does not in itself explain the content, influence and directionality of the information exchange. These are thought to be driven by economic forces operating through the expansion of large multinationals in media, communications and marketing (McChesney and Schiller, 2003). The globalisation of marketing and promotion, aided by the expansion of TFC and global marketing companies, are thought to play an important role in the integration of food markets, changing consumption patterns, and creation of a demand for new products and brands (Hawkes 2002).

2.2.4 Policy and regulatory space

The creation of progressively integrated global markets is underpinned by trade and investment agreements and policies. The WTO remains the main international organization responsible for the global rules of trade between countries.1 Since the early 1990s however, an increasing number of regional and bilateral trade agreements have been negotiated outside of the WTO system.[2] These agreements frequently reflect power imbalances between participating countries, can be heavily influenced by the interests of multinational companies and can have deep impacts on domestic policy (Baldwin, 2011), (Walls et al., 2015). The inclusion of mechanisms for investor-state dispute settlement, whereby companies can directly sue states, is an example of the new ways in which this "new generation" of agreements can reduce the capacity of governments to implement health-oriented regulation that might lead to reduced profits for foreign investors (Phillip Baker et al., 2014), (Sharon Friel et al., 2013), (Walls et al., 2017). Some authors have specifically argued that trade and investment agreements can negatively affect nutritional outcomes by directly reducing the regulatory and policy space for health-promoting initiatives (Thow et al., 2015) (Walls et al., 2017).

2.2.5 Interaction with socioeconomic drivers of nutrition

Market integration and trade and investment agreements not only affect nutrition outcomes through their impacts on the food sector. Globalisation processes deeply transform all aspects of society, in ways which can indirectly affect nutrition outcomes. Globalisation has been found to be associated with GDP and income growth (Berg and Krueger, 2003) (Dreher, 2006), but also to increased income inequality (Dreher and Gaston, 2008), as well as to (Kanbur, 2015) urbanization (Tiffen, 2003), (Aide and Grau, 2004). According to some authors, globalisation has also been associated with a deterioration in labour standards and conditions (Singh and Zammit, 2004), coupled with a transition towards sedentary and "knowledge-based" work (Huneault et al., 2011) while, for others, integration in the global economy increases the returns to labour, encouraging larger investments in health (de Soysa and de Soysa, 2017). Although some mechanisms are better understood than others,

[1] https://www.wto.org/

[2] For more detailed information see the WTO register of regional and bilateral trade agreements as notified to the organization https://www.wto.org/english/tratop_e/region_e/regfac_e.htm

all of these structural socioeconomic changes have been linked to changes in dietary patterns and should be taken into account when assessing the links between globalisation and nutrition outcomes.

2.3 Methods

2.3.1 Methodological approach

Systematic review methods have recently been subject to criticism regarding their inflexible application to social sciences. Critics have pointed out the considerable degree of subjectivity in the interpretation, definition and use of concepts in social sciences, as well as the importance of context, which is often ignored in traditional systematic reviews (Mallett et al., 2012)(Hagen-Zanker and Mallett, 2013). Similar arguments have been made specifically concerning reviews in public health (O'Mara-Eves et al., 2014), ((Wong et al., 2013). Considering this, we undertook a 'rigorous review', following the core principles listed in Hagen-Zanker and Mallet (Hagen-Zanker and Mallett, 2013) as guidance on conducting rigorous, evidence focused literature reviews in international development. Thus, we adhered to the principles of rigour, transparency and replicability at the core of the systematic literature review process, but followed a process that also allows for flexibility and reflexivity (Hagen-Zanker and Mallett, 2013). Importantly, in our analysis we acknowledge the subjectivity of concepts and thus emphasise the importance of context in the interpretation of the studies and their significance for policy-making. Furthermore, our focus on "how" social change works, rather than on "what" the impact of any policy or process is.

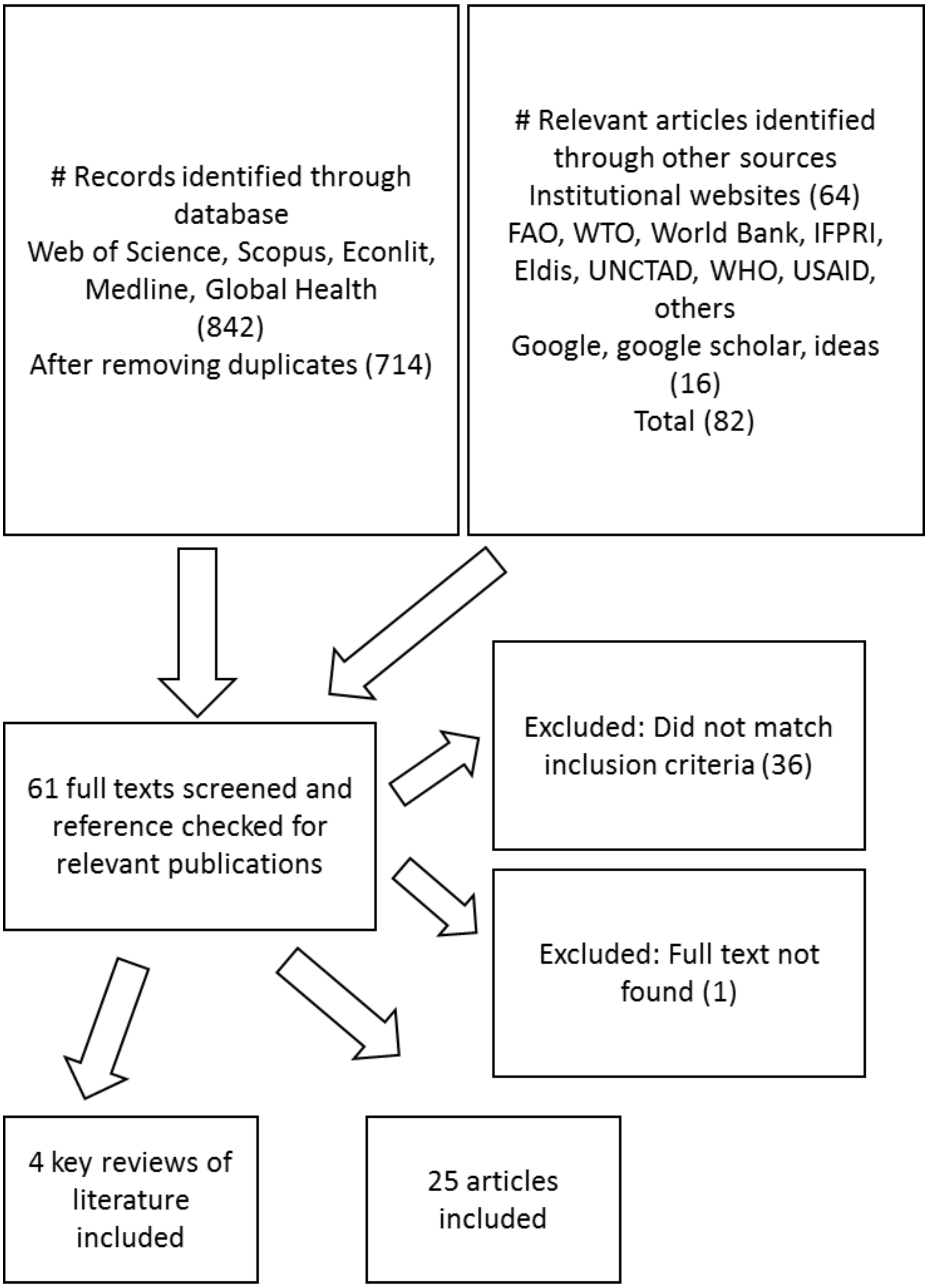
2.3.2 Search

We searched for studies containing terms related to economic globalisation, trade and investment liberalisation, food and food environments, and nutrition and related health outcomes as well as terms related to quantitative research methods. We conducted this search in five databases (Web of Science, Scopus, Global Health, EconLit and MEDLINE) and several institutional websites, including WHO, WTO, UNCTAD, IFPRI and USAID. We complemented this with a general search on Google and Google Scholar. Searches were carried out in March-2017. We checked the reference lists of articles selected for full text review for further relevant publications.

The references were screened by two authors and any disagreements were resolved through discussion. In the first round of screening, potentially relevant articles were selected based on the general focus of the study as judged by the title and abstract. In the second round, relevant references were screened based on inclusion criteria, described in Table 2-1

Figure 2.2 shows the document flow and the number of references retrieved in the different stages of the search and screening process. The search strategy shown in Box 2.1 at the end of the chapter.

Figure 2-2 Document flow diagram



2.3.3 Inclusion criteria

Detailed explanation of inclusion criteria is provided in Table 2-1. The criteria take into account the overall focus of the paper, methods, definition of globalisation and nutrition outcomes, and the year and language of the publication.

Table 2-1. Inclusion criteria

Focus
Includes: Studies that retrospectively analyse the impacts of economic globalisation processes on nutrition and related health outcomes, both in high, medium and low income countries.
Methods
Includes: Quantitative, empirical studies that analyse associations between economic globalisation and nutrition and related health outcomes (e.g. multi-country regression analysis controlling for covariates or country heterogeneity, multi-level regression, quasi-experimental designs, time series analysis).
Excludes: Prospective simulation-based analysis, qualitative studies, studies that use quantitative information descriptively, without statistical analysis.
Outcomes
Includes: Diet-related health outcomes (e.g. diabetes, CVD). Measures and proxies for nutrition outcomes (e.g. anthropometric measurements, body mass index, food and nutrient intake, availability or supply of foods or nutrients in context specific cases (e.g. availability/supply of any foods/nutrients in undernutrition context or availability/supply of unhealthy foods (clearly defined) in any context).
Excludes: Health outcomes that cannot be linked to nutrition; mortality and life expectancy outcomes (cannot be linked directly to nutrition); supply of food (nutrients) without clear link to nutrition in the population context.
Definitions
Includes: Studies looking at trade flows, tariff changes, trade and investment agreements or policies, trade openness; measures of economic globalisation. We do not include studies that focus exclusively on global flows of information, social or cultural globalisation.
Excludes: Studies analysing the impacts of policies or agreements that might be affected by trade negotiations (e.g. national agricultural or monetary policy); impact of measures introduced to counteract the effects of trade liberalisation, such as export bans.
Year and language of publication
Includes: articles published from January 1990 in English language.

2.3.4 Information extraction and analysis

Articles meeting the inclusion criteria were recorded in an Excel database including key information on context (country, time frame), globalisation processes observed (including definitions of the processes), type and source of data analysed, statistical methods applied, and main findings and conclusions from the study. The analysis of the studies included contrasts the findings against the existing conceptual frameworks and theoretical evidence, as well as with the findings of previous reviews on similar topics.

2.4 Results

Through database searches 714 articles were identified from five different databases, another 64 were retrieved from institutional websites, and 16 from additional searches on Google or Google scholar. The abstracts of all studies were screened and the full texts of 63 studies which were found to be relevant were downloaded for screening. 24 of these met our inclusion criteria. In addition, four relevant review studies were identified.

Of the 24 articles included, 11 look at diet-related health outcomes or biomarkers, including underweight, overweight, obesity, diabetes, CVD prevalence and BMI. 13 articles use context-relevant proxies of nutrition outcomes, including energy (kcal) intake per day, dietary diversity, and markers of dietary quality such as consumption of unhealthy food commodities, fat intake, consumption of protein and animal protein. A significant proportion of studies focussed on LMIC (12 out of 24). Most studies used country level data, while only three studies used multi-level models to account for effects occurring at different levels of aggregation. Natural experiments or difference-in-difference designs were used in three studies, and one study relied on single-country time series data. Two studies used less conventional approaches such as non-parametric correlation or structural equation modelling. Details of variables used, study design, data sources and main findings are provided in Table 2-2.

We present the results following the structure of the framework (figure 1) concerning trade, investment, global flows of information, and trade and investment agreements and their impacts on nutritional outcomes. We also comment on the differential results across population groups, defined by the main socioeconomic variables, which mediate the impacts of globalisation.

2.4.1 Economic globalisation: trade and investment

Three of the studies reviewed used index measures of economic globalisation, without reporting disaggregated results for the impacts of trade and investment sub-components (Goryakin et al., 2015), (Costa-Font and Mas, 2016), (Oberländer et al., 2016). Two of these studies find that the impacts of economic globalisation are dominated by the effect of social and political components. Goryakin et al. (2015) find that economic globalisation is associated with significant (although very small) decreases in prevalence of overweight among women in 56 high, low and middle-income countries. Costa-Font and Mas (2016), on the other hand, find that, particularly after controlling for inequality (measured through Gini's index) , globalisation is associated with an increase in the prevalence of overweight, although the impacts of the economic component of KOF index of globalisation3 become insignificant when including the social and political sub-indices. (Oberländer et al., 2016), however, find that economic globalisation is associated with negative impacts on health, increasing the prevalence of diabetes, but that social globalisation is associated with increased supplies of animal protein and sugar. This study is based on data from 70 countries, controlling both for time-invariant and dynamic heterogeneity.

As we will see in sections 2.4.2, other studies obtain clearer results on trade and investment components by analysing these variables separately, and by estimating different impacts for high versus low- and middle-income countries (See for example Miljkovic (2015), Nandi et al. (2014a)).

The studies looking at aggregate indices are relevant, however, in highlighting the importance of aspects of globalisation not captured by the economic index, including flows of information, or political, policy and regulatory space, which we discuss in Sections 2.4.4-2.4.5.

2.4.2 Trade

We identified 10 studies analysing the nutritional impacts of trade openness or reduction of trade barriers. Controlling for a wide range of variables including GDP, income levels, urbanization and other socioeconomic variables such as occupation and household structure, these studies find mixed results concerning undernutrition, with some recent evidence pointing to reductions in undernutrition and underweight associated with trade openness. There is no convincing evidence linking trade openness to overweight, obesity or other measures of diet-related NCD.

Some early studies based on cross-country data found a negative association between dependence on non-service exports and average per capita availability of calories and especially proteins in the Latin-American context (Gacitua and Bello, 1991) and for developing countries in general (Wimberley and Bello, 1992). These studies, however, found the impacts to be small compared to the effects of foreign investment (Wimberley and Bello, 1992) or insignificant after controlling for investment and other economic variables (Jenkins and Scanlan, 2001). (Bezuneh and Yiheyis, 2014)

[3] See http://globalisation.kof.ethz.ch/ for a detailed description of KOF index of globalisation. The economic component includes flows and restrictions (such as tariffs) to international trade, investment and capital flows.

also found that the removal of trade barriers was associated to short-term falls in nutrient availability per capita, with positive longer-term effects and insignificant "net" impacts.

Del Ninno, Dorosh, and Smith (2003) used a quasi-experimental approach, comparing three episodes of severe floods in Bangladesh. They found that, in the absence of private imports, per capita consumption of the rural poor would, measured at the household level, have decreased significantly due to scarcity and increased prices of rice. The authors find, however, that public interventions in price regulation and transfers also played an important role in mitigating hunger following natural disaster episodes.

Based on more recent data, several studies have found that trade openness and tariff reduction are associated with increased calorie availability per capita, (Zakaria and Xi, 2014), improved aggregate indicators of dietary diversity and quality Dithmer and Abdulai (2017), and decreased odds of being underweight for both rural and urban men and women Nandi et al. (2014a). Neuman et al. (2014), however, found no evidence of a significant association between mean tariff rates and mean BMI or underweight in a multi-level multi-country analysis of 30 LMIC.

On the other hand, neither trade as a proportion of GDP or tariff levels seem to be directly associated with increased prevalence of overweight, obesity or NCD. In the study by Nandi et al. (2014a) the impacts of trade and tariff levels on overweight, unlike the effects on underweight, were found to be insignificant. (Miljkovic et al., 2015) also report insignificant effects of trade openness on adult obesity rates at a country level. Perhaps more surprisingly, (de Soysa and de Soysa, 2017) reported a negative association between trade openness and rates of overweight for children and youth. This study also finds negative impacts from FDI and overall economic globalisation on obesity rates, and positive impacts from income levels. The authors argue that if globalisation increases the returns to labour this could increase the incentives to invest in children's health, leading to healthier diets and reduced levels of obesity and overweight.

2.4.3 Foreign direct investment

Overall, studies analysing the role of FDI show evidence that FDI tends to be associated with an increased consumption of sugary and highly processed foods and increases in overweight and obesity in LMIC in particular.

(Schram et al., 2015), using a natural experiment design, found a significant increase in sugar-sweetened beverages sales per capita, attributable to the removal of restrictions to FDI in Vietnam. (Baker et al., 2016) used a similar approach in Peru and found that following trade and investment liberalisation, sales of carbonated drinks stagnated, while sales of juice, energy and sports drinks, as well as bottled water, increased. In this case, both FDI and imports were considered to play an important role. These more nuanced results emphasise the role of branding, diversification of branding and preference change, which can lead to changes in demand towards juice and sports drinks, which are often high in sugar and energy content, but marketed as healthy, potentially reaching a wider consumer base (Schneider and Benjamin, 2011). These findings corroborate previous research by Stuckler et al. (2012) who showed that levels of FDI mediate the impact of GDP on consumption of unhealthy food products, including soft drinks, ice-cream, and confectionery, ultra-processed and packaged foods.

Miljkovic et al. (2015) used a quantile regression specification with cross-country panel data, finding that FDI tended to increase obesity rates only in LMIC. In a multi-level analysis of adults in LMICs, Nandi et al. (2014) found that FDI was associated to increased prevalence of overweight for rural men only. The same study found no impact on prevalence of underweight.

However, (Neuman et al., 2014) find no significant associations with overweight, while Sudharsanan et al. (2015) find that the impact on the prevalence of diabetes is insignificant after controlling for population ageing. As mentioned in Section 2.4.2, (de Soysa and de Soysa, 2017) found that FDI is associated to reductions in obesity rates among children and youth.

Although there is some evidence of an association between FDI and some indicators of malnutrition, we have found no evidence linking it to underweight. The earlier literature analysed this issue within the debate on the "dependency versus modernization" impacts of foreign investment and TNC penetration in developing countries. (Wimberley, 1991; Wimberley and Bello, 1992) find strong negative impacts of TNC investment on per capita availability of calories and proteins, while (Jenkins and Scanlan, 2001) find a positive association which is small compared to the effects of domestic investment. More recently, (Mihalache-O'keef and Li, 2011) and (Djokoto, 2012) added some nuance to this debate, showing that the impact of FDI on nutritional indicators seems to vary depending on the sector. The former study concluded that FDI in the primary sector has tended to harm food security in LMICs through a combination of resource exploitation, labour market effects and negative environmental and demographic externalities. However, FDI in the manufacturing sector leads to modernization, technological and human capital spill-overs and increased wages, improving nutritional outcomes. The negative impact of agricultural FDI on calorie and protein intakes is corroborated by (Djokoto, 2012) in the case of Ghana.

We identified three studies examining the relationship between FDI and underweight, all of which failed to find any significant association for either adults (Nandi et al 2014), ((Neuman et al., 2014) or children (Jenkins and Scanlan, 2001).

2.4.4 Increased flows of information

Three studies analyse the impact of social components of globalisation alongside economic components (Goryakin et al., 2015), (Costa-Font and Mas, 2016), (Oberländer et al., 2016). (Goryakin et al., 2015) and (Costa-Font and Mas, 2016) find that, although globalisation as a whole tends to be associated with an increase in obesity rates, economic components become insignificant once social globalisation is accounted for. (Oberländer et al., 2016), however, find that, while economic globalisation is associated to higher prevalence of diabetes and higher BMI, only social globalisation and its sub-components are associated to increased supply of sugar and animal protein.

Further research is needed in order to interpret these findings in the context of food systems and nutrition outcomes, examining the impacts of specific variables within these indices, as well as elucidating the potential effects of multi-collinearity across sub-components at different levels of disaggregation.

2.4.5 Trade and investment policy and regulatory environments

Two studies analyse the nutritional impacts of political and policy changes underlying globalisation processes, comparing these to the effects of economic integration processes using the political component of KOF index[4]. (Goryakin et al., 2015) suggest that there is a positive and convex relationship between political globalisation, measured by the KOF index, and overweight. This implies that the effect is not proportional and does not tend to plateau as integration increases, but tends to be larger at higher levels of political integration. (de Soysa and de Soysa, 2017), on the other hand, find that both political globalisation measured through KOF index, and

[4] See http://globalisation.kof.ethz.ch/ for a detailed description of KOF index of globalisation. The political component includes Number of embassies, membership in international organizations, participation in UN security council meetings.

the degree of free-market capitalism, measured through the Economic Freedom Index, seem to be associated with reduced rates of child and youth obesity. The studies in this review offer limited evidence on the direct impact of policy and regulatory changes associated with trade and investment liberalisation, providing some potentially interesting results that deserve further analysis, but overall leading to mixed and inconclusive findings.

2.4.6 Socioeconomic and demographic factors as mediators of impact

Only four articles in this review control for individual level factors (Del Ninno et al., 2003), (Nandi et al., 2014b), (Neuman et al., 2014), (Goryakin et al., 2015). Of these, only two estimate differential impacts of globalisation and macroeconomic variables for different subgroups. Both studies found significant differential effects across sub-groups. (Nandi et al., 2014b), for example, find that increased FDI is associated with a 17% increase in the odds of overweight for rural men only. (Neuman et al., 2014) find that, although FDI is positively associated to overweight in most sub-groups, the association is negative for the wealthiest urban category, which is consistent with market segmentation practices whereby healthier products are targeted at high income consumers. Additionally ,the results by de Soysa and de Soysa (2017) suggest that globalisation processes could lead to different effects for children and youth, compared to adults.

2.5 Discussion and interpretation

The empirical evidence analysed in this review highlights the important role of globalisation processes as drivers of dietary change.

There is no agreement, however, with respect to the overall impacts of economic globalisation and its components, or even their sign, as discussed in Section 2.4.1. Results can be affected by the type of countries included (LMI countries only (Nandi et al., 2014a), versus panels including both high and low income countries (Miljkovic et al. 2015)), the population studied ((children and youth (de Soysa and de Soysa, 2017), women only (Goryakin et al., 2015), adults only (Costa-Font and Mas, 2016), or the overall population (Sudharsanan et al., 2015)), the choice of control variables (for example, whether the study controls for inequality), as well as the method chosen to control for heterogeneity (both time invariant and dynamic, (Oberländer et al., 2016)) and to capture non-linearities (Goryakin et al., 2015) and interactions across factors (David Stuckler et al., 2012).

The studies reviewed have some limitations which should be considered when interpreting our results. Several (7) of the articles identified rely on average nutrient per capita availability at a country level, which has been found to be a weak indicator of important nutritional outcomes such as child underweight (Jenkins and Scanlan, 2001). More generally, the use of aggregate indicators of nutrition can mask the uneven distribution of the gains of liberalisation, or hide important sectoral differences, which deserve further investigation. The use of quantitative, a posteriori statistical analysis, moreover, precludes the analysis of some country-specific mechanisms and their interactions, and is better suited for the analysis of broad trends and associations. Although these limitations can be addressed to a certain extent through careful study design, the results from the studies in this review should be interpreted with caution and should be understood as complementary to other types of evidence, both quantitative and qualitative.

Evidence on the impacts of globalisation processes on undernutrition and underweight is limited, particularly compared to the number of studies analysing overweight and obesity. There is a scarcity, of empirical studies, based on cross-country or natural experiment designs which can control for confounding factors and which use individual or household level measures of dietary adequacy and nutritional status including nutrient deficiencies, underweight and stunting.

Despite these limitations, the studies reviewed, particularly when analysed together, provide relevant insights regarding different mechanisms and sub-components, their relative importance, distinctive roles and potential interactions.

First, we found that trade openness and FDI seem to have played distinct roles so far in the nutrition transition. There is some recent evidence linking traded openness to reductions in undernutrition and underweight (Dithmer and Abdulai, 2017), (Nandi et al., 2014b) (Del Ninno et al., 2003) but not to increased prevalence of overweight (Nandi et al., 2014b), (Miljkovic et al., 2015), (de Soysa and de Soysa, 2017). FDI, meanwhile, has been found to be associated with increased prevalence of obesity and overweight in LMIC, (Nandi et al., 2014b), (Schram et al., 2015), (Miljkovic et al., 2015) (Baker et al., 2016), (although not diabetes, according to the study by Sudharsanan et al. (2015)) but there is no clear evidence that it is associated with reductions in undernutrition. ((Mihalache-O'keef and Li, 2011) and (Djokoto, 2012) find that the impacts can depend on sectoral composition and context-specific mechanisms relating to migratory and labour market dynamics.

This pattern of association could reflect a trend towards FDI as the main vehicle for food system integration, which has been identified and described in the literature (Hawkes 2006), (Baker et al., 2016). FDI can provide greater opportunities for market penetration of TFC through vertical and horizontal integration, transformation of the distribution and retail segments, effective advertisement and adaptation to local consumer tastes or 'glocalization' (Roudometof, 2005).

The lack of association between trade openness and over-nutrition could also suggest that availability and affordability of food products, per se, are not enough to lead to the changes in lifestyle and consumption patterns associated to NCD prevalence. Direct investment, on the other hand, has the capacity to deeply transform the food sector and the wider economic system, altering consumer behaviour as part of this process (see Section 2.2.2) .

Additionally, the (relatively scarce) evidence linking trade openness to reduced under-nutrition and under-weight could reflect the impact of trade policies explicitly aimed at improving food security and insulating domestic staple food prices from international price spikes. These measures include selective reductions in import protection of essential foods, sometimes coupled to public stockpiling and distribution programs (Gillson and Fouad, 2015). Despite the controversy around the effectiveness of some of these interventions and their impacts on global price volatility (Anderson et al., 2014), measures aimed at selectively lowering import barriers for food staples has been found to be successful in several low and middle income countries (Anderson et al., 2014), (Haggblade, 2008), (Gillson and Fouad, 2015).

Policy makers can also exert control over FDI and transnational food companies, setting standards for processing, labelling, packaging and retail. Once large investors enter the market, however, food systems are rapidly and deeply transformed in ways that can be hard to control, requiring regulation at many segments along the value chain, from processing to packaging, advertising and distribution (Hawkes, 2009). Moreover, some have argued that, as large companies become established nationally, they can constrain the space for nutrition oriented policy through lobbying and re-location threats (Brownell and Warner, 2009).

The lack of apparent overall association between FDI and under-nutrition can be interpreted as evidence that the most disadvantaged segments of society are excluded from the potential benefits economic growth in general, and of more efficient and modernized food systems in particular. In addition to their low purchasing power, these populations often live either in slums which have little infrastructure (Ruel et al., 2008), or in remote rural areas, providing few economic incentives for the establishment of supermarkets and the delivery of a variety of fresh produce.

The cross-country studies in this review generally measure aggregate flows of FDI at a national level. In terms of its association with overweight and obesity, after controlling for a range of socio-economic variables, this aggregate FDI is generally interpreted as a proxy for greater integration of food systems, and the entry of TFCs into the market (D. Stuckler et al., 2012). While this might be a reasonable assumption in most cases, FDI has deep impacts on the productive and social structure of receiving countries that go well beyond food systems, affecting income distribution, migration patterns and lifestyles, all of which can have important implications for nutrition outcomes (Mihalache-O'keef and Li, 2011). The detailed sectoral analysis of the impacts of FDI on nutrition deserves more attention. A combination of case studies and cross-country analysis might shed more light over complex context-specific mechanisms concerning FDI in the primary, secondary and tertiary sectors.

Another relevant finding in the literature concerns the seemingly crucial role of global flows of information in explaining dietary changes. The empirical literature uses the social component of the KOF index of globalisation which, among others, includes variables reflecting TV ownership, internet access, foreign films viewing, use of phones and number of McDonalds per capita. Two studies find relevant positive associations with overweight, calorie and fat consumption, which seem to dominate the effects of economic flows (Goryakin et al., 2015), (Costa-Font and Mas, 2016). These results offer more than one interpretation, however. On the one hand, the access to communication technologies and foreign entertainment products can lead to increased exposure to globalized food marketing, which has been identified a key component of food system integration. Marketing includes not only conventional advertising but also sports sponsorship and product placement in films, videos and other forms of entertainment (Schmitt et al., 2007), (Hawkes 2002). Moreover, advertising can have indirect effects on diets, as it increases the demand not only for the marketed brand but for the category as a whole, be it snacks, bakery products, fries or hamburgers. The variable reflecting number of McDonalds per capita is part of the "cultural proximity" sub-component of the index. In this context, this variable could potentially be interpreted as a food-specific proxy for FDI influx, and one which epitomises the subordination of the exchange of information and cultural values to economic forces. On the other hand, increased access to technology could be correlated to other changes in lifestyle, social-relational characteristics of labour and socialization, which could lead to changes in dietary patterns, as discussed in Section 2.5. This is a relatively under-studied mechanism, however, and further research will be necessary in order to disentangle the potentially overlapping mechanisms connecting increased interconnectivity and information flows to changes in nutrition outcomes.

Finally, the evidence suggests that globalisation processes have different impacts across sub-groups, without necessarily exhibiting a continuous gradient. This is consistent with the dynamics of market segmentation, which tends to create divergent dietary patterns within countries, with healthier products being targeted towards wealthy urban consumers, while lower income groups become the target consumers for calorie dense "junk foods" (C. Hawkes, 2006).

The existence of important differences in impact across groups can also be a product of interactions between mechanisms, which either compensate or enhance each other's effects. For example, FDI might increase the access to unhealthy food commodities, but associated income growth and increased access to information might compensate by promoting health-seeking behaviour. Conversely, longer working hours or reduced time available for cooking might exacerbate the impacts of changes in food environments. Further analysis of group-specific impacts of trade and investment policies, can be useful when it comes to developing more effective policy interventions.

2.6 Conclusion and implications for policy and research

Our results indicate that, overall, globalisation processes and the trade and investment policies underpinning them have so far played an important role in driving changes in the nutrition status of populations in high, middle and low-income countries. Empirical literature provides, however, a nuanced view of the impact of globalisation on nutrition, indicating that different processes and sub-components have different effects. In particular, trade openness contributes to shifts in dietary patterns, increasing dietary diversity and availability of cheap calories and fats and, on average, reducing under-nutrition. However, trade openness is not sufficient, per se, to explain the increases in obesity and overweight. These seem to be more associated to FDI and global flows of information in LMIC, including food marketing and advertisement.

Moreover, information flows seem to have an important impact on dietary patterns, overweight, obesity and consumption of calories and fats, even dominating the effect of trade and investment flows. This could reflect the impacts of exposure to globalized marketing, or it could reflect other lifestyle changes associated with the use of new communications technologies.

The studies reviewed support the view, suggested by others (Costa-Font and Mas, 2016), (S. Friel et al., 2013) that neither overall protectionism nor unregulated liberalisation are likely to reduce malnutrition, making adequate monitoring and intervention a necessity to avoid negative impacts of globalisation processes on nutrition. In addition, our results suggest that governments do not necessarily face a trade-off in dealing with the double-burden of malnutrition (liberalize, and reduce under-nutrition, but face increases in over-nutrition and chronic disease, or protect against the latter, at the risk of increasing food insecurity). Rather, governments can play an important role in prioritising food security through nutrition-sensitive trade policy, while simultaneously controlling and regulating foreign investment and marketing in the food sector, in order to avoid the creation of obesogenic environments. Furthermore, the existence of significant differences in impacts across population sub-groups, where the most vulnerable populations tend to be affected disproportionately, highlight the need to reduce inequalities in access to food, and to develop targeted policies which can address the needs of those groups which are most vulnerable to the impacts of globalisation.

Table 2-2. Included articles

	Included Articles	Methods	Definition of trade liberalization	Outcome variable	Region	Years	Key findings
1	(de Soysa and de Soysa, 2017)	Multivariate regression using country-level panel data.	KOF index of globalization. Analyse trade openness and FDI components separately	Prevalence of obesity in young people aged 2-19 from GBD study	180 countries	1990-2013	Trade openness, FDI and economic globalization all result in lower obesity among the younger groups of population.
2	(Oberländer, Disdier, and Etilé, (2016)	Multivariate regression using country-level panel data.	KOF index of globalization. The authors distinguish between economic and social dimensions of globalization	Prevalence of diabetes, BMI. Markers of dietary quality (animal protein, free fat, sugar).	70 countries	1970-2011	Economic globalization negatively impacts health outcomes. Socio-cultural globalization increases supplies of animal protein and sugar
3	(Costa-Font and Mas, (2016)	Multivariate regression using country-level panel data.	KOF index of globaliztion. Economic globalization and social globalization analysed separately.	Prevalence of obesity	26 High-income countries	1989-2004	Globalization significantly increases obesity. Both economic globalization and social globalization have a positive impact on the prevalence of obesity but the social component is the most relevant. (Economic component no longer significant when

							both considered separately)
4	Goryakin et al., (2015)	Multi-country multi-level panel data controlling for both individual and country-level covariates.	KOF index of globalization and sub-components	Overweight and obesity	56 countries	1991-2009	Globalization increases overweight, but the social and political components are the most relevant
5	Miljkovic et al., (2015)	Multivariate regression using country-level panel data.	FDI, trade openness, Global Socialization Index (GSI)	Prevalence of obesity	76 countries	1986-2008	Trade openness increases obesity in the fixed effects specification, but not in the quantile regression. FDI and GSI increase obesity for least developed countries, where obesity rates are low.
6	Sudharsanan,et al, (2015)	Non-parametric correlation and multivariate first-difference regression estimates	FDI	prevalence of diabetes in 10-year age groups	both HIC and LMIC	1990, 2000, 2008	Once aging is taken into account, there is no evidence of FDI or other macroeconomic variables such as GDP, having an influence on prevalence of diabetes
7	Nandi et al., (2014)	Meta-regression using multi-country cross-sectional individual level data.	Mean tariff percentage averaged 1990-1999. FDI	BMI, odds of being underweight, overweight and obese at the individual level for women in LMIC	40 low and middle-income countries	2002-2003	Tariff reduction was associated to lower odds of underweight. FDI was associated to higher odds of overweight among rural men only. Higher income is associated to higher odds of overweight

8	Neuman et al. (2014)	Multi-level modelling using cross-sectional data	FDI, mean tariff levels	BMI, over and under-weight	38 LMIC	1991, 2010	FDI is positively associated with BMI among poorest respondents in rural areas.
9	Vogli, R. de et al., (2014)	Multivariate regression using country-level panel data.	KOF index of globalization (economic component)	BMI	127 countries	1980-2008	Globalization is positively associated to increased BMI. Inequality also shows a positive association in high-income countries
10	Schram, Labonte, and Sanders (2013)	Trend analysis and Structural Equation Modelling using cross-country cross-sectional data	KOF index of economic globalization	CVD, overweight, obesity	39 countries	2008 for SEM	Economic globalization negatively impacts all health outcomes.
11	Jenkins and Scanlan (2001)	Multivariate regression analysis with cross-country panel data.	Foreign investment, export dependence	Child underweight, per capita calorie and protein availability	88 Less develope d Countrie s	1970-1990	There is a negative association between dependence on non-service exports and nutritional outcomes but this is non-significant after controlling for other economic variables. There is a small positive impact of FDI on nutrition outcomes in developing countries, but domestic investment has a stronger impact
Context-relevant proxies for nutrition outcomes (per capita consumption of key foods/nutrients)							

12	Dhitmer and Abdulai (2017)	Multivariate regression using country-level panel data.	Trade openness	Consumption of carbonated beverages	151 countries	1980-2007	Trade openness increases average dietary energy consumption, dietary diversity and indicators of dietary quality
13	Baker et al. (2016)	Difference in difference/Natural experiment	Ratification and enforcement of FTA with US	Nutrient supply, calories, proteins, fat	Peru	1999-2013	The study finds a diversification of soft drinks. Sales of carbonated drinks stagnate, but bottled water, sports and energy drinks increase
14	Schram A, Labonte R et al, (2015)	Difference in difference/Natural experiment.	Adoption of trade agreement, FDI	Per capita availability of energy, calories, fat	Vietnam and Philippines	1995-2012	The adoption of a trade agreement increases per-capita sales of beverages
15	Ogundari, (2015)	Multivariate regression using country-level panel data.	Trade openness	Per capita dietary energy supply	43 countries	1975-2009	Trade openness seems to contribute to nutrient supply convergence in Sub-Saharan Africa
16	Zakaria (2014)	Multivariate regression analysis using cross-country panel data	Trade openness	Sales per capita of SSSB	5 South Asian countries	1972-2013	Trade openness and tariff reductions are associated with increased calorie availability per capita
17	Bezuneh and Yiheyis, (2014)	Multivariate regression analysis using cross-country panel data	Implementation of liberalization policies (defined through dummy variables)	Per capita dietary energy supply	37 developing countries	1980-2000	The removal of trade barriers is associated to short-term falls in nutrient availability per capita, with positive longer-term effects and insignificant "net" impacts

18	Stuckler et al. (2012)	Multivariate regression analysis.	FDI, trade agreement with US	Per capita dietary energy supply	44 LMIC	1997-2010?	Both FDI and trade agreements with US increase in sales per capita of SSSB. Economic growth in the absence of FDI does not increase sales of SSSB
19	Djokoto (2012)	Cointegration analysis, time series using country-level data	FDI into agricultural sector	Daily Kcal intake per capita	Ghana		FDI into the agricultural sector is detrimental for food security in Ghana
20	Mihalache and O'Keefe (2011)	Cointegration analysis, time series using country-level data	FDI into primary sector, manufacturing and service sector	Per capita calorie, and protein availability, total and from vegetable sources	56 LMIC	1981-2001	FDI into the primary sector is detrimental for food security. FDI into manufacturing improves food security, FDI into services has ambiguous effects
21	Del Ninno and Dorosh (2003)	Natural experiment. The authors compare three episodes of intense floods, their impact on crops, availability and price of rice, and calorie intake of affected households compared to those not affected	Liberalization of private-sector rice imports from India, in the early 1990s	Per capita calorie and protein availability	Banglad esh	1977, 1988, 1998	In the absence of private sector imports, per capita consumption of the rural poor would have decreased by 44 to 109 Kcal/Day, (out of an average of 1636). Public interventions including price stabilization and transfers also play an important role

22	Wimberley and Bello (1992)	Multivariate regression analysis using cross-country panel data	Primary export dependence, TNC investment	Per capita calorie, protein availability total and from vegetable sources.	59 third world countries	1967-1985	There is evidence of a negative association between FDI and nutrition-related outcomes in developing countries, as well as a much smaller negative association for dependence on non-service exports
23	Wimberley (1991)	Multivariate regression analysis using cross-country panel data	TNC investment	Per capita calorie and protein availability	60 Third World Countrie s	1970-1985	There is a strong negative association between FDI and per capita availability of calories and protein in developing countries
24	Gacitúa & Bello (1991)	Multivariate regression analysis using cross-country panel data	Non-service exports as a proportion of GDP	Per capita calorie, protein availability total and from vegetable sources.	15 Latin-America n Countrie s	1967-1985	This study finds a negative association between dependence on non-service exports and per capita supply of calories and proteins in Latin America
Key reviews							
1	Barlow et al., (2017)	Systematic review	Adoption of trade and investment agreements	Health outcomes, risk factors	Health outcomes , risk factors	--	Trade and investment agreements can increase risk factors for NCD (beverage consumption) while also affecting protective factors (public health policies). However, certain agreements can increase access to patented medicines, with

							positive impacts on health
2	Baker P, Kay A, Walls H. (2014)	Semi-structured review	Trade liberalization, trade and investment agreements, others	prevalence of NCD and main risk factors	ASEAN+ 3, India	--	Trade liberalization can promote NCD through two main pathways: increasing access to unhealthy products and constraining governments' space to promote health
3	Friel et al., (2013)	Review of literature and pathway mapping	Trade liberalization, trade and investment agreements, others	NCD, obesity	Not restricte d	--	The authors identify several pathways through which trade liberalization can affect NCD
4	McCorriston S et al. (2013)	Systematic Review	Various. Trade and related policies	Food Security	Developi ng Countrie s	--	The authors find mixed evidence and a strong context-dependence of associations and impacts

Box 2.1 Search Strategy

1) Economic globalisation; title, abstract (ti ab)

TS=("trade polic*" OR "trade agreement*" OR "trade liberali*" OR "World Trade Organization agreement*" OR "free trade" OR "investment treaty" OR "trade treaty" OR FDI OR Foreign Direct Investment" OR trade openness OR "economic globali*" OR "KOF Index" OR "Maastricht Index" OR "G-Index" OR WMRC OR ATK OR KFP)

2) Food environments; ti ab

food* OR bread OR cereal* OR condiment* OR candy OR chocolate OR dairy OR eggs OR fruit OR honey OR meat OR cheese OR rice OR maize OR flour OR wheat OR corn OR sugar OR coffee OR cocoa OR nut* OR seed* OR vegetable* OR legume* OR bean* OR beverage* OR drink* OR soda* OR juice* OR fat OR oil OR sweet* OR fish OR seafood OR milk OR cream OR "soy* beans" OR "energy drink*" OR "soft drink*" OR "grocer*"OR supermarkets OR "convenience store*" OR snack* OR "farmer* market*" OR "cafeteria*" OR "vending machine*" OR restaurant* OR meal* OR "corner store*" OR "corner shop*" OR "wet market"

3) Nutrition/health; ti ab

TS=(diet* OR nutrition* OR malnutrition OR nutrient* OR macronutrient* OR micronutrient* OR kilojoule* OR "energy intake" OR calorie* OR protein OR carbohydrate OR fibre OR fiber OR sugar OR vitamin* OR mineral* OR underweight OR overweight OR obes* OR "body mass index" OR BMI OR height OR weight OR stunting OR "growth retardation" OR "chronic disease" OR "non-communicable disease" OR NCD OR diabetes OR "cardiovascular disease" OR "heart disease" OR stroke* OR "kidney disease" OR "renal disease" OR "cancer" OR hypertension OR "blood pressure" OR hyperglycaemi* OR "blood sugar" OR "blood glucose" OR cholesterol OR hypercholesterolaemia OR morbidity OR mortality OR "disability adjusted life years" OR DALYs OR health OR malnutrition OR undernutrition OR malnourished OR wasting OR death*)

4) Quantitative, retrospective studies.

Quantitative OR quantif* OR "estimat*" OR "statistic*" OR "econometric*" OR "correlat*" or "control* for" OR "empiric*" OR "cross-section*" OR "cross section" OR "time-series" OR "time series" OR "panel" OR "natural experiment*" OR "difference*in*difference" OR regress*

5) 1 and 2 and 3 and 4 (Economic globalisation AND food environments AND nutrition/health AND quantitative, retrospective studies)

Chapter 3. Background to this study: Historical overview and nutritional impacts of trade liberalisation in the Indian food sector

3.1 Introduction

Starting in the early nineties, India has undergone a process of trade and investment liberalisation (trade liberalisation), which has, to different degrees, affected all economic sectors. In addition to its commitments under WTO, India has signed several regional and numerous bilateral trade agreements and has also carried out unilateral reductions in trade and investment barriers. In many strategic sectors, however, including agriculture and retail, liberalisation has proceeded in a cautious way, and important barriers remain. Food security has played a key role in shaping international trade policies in India, and the impacts of liberalisation on food security have been the object of several studies and much debate (Chand, 2007), (Chang, 2009), (Matthews, 2014). The potential impacts of liberalisation on diet-related chronic disease, however, have traditionally not been considered a policy priority, and have been comparatively under-studied in the Indian context.

In this chapter we provide a brief historical overview of India's trade liberalisation since the early nineties, focussing on the agricultural, food sectors and edible oils sector. Although the focus of this thesis is not on foreign direct investment, we also comment on investment liberalisation in terms of its impact on Indian food systems and food environments. We also provide an overview of the main changes in dietary patterns since liberalisation. This chapter connects our more general discussion of trade and liberalisation as drivers of nutritional change in the previous chapter to the Indian case and sets the background for the rest of this thesis.

3.2 India's agricultural trade liberalisation

3.2.1 Structural adjustment and the WTO

Since the period of post-independence, India's international trade policy was characterized by a protectionist approach, where the protection of national food security constituted an overarching priority (Chang, 2009). Self-sufficiency in the production of staple food commodities was considered a political necessity, in order to avoid dependence on international markets and unreliable flows of foreign food aid. The protectionist tendency intensified in the 1960s with the implementation of policies aiming for near-autarky in key food commodities in 1965 (Hoda and Gulati, 2013).

In 1991, however, India, reached a critical deficit in its balance of payments, which triggered an exchange rate crisis (Cerra and Saxena, 2002). The government, close to default, accepted a comprehensive package of liberalizing and re-structuring policies in exchange for an emergency loan from the IMF (World Bank, 1991). This was the beginning of a process of progressive unilateral reduction of trade barriers. Subsequently, the adoption of the WTO Agreement on Agriculture, in 1994, contributed to further increases in international trade in food products (Greenfield et al., 1996).

However, quantitative restrictions were retained for many agricultural and food products (Goldar, 2005). These were allowed as a safeguard measure in cases of a significant balance of payments deficit (GATT, 1994), and were only gradually dismantled following a trade dispute on this matter which was resolved in favour of the US in 2001 (Goldar, 2005). Despite initial increases in trade barriers in order to compensate for the elimination of quantitative restrictions, the tendency since the early 2000s has been towards the gradual reduction of trade barriers, encouraging a rapid increase in food import and export values (Hoda and Gulati, 2013). As a result of this trend, throughout this period, there has been a large average gap between applied tariff rates and the bound levels established by WTO (Bouët et al., 2008).

Compared to tariff and non-tariff import restrictions, export restrictions were weakly defined and regulated in WTO agreements (Anania, 2013). India, like many other developing countries, has relied on export bans and restrictions in order to protect domestic food availability, particularly for staple grains and edible oils (Shama, 2011) (a partial ban on the export of edible oils was lifted as recently as April 2017) (Department of Commerce, 2017).

The implementation of export restrictions following the 2008 food crisis was identified as an important aggravating factor, particularly in the case of rice. Although no binding agreements have been reached to date, there is a broad consensus to reduce the use of these policy instruments (Anania, 2013).

The Uruguay round agreement limited national policy space for support of domestic agriculture, measured through the Aggregate Measure of Support (AMS) (Konandreas and Greenfield, 1996). Initially, support in developing countries was far from the established limits, which were mainly aimed at curtailing market-distorting support in US and the EU. However, as middle-income countries have increased their subsidy levels, some have come close to breaching the agreed limits, leading to negotiations over increased flexibility and exempt measures (Brink, 2015).

India supports its agricultural sector through a wide range of measures including input subsidies on irrigation, power, seeds and fertilizer. In addition, Minimum Support Price is maintained for 24 agricultural commodities, although established prices are only effectively defended for a few staple food commodities (Hoda and Gulati, 2013). In 2013 India approved a key piece of legislation known as the National Food Security Act (Ministry of Law and Justice, 2013). This new legislation reinforced and expanded the scope of the national-level Public Distribution System, which distributes staple foods (and kerosene) to low income households across Indian States. The regulation implements a rights-based approach to nutrition ("right to food"), and emphasizes access to a healthy, diverse and nutritious diet as an ultimate objective, going beyond calorie sufficiency. Following the approval of the Act, there were some fears that the large cereal purchases at subsidised prices required for full implementation of this policy might breach the AMS limits (Narayanan, 2014). So far, however, farm subsidy levels as reported by India have remained below the established limits (Suneja, 2017).

One exception to this has been the issue of public stockpiling. The 1995 agreement on agriculture imposed limitations on public stockpiles related to producer support policies (Matthews, 2014). Developing countries opposed these limitations in cases where purchases had the objective of "supporting low-income or resource poor producers" or generally "fighting hunger and rural poverty" (WTO, 2008). In the case of India, public purchases made to defend the Minimum Support Price policy would have led India to breach the maximum support (AMS) established in the Uruguay Round agreement (Matthews, 2014). India played a leading role in the negotiations leading up to the Bali ministerial conference on this issue[5], and was one of the main beneficiaries of the resulting interim agreement protecting developing countries from disputes on this matter until the achievement of a permanent agreement, which is expected to be negotiated in the 11th Ministerial Conference in December 2017, (WTO, 2013).

[5] Since 2003, in fact, India has led the G33 group of developing countries which have argued for exemptions to liberalisation in special agricultural products and the creation of a Special Safeguard Mechanism in order to control import peaks through tariff increases (Grant, 2009).

3.2.2 Preferential regional and bilateral trade agreements (PTA)

So far, India has relied to a large extent on multilateral mechanisms for trade liberalisation. Since 2003, however, preferential trade agreements have played an increasingly important role. As of November 2017, India has concluded 19 bilateral and regional trade and investment agreements[6]. These include agreements with South American and European countries, such as MERCOSUR block, Chile and Finland. However, the main focus has been on South and South-East Asia, as part of India's broader Look East (now "Act East") geopolitical strategy (Singh, 2015).

The main bilateral agreements in the region have been negotiated with Nepal and with some of the most developed countries in the region, including Singapore (2005), South Korea (2010) and Japan (2011). In addition, India participates in two major regional trade agreements in Asia.

The first of these is the South Asian Free Trade Agreement (SAFTA) which was signed in 2004 including seven South Asian countries[7]. This agreement was originally seen as an important opportunity to improve food security in the region, given that India and Pakistan are net food exporters whose combined food surplus is larger than the total food deficit of the remaining members (Pant, 2014). As part of the efforts to improve regional cooperation on food security, the SAARC Food Bank[8] was created in 2007, designed to improve temporal and spatial distribution on food in shortage or emergency situations. However, neither the SAFTA nor the SAARC Food Bank can be considered to have had a large impact on food security or nutrition. SAFTA has failed at increasing regional trade in food commodities, given that participating countries placed staple foods in "sensitive commodities" lists excluding them from tariff reduction (Taneja et al., 2011). The SAARC Food Bank, meanwhile, has remained non-operational, due to insufficient supplies and ill-defined action triggers, as well as the significant difficulties posed by the deficient distribution infrastructure in the region (Pant, 2014).

The second key regional trade agreement is the India-ASEAN agreement, operational in India since 2010, and also known as AIFTA (ASEAN-India Free Trade Agreement). Unlike SAFTA, this agreement has the potential to lead to important effects on food

---

[6] http://commerce.nic.in/trade/international_ta.asp?id=2&trade=i

[7] SAFTA countries are: Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka.

[8] SAARC refers to the South Asian Association for Regional Cooperation. http://www.saarc-sec.org/. It includes the SAFTA countries plus Afghanistan.

trade and potentially deep impacts on nutrition and dietary patterns in India (Francis, 2011).

In the first place, this FTA connects Indian value chains to foreign vertically integrated food processors established in ASEAN countries (ASEAN, 2016). It also increases market access for large producers of milk products in Australia and New Zealand, who have an agreement with ASEAN (Australian Government, 2009).

As is the case with other trade agreements, staple foods such as wheat, rice, milk and sugar, as well as some fruits, are placed in an "exclusion list" and are not subject to mandatory tariff reductions. However, experts have argued that under AIFTA it is possible to import close substitutes for domestic products including similar raw commodities and semi-processed versions of the same food commodities. These are included under the sensitive or normal tracks, both of which are subject to considerable tariff reductions, with scheduled upper bounds between zero and five percent. These commitments are significantly more ambitious than WTO tariff bounds, and represent large reductions in protection levels, from average tariff rates of 30%. The inflow of processed, and semi-processed foods and other close substitutes of local products can increase access to a variety of foods, but can also damage domestic producers (Francis, 2011), and increase consumption of unhealthy processed foods (Phillip Baker et al., 2014). In addition to excluded, sensitive and normal products, AIFTA includes four "Special Commodities" (coffee, tea, rubber and palm oil) which are subject to a special schedule for liberalisation (see Section 3.4).

Although it is difficult to quantify the nutritional impacts of the ASEAN-India agreement, it is worth noting that the effects reinforce the observed trends in terms of nutrition transition, which in India has been characterized by significant increases in consumption of milk products and vegetable oils, as well as, to a lesser extent, increased reliance on processed foods (Pingali and Khwaja, 2004), (Misra et al., 2011), (Gaiha, 2012a).

3.3 Foreign direct investment in Indian food supply chains: selective liberalisation and promotion of food processing

Throughout the nineties and 2000s India has followed a cautious approach to investment liberalisation (Teli, 2014). As a result, important transformations in Indian food value chains have been led to a large extent by domestic investors. Overall, however, there has been a significant opening up, with foreign investors playing an increasing role in India's food system (Adhana, 2016). The inflows of FDI into different segments have been shaped by government regulations, resulting in a very unequal participation of foreign capital across agri-food supply chains.

Foreign investment has recently been liberalised up to 100% for several "high value-added" agricultural sub-sectors, including seeds, animal husbandry, pisciculture and cultivation of mushrooms and vegetables under controlled conditions (Department of Industrial Policy and Promotion, 2016). FDI is also liberalised in "plantation" commodities, which include rubber, tea and coffee and which are primarily cash crops. From 2016, palm oil was added to this list, although it was not granted plantation status, which involves changes to land tenure regime and regulated land ceilings. All other primary agricultural sectors are closed to foreign investors. However, there are considerable inflows of foreign capital into associated agricultural services, machinery and fertilizer (Adhana, 2016).

As early as 1990, foreign investment in the soft drinks sector has been driving an upwards trend in soft drink sales. More recently, food processing has attracted increasing flows of foreign investment, amounting to around 2.4% of all FDI inflows in 2016 (Adhana, 2016), and has experienced an estimated increase of around 43% between 2016 and 2017 (Ministry of Commerce & Industry, 2017), (The Economic Times of India, 2017a). This has happened in a context of progressive consolidation in the food processing industry, which has led to important mergers between large domestic players and MNC. Some examples include the joint venture between Fine Organics and New Zealand firm Zeelandia for the bakery goods market or the acquisition of B Natural by ITC for the fruit juice market.

Facilitating foreign investment into food processing is currently a government priority, promoted through the World Food India initiative, with the stated aims of increasing returns to farmers, improving access to food and reducing waste (MOFPI, 2017a).

FDI also plays an increasingly important role in the food wholesale segment. In particular, MNC such as Walmart and Metro own most of the cash and carry wholesale sector, which is growing at a fast rate (Reardon and Minten, 2011a), (The Times of India, 2016). In addition, the government has recently renewed efforts to attract foreign investment into cold chain infrastructure through tax exemptions and other favourable policies (MOFPI, 2017b).

Recently, a process of rapid expansion in modern retail has been led by domestic firms, given that FDI in multi-brand retail has not been liberalised. However, Reardon and Minten (2011b) argue that the expectation of an imminent liberalisation of FDI in this segment encouraged competition and investment among domestic firms, who actively advocated for liberalisation and competed for potential MNC partners. Although the expansion of modern retail is associated to increased consumption of highly processed foods, (Reardon and Minten, 2011b) also highlight the fact that, unlike in the Latin American context, fresh fruits, vegetables and grains constitute an important proportion of food sales from private modern retailers.

3.4 Liberalisation in the edible oils sector

Box 3-1. Simplified Timeline. Edible oil policy in India

1974 Edible oil starts to be systematically distributed by PDS.

1980-1987 Increasing imports for distribution and vanaspati. Research and promotion of red palm oil as a potential vehicle for reduction of vitamin A deficiency.

1987-1990 Trade Mission for Oilseeds. Imports reduced to almost zero.

1991-1994 Structural adjustment program. Beginning of liberalisation

1994-1998 Oil imports liberalised. Progressive tariff reduction. Distribution only in emergencies. Tariffs bound to 300% by WTO agreement.

1998-2005 Low international prices hurt domestic producers. Tariff increases

2008-2016 Food crisis in 2008. Tariff reduction. New scheme for refined palm oil distribution, and promotion of domestic production.

2010 Agreement with ASEAN countries to bind palm oil tariffs to 45%

2016-2017 New tariff increases, up to 40%.

Source: Own elaboration based on various sources

In this section we provide a very brief historical overview of the process of liberalisation in the edible oils sector, which is the main focus of our study. Liberalisation in this sector has proceeded in parallel to the broader historical process described in the previous sections of this chapter but shows important specificities that are worth discussing separately.

In the first place, the process of liberalisation in the edible oils sector has to be understood in the context of historical import dependence. Before liberalisation of the sector in 1991-1994, India aimed for self-sufficiency, controlling imports and striving to improve domestic output, which suffered from low productivity and important constraints to area expansion. In particular, the Technology Mission on Oilseeds (Government of India Archive, 1991) contributed to increasing production between

1987-1991, reducing imports to almost zero. Nevertheless, significant amounts of oil were imported under government monopoly throughout the 1980s and 1990s, with import licences mainly issued for subsidized public distribution (under the PDS program), and for the hydrogenated fats industry, which was encouraged to use imported oils (see Chapters 5 and 6 for a more detailed discussion of these issues).

In 1994, imports for all types of edible oils were progressively placed on Open General Licence, and out of the Government monopoly, starting with palmolein. After this date, the rapid increase in imports of cheap palm oil and soybean contributed to a stagnation in domestic production (See Figure 3-2). The government has, since then, maintained a flexible tariff regime, where we can identify three (or four) different periods (Reddy, 2009). The liberalisation of the sector in 1994 was followed by a period of progressively lowering tariffs and rapid increase in imports, until 1998. Between 1998/99 and 2005, tariffs increased again, responding to low prices in international markets. Between 2005 and 2016, there was another period of reduced tariffs, where edible oil imports peaked, representing up to 80% of domestic availability. Following intense negotiations, tariff reductions were agreed for palm oil imports from Indonesia and Malaysia, with a scheduled upper bound of 45% from 2014 (Francis, 2011). In 2016-2017 import tariffs have increased again up to 40%, getting close to the bound tariff established in the ASEAN-India agreement.

Figure 3-1 Historical tariff rates

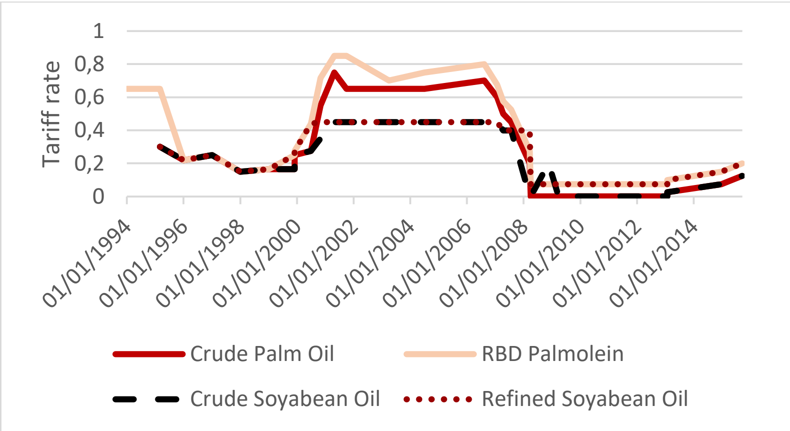
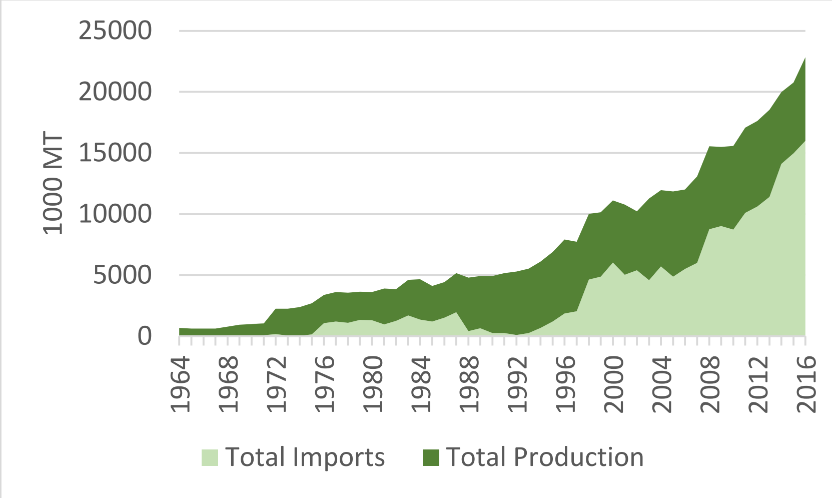


Figure 3-2. Imports and production of edible oils in India



Source: USDA PS&D database. Stack graph. Shaded area represents total supply

3.5 Changing dietary patterns and the role of liberalisation

Over the past 30 years, India has undergone a rapid nutrition transition (Popkin, 2003), (Pingali and Khwaja, 2004), (Misra et al., 2011), with overall decreases in consumption of cereals and pulses, and increased consumption of edible oils, animal source foods and salt (Kumar 2017), (Figure 3-3). The contribution of fat to energy consumption has increased by around 7%, at the expense of calories from coarse cereals and pulses (Misra et al., 2011). Consumption of highly processed foods has also increased substantially (Misra et al., 2011) (Baker and Friel, 2014), contributing to increased intakes of vegetable oils, sugar and salt.

Figure 3-4 shows a more detailed break-up of trends in per capita food supply of different food groups in India since the 1960s. We can see how the main patterns observed in the 1980s accelerate after 2000, particularly the increased consumption of milk, fruit and vegetables and vegetable oils. We can observe that the important trends that start in the 80s and 90s continue or even intensify after 2000, including increased per capita supply of milk, fruits and vegetables and vegetable oils and fats, while cereals and pulses stagnate or fall.

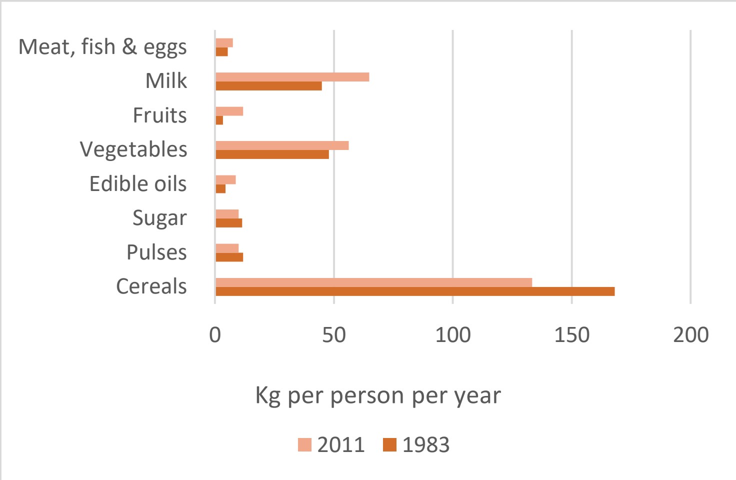
These dietary changes, alongside reductions in physical activity, have contributed to important increases in non-communicable disease (NCD) burdens, including obesity, diabetes and cardiovascular disease (Misra et al., 2011). Meanwhile, it has been estimated that around 35% of the adult population suffers from chronic energy deficiency (Kumar 2017), contributing to a large double burden of malnutrition.

Table 3-1. Average composition of Indian diets: Macronutrient intakes (1983-2011)

	1983	2011
Calories (Kcal per capita per day)	2153	2104
Protein (contribution to energy)	11%	11%
Fat (contribution to energy)	12%	19%
Carbohydrates (contribution to energy)	76%	70%

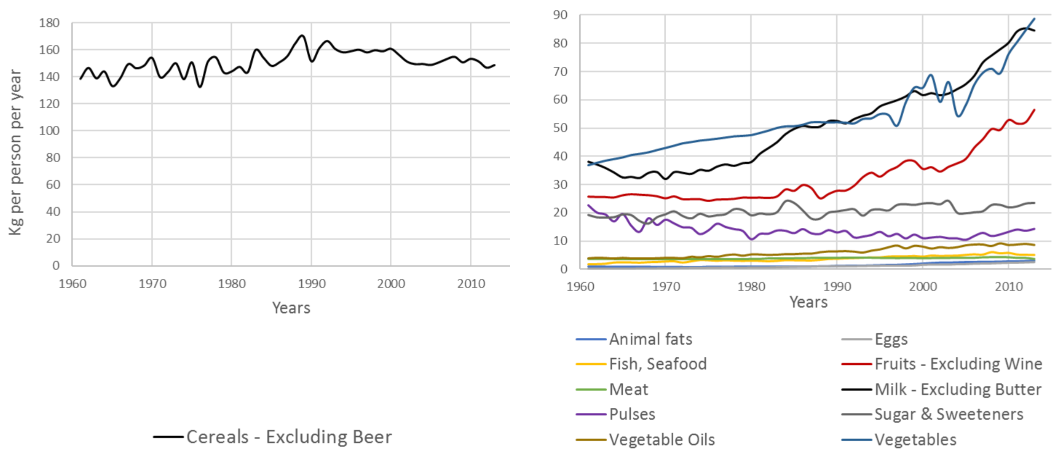
Source: NSSO consumer expenditure survey, (Kumar, 2017)

Figure 3-3. Average composition of Indian diets: Consumption of main food groups



Source: NSSO consumer expenditure survey, (Kumar, 2017)

Figure 3-4. Per capita availability for domestic food consumption in India, main food groups



Source: FAOSTAT. FAO food balance sheets

The impact of structural adjustment and WTO agreements on national food security, domestic small-holders and price volatility has been the object of much debate in the academic and policy arenas (Greenfield et al., 1996), (Chand, 2007), (Matthews, 2014). Our main focus, however, is the contribution to the nutrition transition and risk factors for NCD.

In this respect, the liberalisation of trade and investment has been identified as one of several factors driving dietary changes including income growth and urbanization (Popkin, 2006a) as well as technological and organizational transformations in the food system (Gaiha, 2012b).

In this respect, the clearest impact of liberalisation has been the increased availability of cheap vegetable oils (Popkin, 2006a), contributing to an important increases in fat consumption throughout the population. In the case of India, unlike Western countries, vegetable oils are the main source of fat for most of the population (Popkin, 2006a). (Panda and Ganesh-Kumar, 2009a) simulated the impacts of tariff liberalisation under a Doha-like scenario, concluding that calorie and protein consumption would decline for low-income households, due to a combination of income and price effects, while fat intakes increased for all household groups. However, and although rapidly increasing, consumption of vegetable oils and fat is unequally distributed, showing a socio-economic gradient. While fat intake for lower-income households is still below dietary recommendations, higher income groups consume above the recommended limits (See Figure 3-5)

Consumption of vegetable oils has not only increased but has substantially changed in terms of composition, as mentioned in the above paragraphs, shifting from traditional oils such as rapeseed and groundnut oil, towards palm oil and, to a lesser extent, soybean oil (See Figure 3-6). Differences in consumption patterns persist across regions, particularly for traditional oils (GAIN, 2017a)[9].

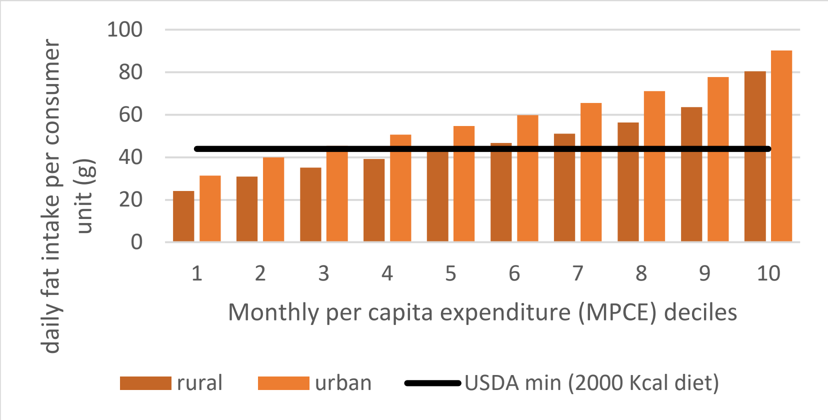
Palm oil has one of the highest contents of saturated fat amongst vegetable oils. It contains 49g of saturated fat per 100g of oil, compared to 6g in rapeseed oil, 12g in mustard oil and 15g in soybean oil [10], leading to concerns regarding the potential contribution of this dietary change to cardiovascular disease burdens.

---

[9] Coconut is more widely consumed in the South, groundnut is typically consumed in southern and western regions, mustard/rapeseed and vanaspati are consumed in north, north-eastern and central areas. Palm oil is consumed throughout India in food processing and the food services industry. It is most valued for cooking in southern regions, because it has similar properties to coconut oil. It is also highly consumed by low-income households (eg. In north-eastern States) (GAIN, 2017a).

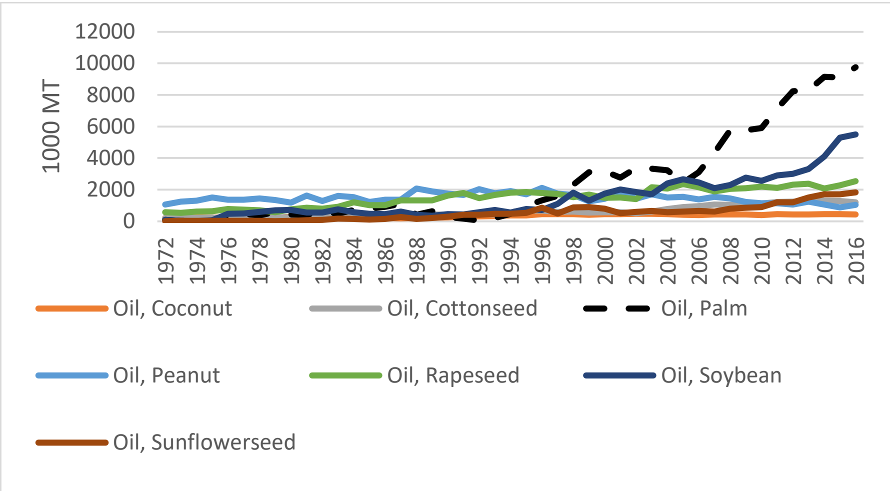
10

Figure 3-5. Daily fat intake per consumer unit 2011-12. Socioeconomic gradient.



Source: NSSO consumer expenditure survey round 68.

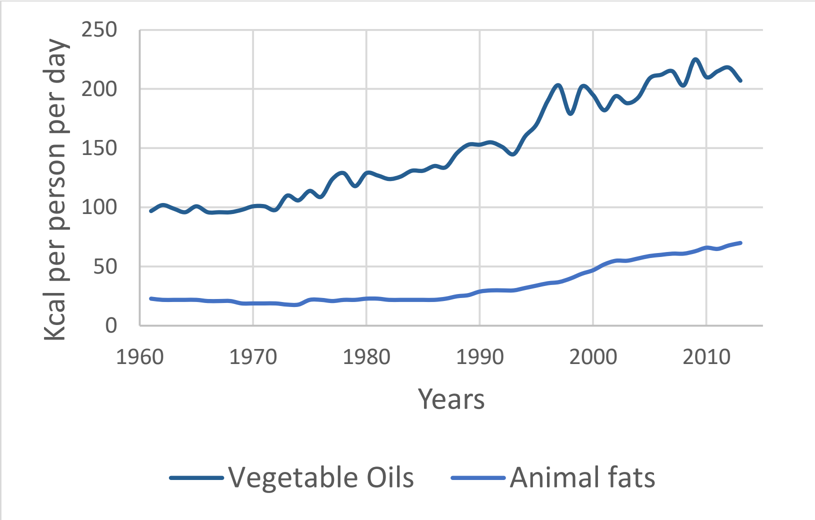
Figure 3-6. Availability of edible oils for consumption in India



Source: USDA PS&D database

In addition to increased consumption of vegetable oils, the consumption of animal fats has also increased, particularly since the 1990s, contributing to growing intakes of saturated fats (See Figure 3-7).

Figure 3-7. Trends in consumption of vegetable oils and animal fats in India

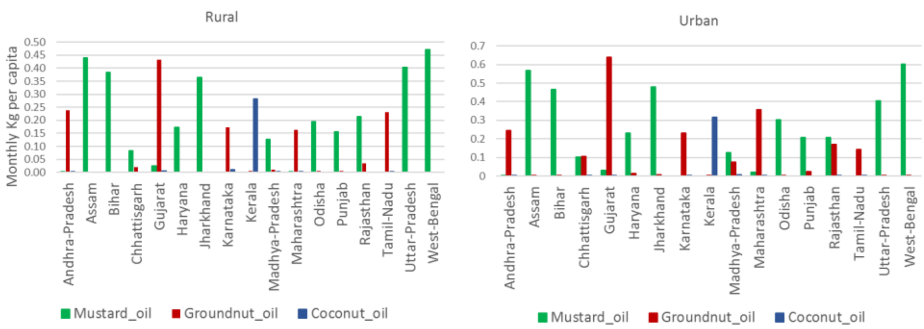


Source: FAOSTAT. FAO food balance sheets

There are persistent regional differences in edible oil preferences and consumption, especially for the main traditional oils, which have marked regional production patterns (Srinivasan, 2012). These are illustrated in Figure 3-8. Rapeseed/mustard oil is most popular in the north-eastern regions, as well as in the north and east. In the south and particularly certain western regions such as Gujarat there is a stronger preference for groundnut oil, while coconut oil is mainly consumed in the South. Aside from the major traditional edible oils, soybean is most consumed in the central and Northern regions where most of the production is concentrated, and palm oil is consumed in all regions, particularly in the "out of home" segment, but it is better accepted in southern regions because its consistency is similar to the traditional coconut oil (GAIN, 2017).

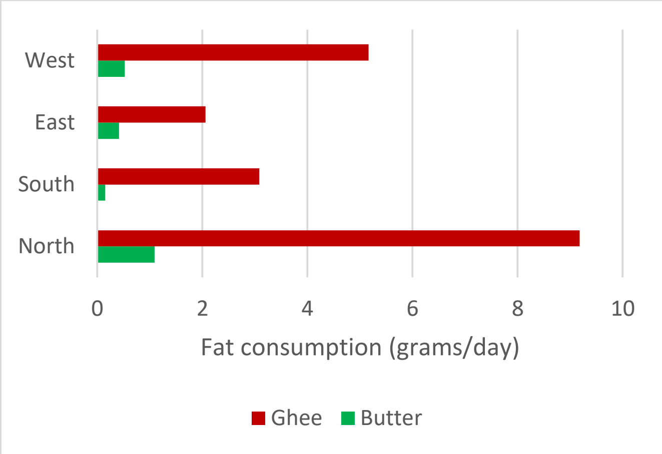
The consumption of animal fats also differs across regions, with ghee (clarified butter) consumption being highest in the Northern regions (see Figure 3-9) (Kumbla et al., 2016).

Figure 3-8. Regional patterns of consumption of major edible oils in India



Source: (Jha et al., 2012)

Figure 3-9.Regional consumption of animal fats in India



Source: (Kumbla et al., 2016)

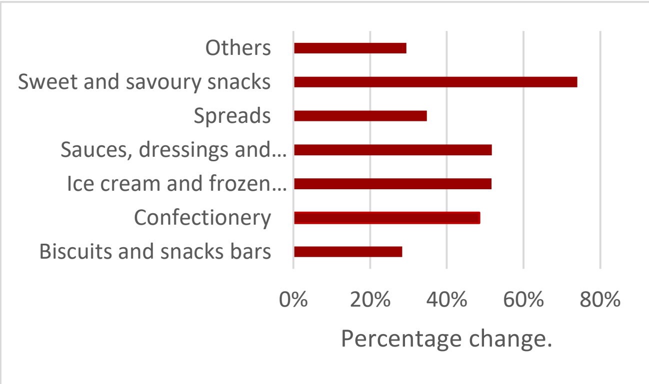
In our quantitative model, ghee and butter are included in the animal husbandry sector, along with other animal source products. Therefore, we cannot explicitly model potential substitution between ghee and vegetable oils in response to policy shocks. This limitation of our quantitative analysis should be taken into account when interpreting results as this could affect the findings in the study, particularly in the northern regions where ghee and butter are most consumed. It is difficult to comment on the extent to which the exclusion of ghee might affect findings and previous studies offer limited guidance on this. (Basu et al., 2013) do not include ghee our butter in their demand model for edible oils. (Pan et al., 2008) do include "liquid butter" and find significant cross-price elasticities with respect to groundnut oil but not for others.

A more recent trend is the increase in consumption of processed food, including packaged products, but also served food consumed out of the household, snacks and street food. Recent data on sales of packaged food show a double-digit growth in sales for many products over a period of five years, led by packaged sweet and savoury snacks, which have increased by over 70% between 2012 and 2016 (GAIN, 2017b) (Figure 3-10). Although the share of packaged food is increasing, this reflects a wider trend towards consumption of food out of the house.

Although liberalisation has so far played a limited role as a driver of processed food sales (See Section 1.3), regional trade agreements, together with the current efforts to attract FDI, are likely to have a bigger impact, given that they represent more ambitious and rapid liberalisation commitments than WTO, and lack some of the safeguards and flexibilities provided by multi-lateral agreements (Francis, 2011), (Baker et al., 2014).

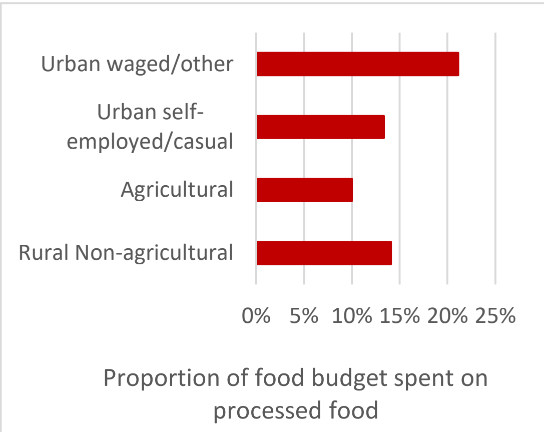
Although processed food tends to represent a larger share of food expenditure in urban areas, it does not show a clear socio-economic gradient, particularly in rural areas (Figure 3-12). On the other hand, household occupation seems to be a better predictor of reliance on processed foods[11], with agricultural households in rural areas and self-employed or casual workers in urban areas spending a smaller proportion of their food budget on processed foods (Figure 3-11).

Figure 3-10. Increased sales in packaged processed food (2012-2016)



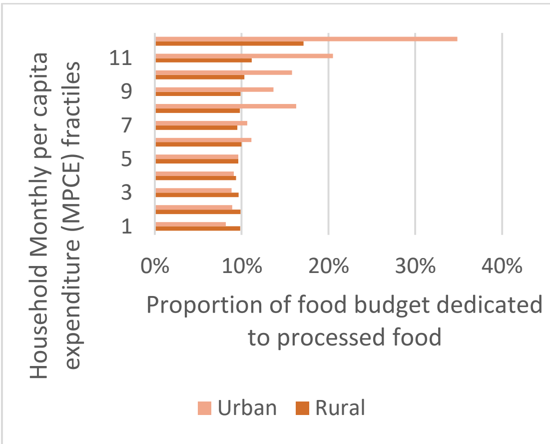
Source: Euromonitor data as provided in (GAIN, 2017b)

Figure 3-11. Pattern of processed food expenditure by household type in India 2009/2010



Source: SAM of India 2007/08.

Figure 3-12. Pattern of expenditure on processed foods in India, 2011-2012



Source: NSSO round 68, 2011/2012.

[11] Recent unpublished work confirms the existence of clusters of individuals, mainly defined by household occupation, whose diets are characterized by higher consumption of processed foods (Tak 2018, unpublished). We will use an occupation-based classification of households for our quantitative analysis in order to capture differential impacts of policy interventions across household groups.

3.6 Conclusion

In this chapter we have provided a brief overview of the main developments in trade and investment liberalisation with relevance for food and diets (Pingali and Khwaja, 2004). We have then focussed on trade liberalisation in the edible oils sector from a historical perspective. Finally, we have discussed the main changes in Indian dietary patterns since liberalisation.

India has undergone a rapid process of liberalisation in many agricultural and food sectors, starting with structural adjustment and the WTO agreement on agriculture. More recently, however, regional trade agreements have gained in importance, as India has concluded several trade agreements with countries in South and South-East Asia including an agreement with ASEAN countries (AIFTA) (Francis, 2011).

As for the edible oils sector, imports of palm oil started in 1974, through government licenses, and liberalisation started in 1994 when oils were progressively placed under Open General Licence for imports. Since then, although the overall trend has been towards tariff reduction, liberalisation has proceeded in waves and large changes in tariffs are still frequent. Palm oil is currently the largest food import in India and was the object of intense negotiations in the context of the agreement with ASEAN (Francis, 2011).

Food security and producer protection have been a central policy concerns for India in the context of trade agreements since the early WTO negotiations (Chand, 2007), (Chang, 2009). These concerns have been reflected in the use of import and export restrictions and, more recently, in the negotiations on public stockpiling preceding the Bali ministerial declaration, where India led the G33 in demanding an agreement that allowed improved flexibilities for developing countries to protect food security (WTO, 2008) (Matthews, 2014).

Liberalisation of investment has proceeded at a comparatively slower rate and is highly unequal within food value chains. The government has liberalised foreign investment into relatively high value-added sectors such as animal husbandry, growth of vegetables under controlled conditions, palm oil, cold chain infrastructure and food processing. Access for international investors to most traditional agricultural sectors and to multi-brand retail, on the other hand, remain restricted.

Overall, liberalisation has been identified as key contributing factor to the nutrition transition, reinforcing existing trends in dietary patterns, (Francis, 2011), (Panda and Ganesh-Kumar, 2009a), and potentially contributing to NCD burdens (P. Baker et al., 2014). Access to imported oils has contributed to progressive increases in fat consumption across population groups, at the expense of carbohydrates and coarse cereals (Misra et al., 2011). Additionally, foreign direct investment in food processing (Ministry of Commerce & Industry, 2017), (The Economic Times of India, 2017a) is contributing to the transformation of food systems and food environments, and in particular to the increased consumption of processed foods and foods consumed out of the house (Misra et al., 2011), (GAIN, 2017b). In the following chapters we will focus on the edible oils sector and edible oil imports. We will analyse the main characteristics, incentives and policy options in the sector, in terms of their impacts on nutritional and sustainability outcomes.

Chapter 4. Qualitative methodology for this study

4.1 Introduction

The qualitative component of our research aims, firstly, to analyse the structure of the Indian edible oils sector, with particular focus on imported oils and palm oil, and on understanding synergies and trade-offs across nutrition and sustainability outcomes. Secondly, we aim to identify opportunities and barriers for the promotion of sustainable, healthy oil consumption in the sector.

We carry out an analysis in two steps. In the first step (Chapter 5), we use a simplified qualitative value chains analysis framework, which provides the basic structure for our understanding of the sector and its context. We identify the structural characteristics and incentives that contribute to creating the existing challenges for sustainable nutrition. We then discuss potential areas of intervention for sustainable nutrition, including synergies and trade-offs across key sustainability and nutrition outcomes.

In a second step (Chapter 6) we analyse the “policy space” as it is shaped by the context, the policy processes or agenda setting circumstances and the characteristics of existing interventions (Grindle and Thomas, 1991). This analysis serves to identify opportunities and challenges for the promotion of sustainable, healthy oil consumption.

Previous studies have analysed the Indian edible oils value chain, focusing on the potential for reformulating trans fatty acids (Downs et al., 2013), as well as the barriers for increased coherence between agricultural and public health policies in the oilseed and oils sector (Downs et al., 2015) or the potential for aligning food processing policies (Downs et al., 2014).

We add to this literature by focussing on palm oil, and incorporating the dimension of sustainability (Gustafson et al., 2016), in particular, identifying potential synergies and trade-offs between environmental and nutritional objectives. Other studies have analysed the Indian edible oils and oilseeds sector as a whole (Chaudhary, 1997), (Persaud et al., 2006)[12], (Shivakumar et al., 2007), (Srinivasan, 2012), (Jha et al., 2012) with a focus on economic outcomes and incentives, but have not addressed sustainable nutrition.

The literature on palm oil value chains in India is still scarce, and has mainly focussed on issues related to environmental sustainability and engagement with industry environmental standards and voluntary commitments (Schleifer, 2016), (Greenpeace India, 2012), (Centre for Responsible Business, 2014)[13]. Recent research, however, has pointed to the need for alternative approaches and a potentially increased role for public regulation in the Indian context, where industry voluntary commitments are not sufficient to produce strong and context-relevant incentives for improved sustainability (Schleifer, 2016). Our study also contributes to this debate, by discussing potential policy interventions, and the interactions between different policies related to nutrition and sustainability.

4.2 Methodology

4.2.1 Theoretical framework

In this section we will describe our theoretical approach as well as the main concepts used in the analysis. We will begin by framing the notions of nutrition and sustainability in the Indian edible oils sector, using a multi-dimensional definition of sustainable nutrition security (Gustafson et al., 2016). We then proceed to discuss our theoretical approach to value chain analysis and the theoretical framework for our subsequent analysis of the policy space.

[12] Persaud et al. (2006) provide a thorough overview of market trends and policy interventions in the oilseed sector. However, it is worth taking into account that this is a USDA publication which strongly advocates for deregulation of GM oilseed imports. Given the US interests in this market, this is not necessarily an unbiased publication in terms of its findings and recommendations.

[13] The latter two references are NGO reports and, therefore, potentially subject to bias.

4.2.1.1 Defining nutrition and sustainability outcomes in the context of the Indian edible oils sector

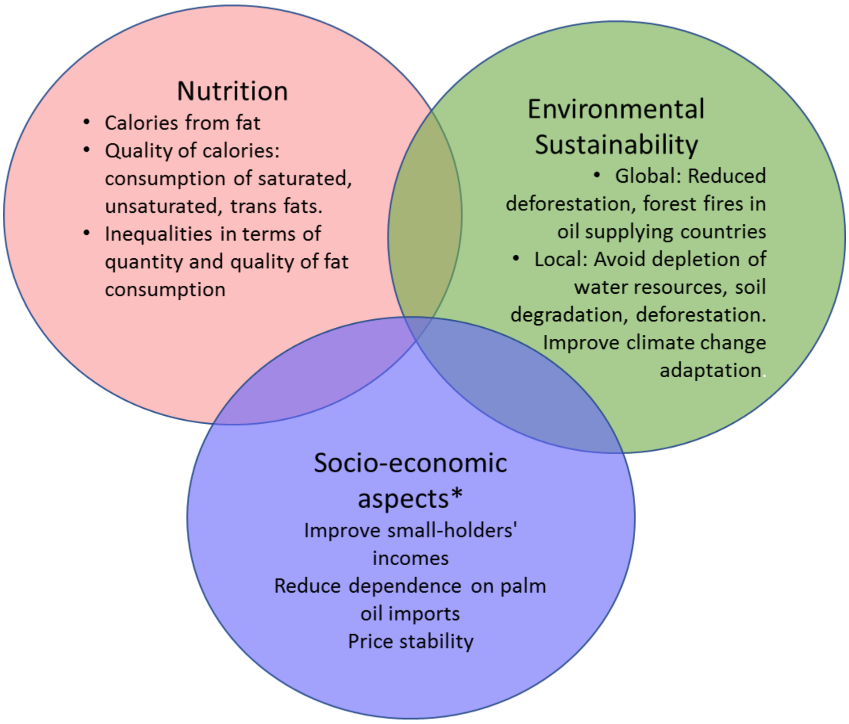
Throughout our analysis, we refer "nutrition outcomes" and "sustainability outcomes", or to the promotion of "sustainable, healthy fat consumption". Although these are commonly used and understood concepts, they are also broad and subject to different interpretations. In recent years, the sustainability of food systems has been recognized as a multi-dimensional concept incorporating nutritional, environmental and social dimensions (Gustafson et al., 2016). In order to articulate a clear definition of nutrition and sustainability outcomes we rely on the concept of sustainable nutrition security as defined by FAO (Traore et al., 2015) and applied by Gustafson et al. (2016). The goal of sustainable nutrition security has been defined as creating:

> *"A global food system in which all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life, without over-consumption or avoidable waste, and while also satisfying the economic, environmental, and social imperatives implied by the constraints of long-term sustainability."*(Gustafson, 2013), (Traore et al., 2015), (Gustafson et al., 2016).

Given that this is fundamentally a concept aimed at assessing food systems and their performance with respect to nutrition, the environmental and socio-economic dimensions are considered in relation to nutrition outcomes, in so far as they support, undermine or constrain them, or create trade-offs or synergies. We use this concept of sustainable nutrition security to support our analysis, providing a precise understanding of the relevant concepts. The environmental and nutritional aspects, which are the focus of our study, are discussed in the context of socio-economic dimensions of sustainability.

Our analysis focusses on specific nutrition and sustainability outcomes which have been identified as relevant in the context of the Indian edible oils sector. These are illustrated in Figure 4-1, based on the multi-dimensional framework provided by Gustafson et al. (2016), who distinguish seven main dimensions of SNS, grouped into three main areas. (Table A1-3 in the Appendix provides a more detailed and broader description of SNS dimensions). Nutrition outcomes of interest include the consumption of calories from fat, and the quality of these calories, with focus on the balance between trans, saturated and unsaturated fats (Popkin, 2006a), (Downs et al., 2013), (Downs et al., 2015), as well as inequalities in terms of quantity and quality of fat consumption (NSSO, 2014). Environmental dimensions of interest include, at a global level, deforestation in oil supplying countries (Schleifer, 2016), (Byerlee et al., 2017) and, at a local level, are related to conservation of water resources, soil degradation, deforestation and climate adaptation (Jha et al., 2012). Relevant socio-economic dimensions of sustainability (not the main focus of our study) include price stability (Persaud et al., 2006), wastage and impacts on the incomes and livelihoods of small-holder farmers in the sector, which can directly affect nutrition outcomes (Kadiyala et al., 2014).

Figure 4-1. Sustainable nutrition security in the Indian edible oils sector. Dimensions of interest. Simplified diagram



Source: Own elaboration based on Sustainable Nutrition Security: What is it? Gustafson, 2013. Original source: Food Security Network of Newfoundland and Labrador (http://www.foodsecuritynews.com/What-is-food-security.htm) *Not the main focus of the qualitative analysis

4.2.1.2 *Complementary analysis of the value chain and policy space for intervention*

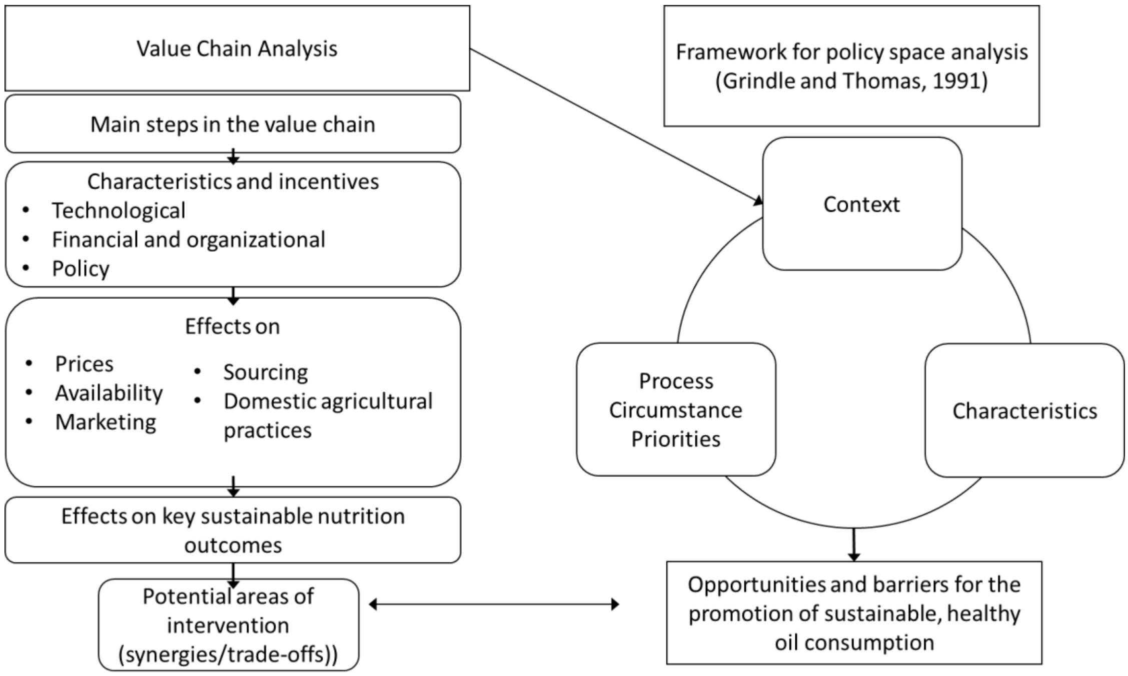
In order to identify opportunities and challenges to address nutrition and sustainability outcomes in a synergistic way, we carry out a complementary value chain and policy space analysis.

In the first step of our analysis, we have used a simplified qualitative value chains analysis framework, which provides the basic structure for our understanding of the sector, and also helps us identify and assess key areas for intervention, where there are opportunities to achieve synergistic improvements nutrition and sustainability outcomes.

In the second step we analyse the "policy space" as it is shaped by the context, the policy processes or agenda-setting circumstances and the characteristics of existing interventions (Grindle and Thomas, 1991), identifying opportunities and challenges for policy intervention along the value chain.

The analysis of structural characteristics and incentives in the value chain complements the policy space analysis, providing valuable contextual information and helping us structure our analysis of the sectoral policy space.

Figure 4-2. Integrated value chains and policy space analysis: Synergistic nutrition and nutrition policy interventions



4.2.1.3 Value Chain Analysis: Theoretical Framework

Value chain analysis (VCA) is a form of systems analysis which focusses on a single product or a family of products and analyses the activities that bring this commodity from production to consumption (and disposal). Compared to more general approaches to systems analysis or mapping, VCA provides an analytical framework to study the inter-linkages between actors in the supply chain, including the role of economic incentives, governance and globalization processes (Kaplinsky and Morris, 2000).

Value chain analysis typically relies to a large extent on analysis of policy documents, corporate reports and existing literature. Formal or informal expert interviews are often used to inform the analysis, but often play supportive role, aiding the interpretation of information obtained from documentary sources (Gereffi et al., 2009), (Hawkes, 2009), (Alonso-Fradejas et al., 2016).

Within VCA there are different traditions and approaches. As this type of analysis is highly context-specific, researchers tend to choose the type of approach based on the context and combine concepts and tools from different traditions which are found to be most useful and appropriate in each case (Morgan et al., 2018) (Alarcon et al., 2017).

Morgan et al. (2018) distinguish between three (overlapping) approaches to value chain analysis as they have been applied to nutrition.

The first is a "problem solving" approach, linked to the strategic management tradition of value chains, which views the improvement of nutrition outcomes as a business opportunity. This type of analysis aims to support continuous improvement, most often in short value chains, where markets are served by local or regional producers see for example (Temu et al., 2014)

The second and third types are the "Global Value Chains" approach (Gereffi et al., 2005), (Gereffi et al., 2009) and the "Consumption-oriented" approach (Hawkes, 2009). These two are parallel frameworks and have mainly been applied to the analysis of long value chains, which include international trade and/or industrialized production. Both approaches start by mapping the main steps and structure of the value chain, including actors involved and input-output flows. In subsequent steps of the analysis, both frameworks place a strong emphasis on institutional context and governance structures. Unlike the GVC framework, consumption-oriented analysis has been explicitly designed for the study of nutrition-related outcomes. As such, it explicitly aims to understand how the main characteristics of the value chain and the incentives they create affect key drivers of nutrition including availability, pricing and marketing.

For our analysis we have applied an adapted version of the consumption-oriented value chains framework, (Hawkes, 2009) . This framework is particularly suitable given our strong focus on nutrition outcomes and the fact that we are analysing a "long" value chain. We have adapted this framework to incorporate key sustainability outcomes and combined this approach with concepts from the GCV framework to categorise different types of governance structure.

Our framework allows us to retain a strong focus on nutrition outcomes, while incorporating key sustainability issues and analysing the role of financial, organisational, technical and policy characteristics. Table 4.1 summarises how the characteristics of our study (context) relate to the choice of a value chains framework.

Table 4-1 Context, study characteristics and choice of value chain framework

Context and study characteristics	**Choice of theoretical framework**
Focus on specific nutrition-relevant commodity (palm oil) and its related "family" of commodities	Choice of value chain analysis over other types of systems analysis
Interest in economic incentives, governance and institutional factors	
Long value chain	Combining GVC with consumer-oriented value chain analysis
Research is done adopting an "outsider perspective"	
Strong focus on nutrition (and sustainability) outcomes	An adapted version of consumption-oriented value chain analysis is used as our main framework for reference (Hawkes, 2009)

In what follows, we describe our adapted framework, as depicted in Figure 4-3

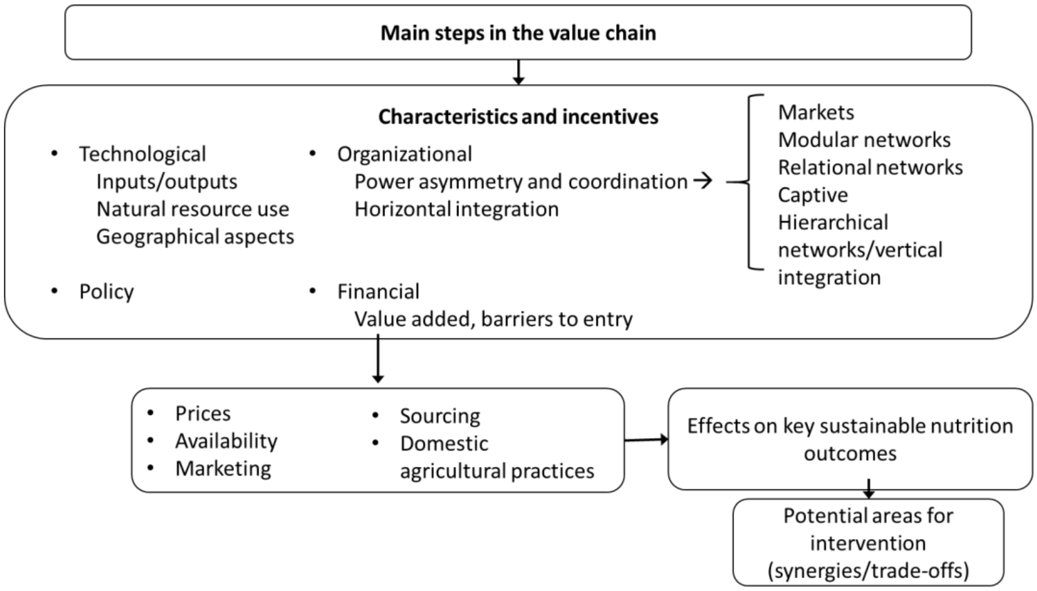
We aim to understand the Indian edible oils sector as a value chain, or as a value web of inter-related commodities (Borras Jr et al., 2016). We focus primarily on palm oil, but situate this commodity in its wider context which, in the Indian case, is given by the edible oils sector [14]. We draw on concepts from the literature on consumer and nutrition-oriented value chain analysis (Hawkes, 2009). Value Chain Analysis (VCA) focuses on understanding where and how products gain value along specific supply chains. Economists and sociologists have used this approach to study power relations between different actors and the associated environmental and socioeconomic impacts.

Previous research in this area has provided a framework for the incorporation of nutritional and health concerns into a value chain perspective, (Hawkes, 2009),

[14] In other contexts, the biofuel or chemicals sector play a more relevant role in the wider "value web". In the Indian case, the food segment dominates and the most relevant value chain dynamics occur across different edible oils

(Hawkes and Ruel, 2012), (Gelli et al., 2015). In what follows, we describe our adapted framework, as depicted in Figure 4-3.

Figure 4-3. Value chain analysis for sustainable nutrition. Theoretical framework



Source: Own elaboration based on (Hawkes, 2009), (Hawkes and Ruel, 2012), (Gereffi et al., 2005)

Following Hawkes, (2009) we analyse technological, organizational, financial and policy characteristics in each segment of the value chain, and the incentives they generate.

Technological characteristics concern physical inputs and outputs, as well as factors of production, including use of natural resources, as well as the geographical dimensions of production processes.

Organizational characteristics concern how actors in the value chain relate to one another and to the broader institutions that regulate their behaviour. In order to describe organizational aspects we use the classification proposed by (Gereffi et al., 2005), where the authors classify networks of interaction based on the degree of power asymmetry and of coordination. Markets represent the lowest degree of both market asymmetry and coordination, where interactions are mediated entirely by prices. Vertical integration or hierarchical relationships represent the opposite end of the spectrum, where the relationships between suppliers and buyers are regulated through direct ownership. Modular, relational or captive networks are intermediate cases. In modular and relational networks, suppliers adjust their product and processes to match the requirements of buyers. In the case of modular networks, most information can be "encoded" in the form of certifications, for example. Relational networks, on the other hand, require, more explicit coordination. Finally, captive networks are characterized by high degrees of coordination, combined with a high degree of power asymmetry, where either suppliers or buyers are "captive" with respect to one powerful buyer/seller. Captive networks can also be described as a monopoly or monopsony (demand-side monopoly). Other relevant organizational aspects include the degree of horizontal integration or the existence or diversification in the segment.

Financial characteristics concern economic flows, profitability, the distribution of value-added along the value chain and the incentives these generate. Relevant aspects include barriers to market entry through high initial costs and incentives for small producers.

Finally, the main policies affecting a particular segment are identified, mapped, and their impacts are analysed.

The methodology proposed by Hawkes (2009) is primarily consumption-oriented, and focusses on identifying how value chain characteristics affect nutrition outcomes through their impacts on prices, availability and marketing. In order to incorporate the environmental dimensions of sustainable nutrition security into this framework, we broaden our focus beyond an exclusively consumption-oriented approach. It is important to note, however, that we are not conducting a full assessment of environmental impacts at each step of the value chain, which would require a life-cycle analysis, or a product road-mapping approach (Watkiss, 2009), (Sustainable Development Commission, 2007). Rather, we focus on key environmental dimensions of interest (Figure 4-1) and assess how they interact with nutrition outcomes in different segments of the value chain, identifying trade-offs and synergies.

In order to address these issues, alongside prices, availability and marketing, as proposed by Hawkes, (2009), we consider how supply chain characteristics can affect sourcing (Schleifer, 2016) (incentives for producers to source sustainable products) or shape incentives for domestic agricultural practices (whether there are incentives for sustainable or nutrition-sensitive agricultural practices). Although this is not the focus of the study, we also comment, to the extent that our analysis permits it, on important trade-offs or synergies with socio-economic dimensions of sustainable nutrition security, such as domestic small-holder livelihoods, which can support or constrain nutrition and sustainability outcomes.

Environmental and social impacts in other steps of the value chain, including pollution from milling or processing, transport or packaging, are not considered in our analysis. Furthermore, the steps occurring in the producing countries, are only considered from the point of view of Indian actors' decisions (whether there are incentives to import palm oil or to source domestically, whether or not there are incentives to source sustainable palm oil). Figure 5-1 shows a simplified diagram of the value chain. The most relevant policy interventions have been mapped along the value chain and are identified with numbers. The reference policy documents and a brief explanation are provided in Table 5-5.

To conclude, we discuss potential areas of intervention for synergistic improvement of nutrition and sustainability outcomes. Others have referred to "leverage points", defined as those segments in the value chain where appropriate interventions could address key constraints and sector characteristics, affecting incentives throughout the value chain and generating structural change (Gereffi et al., 2009), (Hawkes, 2009), (Downs et al., 2015). We do not attempt to systematically identify all possible "leverage points" in the value chain but have focussed on the main areas of intervention discussed as relevant by interviewees. We have focussed on areas of intervention that were discussed as highly relevant by at least three interviewees, from more than one background (researchers, industry, civil society). We then discuss, based on our characterization of the value chain, the potential to address key incentives for improved nutrition and environmental outcomes in these areas.

It is important to note that our analysis focuses on sector-specific policies. Others have identified broader policies which might support nutrition goals in the oils sector but whose main focus would not be related to edible oils. This could include, for example, a move from procurement structures based on intermediaries and regulated markets towards direct contract farming with multinationals, improved road infrastructure or broad policies promoting food processing (Downs et al., 2015), (Downs et al., 2013). We do not include these broader policies, which were also not covered in our interviews and document analysis.

4.2.1.4 Policy Space analysis

We use the framework proposed by (Grindle and Thomas, 1991) in order to analyse the policy space. This framework situates itself in between societal and state-centred approaches, and has previously been used for the analysis of policy space for the dual burden of malnutrition in India (Thow et al., 2016).

Societal approaches include class analysis (Amīn, 1977), pluralist perspectives (see for example McConnell (1966)) or public choice theory (Buchanan and Tollison, 1984), which has often been adopted by neoclassical economists due to its parsimonious methodology. These approaches tend to assume that policy action is a reflection of social interests or the pressures of interest groups, leaving little room to account for initiative, leadership, training or ideology in policy-making (Nordlinger, 1987).

On the other hand, the category of state-centred theories includes a wide range of approaches, such as rational actor models (Allison and Graham, 1999), theories of incremental decision-making (Lindblom, 1959) and approaches to bureaucratic behaviour (Rosati, 1981). Although these theories present important differences and each can contribute valuable insights, they tend to assume that "policy occurs within bureaucratic organizations" (Grindle and Thomas, 1991), and focus on interactions between policy elites, whose actions are based on personal and professional incentives, with little account of the role of social, cultural and historical context, including the legacy of previous policy initiatives.

Following (Grindle and Thomas, 1991), we understand policy as an interactive, rather than top-down process. We place a strong emphasis on context and non-state actors, highlighting how "policy space" can be shaped by the views and interests of different organizations and social groups that have a stake in how a specific system functions (Sutton, 1999), which create barriers and opportunities for specific initiatives. At the same time, we consider that policy-makers' perceptions, ideas, values, organizational structure and political legacy also play an important role in creating the space for policy action and can be particularly important in explaining "good policy".

The final section in Chapter 6 provides a more normative discussion of the sectoral policy portfolio. In this section, we apply concepts from the seminal work of Tinbergen (1952), combined with recent developments on the analysis of complex policy mixes (Del Rio and Howlett, 2013), in order to match potential policies to key policy goals. In order to improve readability, the theoretical concepts underpinning this discussion are discussed directly at the beginning of Section 6.5.

4.2.2 Sampling and data collection procedure

This study is based on the analysis of 70 documents and 14 semi-structured interviews with experts and actors from policy, industry and civil society. The research protocol was approved by the ethical review board of the London School of Hygiene and Tropical Medicine and the Public Health Foundation of India.

Interviews

Interviewees were initially contacted via phone or email. Whenever email contact was available, an explanatory letter was sent and consent was sought for an interview. Interviews have been conducted in person, in English language.

We obtained our initial sample through purposeful sampling (Marshall, 1996). In particular, the initial sample follows a normative approach and is based on a representation of "how the system works" (Hare and Pahl-Wostl, 2002). A schematic representation of the system which, in this case, corresponds to the value chain, is provided in Figure 5-1. Additional interviewees were contacted through snowballing. The aim was to include interviewees that can provide knowledge of different segments of the value chain, from different perspectives including policy, industry, civil society and academic expertise.

In order to determine sampling size we aimed for adequate "information power" (Malterud et al., 2016). This method considers that sample size for qualitative research is inversely proportional to the informational content of the sample, which depends on five specific dimensions. According to this theory, the necessary sample size depends on the research aim, the specificity of interviewees needed, the theoretical basis for the study and the quality of the dialogue and nature of the study (case versus cross-case). In this case, the research question is relatively broad but well defined, the sample is highly specific, composed of experts and senior representatives of institutions, with a high degree of articulateness, and the analysis is strongly based on an a priori theoretical framework, which also guides the sample design. For this reason, we aimed for a relatively small but highly informative and specific sample, guided by our initial representation of the system (Figure 5-1), while seeking to include interviewees providing information on different segments of the sector, from the points of view of policy, industry, civil society and academic expertise.

All fourteen interviews were carried out in person, and written informed consent was obtained at the time of the interview. Interview duration was approximately 40 minutes. All interviews are anonymous, and permission was sought for recording. This was granted in all but two cases. In these cases, detailed notes were taken throughout the interview.

Interviewees were identified among senior representatives of the relevant institutions at the level of Director or CEO. In the case of academic researchers, we sought to interview experts with a long and established experience and reputation in the relevant field. On three occasions, the interviewees initially selected designated or delegated on a spokesperson who attended the interview on their behalf, having less seniority but more technical or hands-on expertise. Industry interviewees include representatives of relevant industry or professional associations in the edible oils and food processing sectors, as well as large individual oil and food processing companies. Other interviewees include senior representatives of civil society organizations and NGO, senior representatives from the most relevant government bodies involved in policy and regulation in the edible oils sector and of one nutrition advocacy group. We also interviewed academic experts and researchers in the areas of nutrition, health and food policy. It is worth mentioning that all researchers except one performed policy advisory roles or were directly involved in policy planning in addition to academic research, providing a combination of policy and research expertise. Two civil society interviewees had also held previous positions in other areas of the sector, respectively in policy and industry.

Quotes in the text are marked with the following initials CS (civil society), IN (Industry), P (Policy maker), AD/R (policy advisor/researcher). Some of the experts interviewed fit in more than one category and many have had different roles in the sector at different points in time. The most fitting category was used.

Interviews covered some broad common topics, including perceptions about drivers of edible oil (palm oil) consumption, organizational and individual roles and relationship to policy-making, , main characteristics, incentives, trends and future changes in the sector, most relevant policy interventions and impacts, perceived importance of different dimensions of Sustainable Nutrition Security and policy approaches to these issues, actor priorities and perceived actor influence.

These topics are designed to follow our theoretical framework providing information on value chain characteristics, and policy context, process and content. However, topics were not necessarily addressed in this order, additional questions and topics were added according to each interviewee's area of expertise, and different emphasis was placed on different topics also according to the participants' knowledge, experience and willingness to discuss specific topics. Some technical and quantitative questions were added for interviewees with specific technical knowledge, for example regarding the relative importance of specific uses of palm oil in the industry, or the impact of trans fat regulation on palm oil demand.

Document search

Information obtained from interviews was complemented with a document analysis. This included mainly primary documents (written by someone who witnessed or participated in the events) and, in two instances, secondary documents (written by someone who did not directly witness the events) (Mogalakwe, 2006). Primary documents include annual reports (19), resolutions, notifications, regulations and acts (35), official press releases (1), minutes of meetings (1), draft regulations (1), official government presentations (1) and corporate reports (11). Secondary documents include reports from non-governmental organizations (1). In total, 70 documents were analysed. We searched for documents in the official websites of relevant government departments and the web pages of the key institutional and corporate actors identified during our research (See Table A1-4 in the appendix. We complemented this search with internet searches referring to specific regulations or policies which were either mentioned by interviewees or mentioned in the documents initially retrieved.

Search terms were adapted to each source, depending on the value chain segment and actor type that the search referred to. If the website did not include a search tool or this tool did not provide satisfactory results we manually searched and obtained annual reports or relevant documents. Depending on the relevant value chain segment and type of actor we searched for terms related to the following concepts: Edible oils sector (edible oils, vegetable oils, hydrogenated fats, vanaspati, fats and oils, palm oil, soybean oil, mustard oil, rapeseed oil, groundnut oil, coconut oil, oilseeds, oil palm); Nutritional aspects of oil consumption (saturated fat, trans fat, fatty acids); Sustainability in the oils sector (sustainable, sustainability, certified, RSPO).

Documents from the year 2010-June 2017, and in one case one annual report from the year 2009 (for convenience, since this reflected the beginning of the scheme for distribution of edible oils).

We included documents that would reflect the main policies affecting each value chain segment (policy mapping) or the approaches of key actors to different dimensions of sustainable nutrition security in the edible oils sector. In addition (ex-post), we applied criteria of authenticity, credibility, representativeness and meaning: All the documents included were obtained from trustworthy sources and were typical of their category (credible). Most of the documents represent the official position of key actors and can therefore be considered representative. In the case of minutes of a meeting, it is harder to assess the representativeness of this document, which is used only to corroborate, and triangulate information obtained in the interviews. In terms of meaning, although some of the documents included highly technical information, the relevant information was generally comprehensible. Actors' approaches were often either explicitly stated or relatively easy to infer from the information provided.

Although we have aimed to maintain transparency in the document search and inclusion process, there are some limitations to our search methods. In the first place, we relied exclusively on documents published online, and did not search paper-based institutional archives. Secondly, although we have sought to avoid any biases, the "snowballing" approach to document search and complementary internet (Google) search for specific documents or policies, while adding to the completeness of the information, can reduce the replicability of the search.

4.2.3 Information extraction and analysis

Interview analysis

Interviews were transcribed verbatim, manually coded and analysed combining content analysis and thematic analysis (Ritchie and Spencer 2002). After an exploratory analysis of the data, or familiarization, an initial framework was developed, where the main emerging themes were noted and classified. This initial classification was informed by our theoretical framework, using concepts from value chain and policy space analysis, distinguishing between value chain characteristics and policy context, circumstance (or process) and content (Grindle and Thomas, 1991), which were used as broad categories across which emerging sub-categories and concepts were classified and organized. The resulting provisional framework was applied to the data and discussed with the supervisors. Following this initial coding, further categories were added, and codes refined. Subsequently, the coded data were analysed based on our theoretical framework, described in the above section and graphically shown in Figure 4-2. (See appendix A-2 for interview guidelines and themes used for analysis). We identify themes related to technological, financial and organizational characteristics in the value chain and key policies and areas for intervention, which informs our value chain analysis. We also identify international and national contextual factors (eg. trade agreements or broad national policy trends) which can shape the space for the promotion of healthy, sustainable oil consumption), actor roles, priorities, influence and perceptions around sustainable nutrition, and characteristics of important interventions in the edible oils sector, including explicit goals, approaches and distribution of costs and impacts.

Document analysis

Documents were analysed before, during and after interview data collection, providing background and context for the analysis, suggesting additional questions and lines in inquiry, corroborating or verifying information obtained through other sources, and supplementing information (Bowen, 2009). Additionally, the analysis of policy documents and reports provided the means to track change in time, through the comparison of annual reports, regulatory notifications and different versions of draft documents. Documents were analysed using the same theme categories (see appendix A-2). In general, we identified the main actors involved, the value chain segment addressed and stated/explicit goals. Where relevant, we also identify mentions to relevant contextual factors (broader policy frameworks), narratives or priorities with respect to sustainable nutrition and, in particular, healthy fat consumption, and distribution of intervention impacts and costs.

Where documents contained highly repetitive information with other similar (later) documents, we focussed on the most recent version of the document. Additionally, some documents contained information that was unrelated or only peripheral to our analysis of the edible oils sector or to issues related to healthy, sustainable fat consumption. In these cases, we focussed only on those sections or mentions in the document that are relevant to our analysis.

4.3 Summary

In this chapter we have discussed the methodology and theoretical framework for our qualitative analysis.

Chapter 5 contains the value chain analysis, including an analysis of structural characteristics and incentives in the value chain and their impacts on key sustainability and nutrition outcomes, followed by a discussion of potential areas of intervention for sustainable nutrition. In Chapter 6, we analyse the policy space for the promotion of healthy, sustainable oil consumption, as it is shaped by policy context, process and characteristics.

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
www.lshtm.ac.uk

Registry
T: +44(0)20 7299 4646
F: +44(0)20 7299 4656
E: registry@lshtm.ac.uk

LONDON SCHOOL of HYGIENE & TROPICAL MEDICINE

RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Soledad Cuevas Garcia-Dorado
Principal Supervisor	Marcus Keogh-Brown
Thesis Title	The nutritional and economic effects of palm oil trade liberalisation in India: A policy analysis

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
When was the work published?			
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*		Was the work subject to academic peer review?	

**If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.*

SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Supply Chain Management
Please list the paper's authors in the intended authorship order:	Soledad Cuevas, Shauna Downs, Suparna Ghosh-Jerath, Aafrin, Bhavani Shankar
Stage of publication	Not yet submitted

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	SC is the main contributor and has designed the study, carried out the research and written the manuscript. SGJ and A have assisted in data collection. SD and BS have advised on study design, and on the manuscript.

Student Signature: [redacted] **Date:** 20/May/2018

Supervisor Signature: [redacted] **Date:** 25/05/2018

Chapter 5. The Value Chain for edible oils in India: Characteristics, incentives and areas of intervention for sustainable nutrition

5.1 Introduction

In this chapter we analyse the characteristics of the value chain for edible oils, with focus on imported oils and palm oil. We analyse the incentives and impacts that these structural characteristics generate in relation to nutrition and sustainability outcomes.

This chapter relies to a large extent on the analysis of policy documents and corporate reports, as well as on existing literature. Interviews with experts and value chain actors are used for corroboration and interpretation of existing evidence, as well as in those areas where there is a lack of published evidence. This is standard practice in value chains analysis, where the goal is not to produce new evidence but to use existing evidence to provide an interpretive framework (Gereffi, 2001).

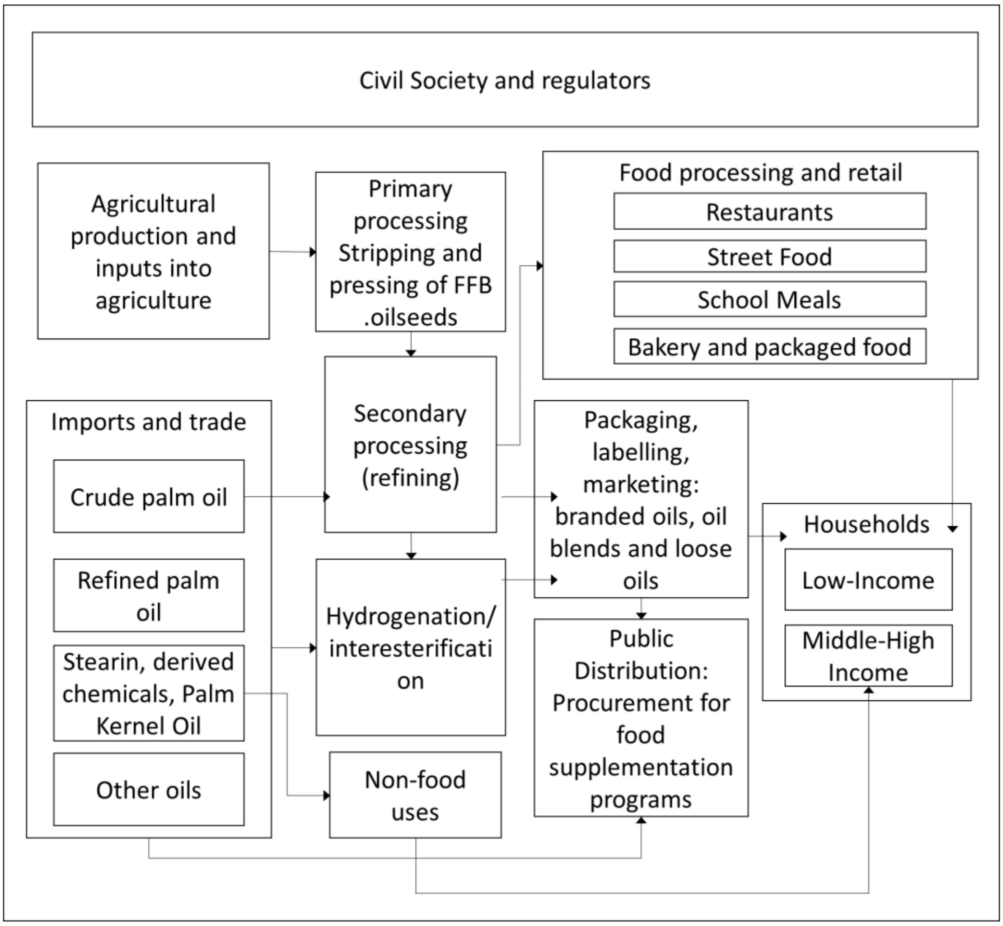
We rely on interviews in the last step of our analysis, in order to guide our discussion of potential areas of intervention, which are discussed in terms of impacts on key nutrition and sustainability outcomes, based on our characterization of the value chain.

The theoretical framework and methods have been described in (Chapter 4). This analysis complements and provides the context for the policy space analysis in the next chapter.

The rest of the chapter is organized as follows: Section 5.2 analyses the technological, organizational, financial and policy characteristics, and the incentives they create (Hawkes, 2009). Section 5.3 discusses the impacts of key sector characteristics on oil availability, prices, marketing, sourcing (oil procurement strategies) and agricultural practices (incentives for the adoption of sustainability practices, as they mediate sustainability and nutrition outcomes. Section 5.4 discusses potential areas of intervention for sustainable nutrition and Section 5 concludes.

5.2 Characteristics and incentives of the value chain

Figure 5-1. Simplified diagram showing the main steps in the supply chain for palm oil in India



In this section, we analyse the technological, financial, organizational and policy characteristics of the Indian edible oils value chain and the incentives they generate, with focus on palm oil.

Figures A2-1 and A2-2 and Table A2-2 in the appendix provide a fuller depiction of the value chain, including organizational characteristics and a policy mapping.

The first step in the supply chain is agricultural production. Although we are mainly focussing on palm oil, the constraints and incentives for production of domestic oilseeds and substitutes need to be incorporated into the analysis in order to fully understand the incentives for palm oil imports. As for domestic cultivation of oil palm, this is a very small segment, representing only around 2% of palm oil supply. Domestic oil palm cultivation, therefore, is not the main focus of this analysis. However, it is relevant to understand the main characteristics, potential and constraints for domestic expansion, as they affect incentives in the value chain.

The next steps in the supply chain are international trade, oil processing, marketing and distribution, food processing and household demand. We will discuss characteristics and incentives in each segment separately. A summary is provided inTable 5-2 and Table 5-3 at the end of this section.

5.2.1 Domestic agricultural sector: constraints, incentives and policy

The main oil crops in India are rapeseed/mustard, groundnut and soybean. Other important oilseed crops include coconut, grown in the south, or sunflower. Previous research has identified supply-side constraints to oilseed production as an important barrier for healthier oil consumption in India (Downs et al., 2015).

Oilseeds in India are produced to a large extent by small-holders, often supported by farmers cooperatives, (Chand, 2007). Production of oilseeds is constrained by several environmental, technological and organizational factors. All oilseed crops are affected by droughts and water scarcity (Kumar and Gautam, 2014), and are often grown in marginal land with degraded soil quality (Jha et al., 2012). These constraints are compounded by the lack of access to good quality seed, inefficient fertilizer use and lack of infrastructure for sustainable irrigation, such as drip irrigation (Srinivasan, 2012), (Jha et al., 2012). As a consequence, the yields for traditional oilseed crops such as rapeseed or groundnut have remained significantly below international averages, and below the estimated area-specific potential yields, (Jha et al., 2012). Recent studies have also pointed to inadequate procurement as an aggravating factor, being dominated by intermediaries who often impose low prices and involving important wastage at the sites of collection and at wholesale markets (Downs et al., 2015).

The overall low yields, unreliable output and price fluctuations act as an important barrier to entry for farmers. Several interviewees coincided in highlighting the extent to which these factors had constrained area expansion for oilseeds by disincentivizing farmers, who have switched to more profitable crops. One interviewee commented *"we have to give farmers a lot of incentives"* (P) while another argued:

"That's the bigger challenge. We used to produce our own oil. What happened to that? Why did we move 'en masse' to cotton and sugarcane? And other products, which are more market-oriented than food products which are required. We have the domestic capacity to produce oil [CS]"

In addition to the negative impacts on oil supply and consumption, current agricultural practices in the sector, including inefficient water and fertilizer use create direct challenges for environmental sustainability and climate adaptation.

Policy interventions in the sector are currently attempting to address these issues through various initiatives integrated in the National Mission on Oilseeds and Oil Palm (Ministry of Agriculture, 2014a). This program is oriented mainly towards area expansion and, particularly, yield improvement of oilseeds, facilitating access to inputs and including investment in irrigation infrastructure, R&D and training. In addition, major oilseeds are subject to minimum prices according to a price support scheme (CCEA, 2016), (Ministry of Agriculture, 2017a), which has historically remained below market prices, having little impact on incentives (Reddy, 2009).

Domestic cultivation of oil palm is, so far, a small sector in India, which and has experienced a relatively slow growth since the early nineties. In 2016, domestic output amounted to around 2% of total availability (USDA, ps&d data). Plantations concentrate in the few geographical areas which provide the adequate tropical humid climatic conditions. These including Kerala, Andhra Pradesh, Telangana, Karnataka and Tamil Nadu. Most recently, oil palm development is being encouraged in North-Eastern regions, known for their humid climate and high forest cover (Ministry of Agriculture, 2017b). Oil palm is seen as a desirable crop due to its comparatively high yields and the fact that it provides a continuous, non-seasonal output, providing a steady source of income for cultivators (Byerlee et al., 2017).

Oil palm cultivation, however, requires large amounts of water and important initial investments. These investments need to cover the installation of on-site milling facilities to process highly perishable fresh fruit bunches, the tree saplings, and the costs for the first five years before oil palms start producing a positive cash flow (Byerlee et al., 2017). Additionally, in India, oil palm often requires irrigation, which implies additional fixed costs to dig wells or install the necessary infrastructure (Ministry of Agriculture, 2014a). In other countries, logging of forested areas has often provided a source of funding to cover fixed costs and the initial period of cultivation. In India, however, cultivation has mainly taken place on previously tilled land, implying the need for substantial up-front investment.

Water requirements, the substantial up-front costs and long gestation period were perceived as the main barriers to expansion in the sector. Interviewees commented:

"[palm oil] has been stuck for a few years, because it requires a lot of water, it requires certain climatic conditions" (P);

"It's due to water and also, farmers are not interested, because of the four years of gestation period, so that has been the main drawback, the gestation period"(IN)

The most powerful actors in this segment are vertically integrated milling companies, including oil processing companies who have diversified into oil palm cultivation. The sector is highly consolidated, with four players controlling most of the market, including large oil processing companies who have diversified into domestic oil plantations[15]. Palm oil cultivators generally have a captive relationship or monopsony with millers, leading to the need to regulate contracts in order to avoid potential abuses of power (Cramb and McCarthy, 2016). So far, land ownership has remained to a large extent in the hands of small-holder farmers. Expansion, therefore, has been determined by the interaction of farmers' incentives to switch to palm oil and companies' incentives to put forward the necessary investment.

Since the early 1990s, several public interventions have attempted to promote area expansion, mainly through small-holder oriented subsidies, with limited success. Previous schemes include the oil palm development plan (OPDP) in 1992, the ISOPOM (2004) and the Oil Palm Area Expansion scheme (OPAE, 2011) and the Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize ISOPOM. Currently, the NMOOP promoting oilseed cultivation includes a component of oil palm expansion, providing farm-based subsidies for inputs and irrigation.

Given the limited success of initiative targeting small-holders, the government is increasingly attempting to attract corporate investment into the sector, allowing for FDI up to 100% and relaxing the land ceiling for farm subsidies (Press Information Bureau, 2017)

In addition, contracts between farmers and milling companies are subject to specific regulation (Commissioner of Horticulture, Andhra Pradesh, 2014) in order to protect the interests of both parties and a balanced risk sharing. This includes regulated prices for palm fresh fruit bunches through a fixed formula taking into account oil and palm kernel prices (Ministry of Agriculture, 2013). More recently, national sustainability standards have been implemented, collecting pre-existing regulations and establishing guidelines for good practices (Solidaridad, 2017).

Regarding nutritional impacts, palm oil promotion has been identified as a potential barrier for NCD prevention, given its high content in saturated fat (Downs et al., 2015), (Thow et al., 2016). It is worth pointing out, however, that even if palm oil production increases substantially beyond current levels representing 2% of total

[15] Four companies control an important share of domestic production. These are: Godrej Agrovet, Ruchi Soya and 3F and Navabharat Agrotech Ltd.

availability, nutritional impacts would depend on the extent to which domestic production replaces imports, and the role of the export market.

In terms of environmental impacts, interviewees from industry and civil society seemed to agree that the risk of deforestation is low, with expansion mainly taking place in previously cultivated land. In fact, the domestic industry perceives an advantage in terms of sustainability with respect to Indonesia and Malaysia, expressing interest in focussing on high-value added sustainable products for the export market. As one interviewee put it, *"India supports sustainability, [and] people in developed countries can afford to pay higher price for the certified palm oil" (IN)*

Some stakeholders have expressed concerns, however, about the fact that current policies promote expansion in "wasteland and degraded land" without providing a clear definition of these concepts (Centre for Responsible Business, 2014).

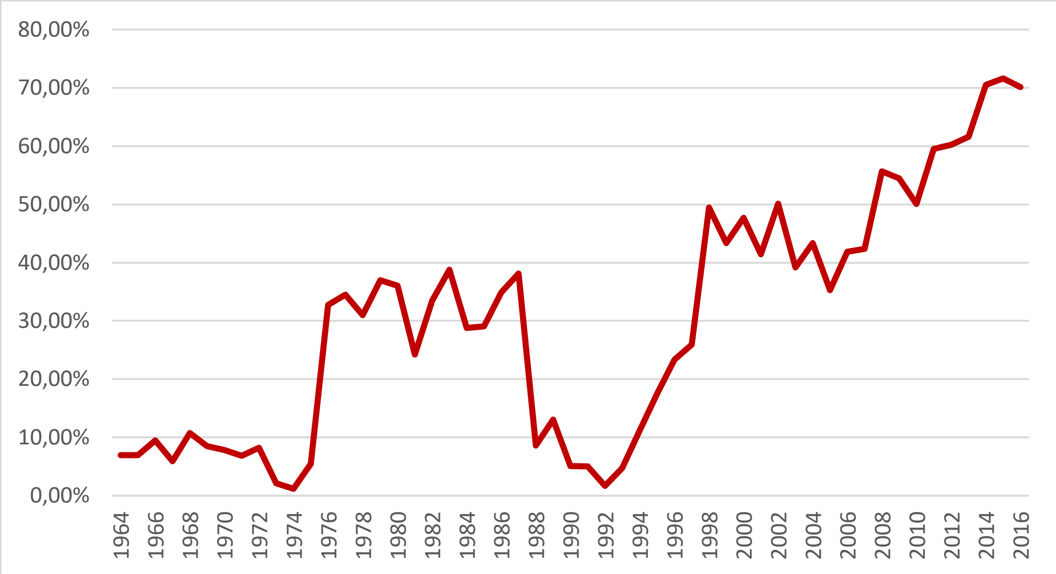
The concept of expansion at "wasteland areas" holds some similitude to Indonesian policy narratives of palm oil expansion at the forest "frontier". In the Indonesian case, McCarthy and Cramb, (2009) describe policy narratives as being involved in simultaneously defining and transforming the frontier. The authors analyse how, by characterizing frontier areas in terms of their "lack of" (lack of developed agriculture, lack of protected forest), the ecological characteristics and forms of livelihood in these areas tended to be overlooked. Interviewees, however, highlighted also the important perceived differences with the Indonesian context, and identified various protective factors, including regulatory frameworks, land property and industry incentives.

Water use, on the other hand, was identified as a more pressing concern. Under the NMOOP, support for irrigation infrastructure and well drilling is restricted to areas not classified as "critical, semi-critical or over-exploited ground water zones" (Ministry of Agriculture, 2014a). Interviewees stressed the need for innovative water conservation strategies to support any future oil palm expansion. Overall, the potential for input substitution through palm oil expansion is limited, particularly if we consider sustainability constraints. Nevertheless, increased interest and involvement in domestic cultivation from industry and policy-makers can have a relevant impact in terms of policy incentives, potentially encouraging domestic producers.

5.2.2 International trade

Although India is a large oilseed producer, it is heavily reliant on imports of palm oil and soybean to meet its increasing domestic demand (See Figure 5-2). Imports of other oils, such as sunflower, are small in comparison. In the past decade, imports have represented between 50% and 80% of all oil available. Palm oil is imported mainly from Malaysia and Indonesia, while the main suppliers of soybean are Argentina and Brazil. India's imports of palm oil are close to 20% of total global trade (Srinivasan, 2012).

Figure 5-2. Import dependence for edible oils



Source: Own elaboration, based on USDA, PSD database. Import dependence is defined here as the proportion of imports over total domestic consumption, in physical volume units.

Cultivation of palm oil in Indonesia and Malaysia has been linked to deforestation of tropical forests and peatlands, considered critical carbon sinks and biodiversity reserves (Agus et al., 2013), as well as to conflicts over land tenure, (McCarthy and Cramb, 2009) 16. Seeking to improve practices in the sector, multiple private and state-backed initiatives have emerged engaging multinational brands through corporate social responsibility and certification schemes (Rival, 2017). The most relevant platform, in terms of industry engagement and global legitimacy, is the Roundtable on Sustainable Palm oil (RSPO), whose certification schemes, although not exempt of criticism, have become a sort of gold-standard in international markets (Schouten and Glasbergen, 2011).

[16] Although soybean cultivation has also been linked to negative environmental and social effects, this is not the focus of our analysis. See (Pengue, 2005) for a discussion on the impacts of transgenic soybean in Argentina, which is one of India's main supplying countries.

Private companies and traders import most of the oil, while the occasional public sector imports for food security programs are carried out directly by various Public Sector Undertakings (PSU) (DFPD, 2011).

Although quantitative estimates are lacking, there seems to be a trend towards increased direct sourcing of palm oil from Indonesia and Malaysia. Direct sourcing is feasible for large, vertically integrated firms, and facilitates the implementation of sustainability commitments (Godrej Industries, 2017), (Hindustan Unilever, 2017). In the medium term, this shift can transform the influence that the Indian market has over global production, from a market-based influence, mediated through prices, towards a more direct influence, mediated through hierarchical, relational or modular network structures, where there is increased interaction between buyer and supplier (Gereffi et al., 2005). Until 2016, however, actual import volumes of CSPO have been very low (Schleifer, 2016), (WWF India, 2017).

Import volume and composition are affected by changes in tariff levels, which are frequently adjusted in reaction to market fluctuations, as well as by the gaps between crude and refined oil (Dohlman et al., 2003). Although there are no quantitative restrictions to oilseed imports, these are de facto restricted disincentivized by stringent sanitary and phytosanitary regulations concerning the imports of genetically modified seeds (Persaud et al., 2006), (GAIN, 2017a).

In recent years, the government has restricted exports in order to control consumer prices and ensure availability. In response to international and domestic price increases, edible oil exports were banned in 2008 (Director General of Foreign Trade, 2008) until March 2017, when the ban has been lifted for all the main edible oils, following a price reduction for domestic oils (Department of Commerce, 2017).

Soybean meal is the main export from this sector, marketed as non-GM and sold at a premium in international markets. Steady increases in the national demand for feed products can lead to important changes in the sector, reducing meal exports but potentially increasing the returns to soybean, rapeseed and other domestic oil crops (Chaudhary, 1997), (Persaud et al., 2006).

5.2.3 Edible oil processing industry

Oilseeds are crushed in mechanical expellers or processed through solvent extraction, in order to obtain oil. Although these are not the focus of our analysis, important by-products are obtained in this step, including protein-rich oil meal, which is used for animal feed or, in the case of palm oil, a small proportion of oil from the kernel, which is used mainly for industrial purposes. The oils obtained from primary processing can be filtered and distributed raw to consumers or can be refined. In the case of palm oil, crude oil is not distributed for consumption.

Refining is the chemical treatment of oils, in order to alter their organoleptic and chemical properties, increasing their thermal stability and shelf life. In this process, important micronutrients can also be lost. For example, crude palm oil is a rich source of beta-carotenoids (vitamin A). These are lost, however, in the standard refining process, which produces what is known as refined, bleached deodorized palm oil (RBD) palm oil. The non-edible oil fractions that result as a residual of palm oil processing are also used for industrial products. In the Indian context, around 90% of palm oil is used for food.

The Indian oil processing industry has traditionally been characterized by a large number of small and relatively inefficient units. Previous studies have partly attributed this to historical government policies (Persaud et al., 2006). In the first place, the vertical integration of primary and secondary processing units was restricted as part of a small-scale industry reservation policy. This policy was effective for several decades and only gradually lifted in recent years (in the case of mechanically expelled groundnut, as recently as 2015) (MCI, 2015).

Subsequent public incentives for modernization, while increasing capacity and potential technical efficiency, have failed to fully address the problem, contributing to excess capacity, which is not matched to local supplies and reduces overall efficiency (Srinivasan, 2012), (Jha et al., 2012). Under-utilized capacity (currently at around 45%) is currently perceived as a key constraint for increased domestic production and an important policy concern, depressing oilseed prices and reducing investment. Currently large, integrated oil processing companies are the most powerful actors in the edible oils supply chain.

The situation of permanent dependence on oil imports has encouraged investment in large plants and "processing hubs" situated near or at the main ports for international oil trade. Key ports include Kandla in Gujarat, JNP in Mumbai and Haldia south of Kolkata among others (Ruchi Soya Industries Ltd, 2016). Gujarat, in addition, hosts Mundra port, which has a Special Economic Zone status (SEZ) and which is privately owned by Adani Group whose joint venture with Singapore palm oil giant, Adani Wilmar, controls an important share of the Indian oil market (Adani Enterprises, 2015). These hubs host large soybean and palm oil refiners, strategically positioned to benefit from the availability of imported raw materials and create economies of scale. Despite overall modernization across the processing industry, the comparative efficiency of these processing hubs is likely to increase the price advantage of palm oil and soybean with respect to other oils and reinforce the creation of diverging processing infrastructures (a less efficient and fragmented infrastructure for processing of traditional oils and an increasingly efficient import-oriented segment). This trend was identified by interviewees as an important transformation in the sector, along with overall increased capacity and integration:

> *"[Now] the units are on the ports, so you can import the oil, and refine the crude oil […] It's economically viable also to refine it at the port itself, rather than carrying it around the country. They have shifted to just refining the crude oil rather than crushing. Now big plants are there, the capacity is more"(P)*

One consequence of this trend is the differential sensitivity towards tariff incentives. Import-oriented processors are highly sensitive to tariff differentials between crude and processed oil. To the extent that some of these companies are vertically integrated and involved in agricultural production, sensitivity to overall tariff levels can be somewhat mitigated. Processors that depend on domestic supplies for crushing or solvent extraction, on the other hand, are more sensitive to overall tariff levels for competing palm and soybean imports.

Furthermore, in India, oils are also frequently consumed hydrogenated. Artificially partially hydrogenated vegetable oils (PHVO) were introduced into the country in 1937. PHVO were commercialized as an affordable alternative to animal fats (ghee) that became known as *vanaspati ghee*. The popularization of hydrogenated vegetable oils as a cooking fat and an ingredient in food processing (for bakery products, snacks and others) was responsible for the increased consumption of trans fatty acids in India (Downs et al., 2013).

Vanaspati has typically had a very high content of TFA, in order to achieve the desired solid, granular consistency. While branded products contained up to 23% TFA, higher contents have been found in samples including unbranded products. (Ghafoorunissa, 2008) reported levels of around 40%, while (L'Abbe et al., 2009) found levels ranging from 4 to 65%. Since 2014, the TFA content of PHVO was limited to 10% by regulation, and subsequently further reduced to 5% (FSSAI, 2013) (other countries, like Denmark, have established a limit of 2%), promoting a recent shift towards total hydrogenation, or interesterification processes. Recent studies, however have also found incomplete adoption of the regulation, with 28% of study samples exceeding the (10%) limits (Dorni et al., 2017). Although intakes are low at the population level (Dixit and Das 2012) , these results suggest potential dangers to the health of specific groups of population whose intake of TFA is higher than average (Dorni et al., 2017). Previous research has also identified important links between the consumption of TFA/vanaspati and palm oil (Downs et al., 2013), (Downs et al., 2015), which are summarized in Box 5-2.

Box 5-1.. The links between trans fat, and palm oil in India

- Traditionally, palm oil has been an important input into vanaspati/PHVO. This is because its relative affordability compared to other oils, but also due to historical and technical issues.
- Historical and policy links: Before liberalisation, a large proportion of the import licences for palm oil were allocated to the PHVO industry (Aneja et al., 1992). After liberalisation, in the 2000s, the PHVO industry was allowed imports of palm oil at a reduced rate.
- Palm oil as an input to PHVO/vanaspati: The high saturated fat content of palm oil can help achieve the desired consistency, high smoking point and thermal stability for vanaspati, with lower content of TFA (Downs et al., 2013).
- Palm oil as a substitute for vanaspati: Refined palm oil has become an affordable substitute for PHVO in cooking and in food processing. Thanks to its high content in saturated fats, it has desirable properties for food processing which are similar to those provided by PHVO, increasing shelf life of the products and providing an adequate texture for margarines, spreads and bakery products. Industry sources and experts coincide that the availability of cheap palmolein has contributed to reduced consumption of vanaspati.
- Given that palm oil is both an input and a substitute for PHVO, changes in palm oil prices or tariffs could lead to changes in TFA consumption. The magnitude and sign of this effect, however, is a priori ambiguous.

5.2.4 Marketing and distribution

Although some brands have been household staples for decades, such as the hydrogenated oil brand Dalda[17], the bulk of edible oils has been typically sold loose or unbranded, often produced and sold locally by small processors. Even today,

[17] This brand, currently owned by Bunge India, was introduced in the country by Hindustan Lever. The name vanaspati which is currently used as synonym of hydrogenated fats and oils derives from the original manufacturer of Dalda in India, Hindustan Vanaspati Manufacturing Co.

industry sources estimate that only 35 to 40 percent of the Indian edible oil market is branded (GAIN, 2017b).

Sectoral dynamics are rapidly changing, however. The market for consumer-packaged branded oils is highly concentrated, with four firms controlling over half of the sales in this segment (Adani Enterprises, 2015), (Ruchi Soya Industries Ltd, 2016)18. Competition between leading firms has been largely based on health-oriented marketing of specific blends and oils, promoting a rapid expansion in sales of around 13% per year (Adani Enterprises, 2015), mainly among the upper and middle-classes (Pan et al., 2008). Recent estimates show that the volume of packaged edible oils sales has almost doubled between 2012 and 2016 (GAIN, 2017b), situating oils as the main packaged food category, above dairy (The Economic Times of India, 2017b).

Soybean, sunflower and blends of other oils are most frequently sold in this form, although a market for premium branded traditional oils including mustard oil is emerging.

Overall, interviewees perceived health awareness from the middle classes as a business opportunity. One interviewee described the perceived need to stay up-to date with the latest health trends:

> *"as an industry, my R&D will find some study which they feel can be exploited to get into the news section or in the market, or a new kind of product (…) right now there is a trend of cholesterol-free oil" (IN).*

The Indian oil industry, however, has not succeeded in obtaining a premium for palm oil, which is perceived by consumers as an inferior quality product. One interviewee described unsuccessful historical attempts at marketing micronutrient-rich versions of palm oil as a high-quality healthy product:

> *"Everyone was talking about palm oil as a wonder solution to vitamin A deficiency. [...] then there was also the thing about having too much […] saturated fat, […] so then palm oil was not a good fat to have. Then we shifted from vitamin A deficiency to noncommunicable disease, the focus. So, palm oil kind of waned off […] We did some research into formulating blends. There were no blends in the market at that time, so we added palm oil, groundnut oil, sunflower oil, to see what proportions [were] acceptable, because palm oil*

[18] Market leaders Adani Wilmar and Ruchi Soya hold around 20% of the market share for consumer branded oils, and another 20% is in the hands of Cargill and Mother Dairy.

per se was not acceptable in that form [referring to low consumer acceptability of beta-carotene rich forms]. *[…]* [Now] *I know it's refined, it's bleached, it's deodorized [...] they don't even claim it as a rich source of vitamin A anymore. [...] Like I said, we developed lots of recipes, but it kind of waned off, that was it. In a way, policy, or programmes are business-driven." (R)*

Although efforts to improve acceptability lost traction, this did not deter palm oil imports, which continued to increase yearly. Palm oil is currently marketed as an affordable cooking oil for lower-income price-sensitive consumers, most often unbranded, as well as used to blend with or adulterate more valuable local oils. Several interviewees commented on the importance of adulteration and unbranded blends as a strategy for market segmentation and marketing of palm oil.

"When you see refined oil, it is nothing but palm oil" (CS);

"Palm oil being the most economic edible oil […] is also used for blending the other oils. Palm oil is consumed the most by the lower income category" (IN);

"Due to acceptability […] 70% of the palm oil imported is used for blending, officially and unofficially" (P).

In addition to contributing to inequalities in the quality type of oil consumed, the distribution of unbranded or loose palm oil, and its use to adulterate other oils, it undermines the effectiveness of dietary advice and efforts to increase consumer health awareness, particularly eroding consumer agency and awareness among lower socio-economic groups. To a certain extent, this also reduces incentives for sustainability-oriented product differentiation.

With regards to sustainability, interviewees agreed on the lack of demand for sustainable palm oil products, even among the emerging middle classes. Beyond the lack of demand among price-sensitive low-income consumers, interviewees also highlighted the role of distribution patterns, and the associated low perception and "invisibilization", in discouraging demand from middle-class consumers. This in turn discourages consumer-focussed labelling and marketing approaches to sustainability in the palm oil sector. These approaches have arguably driven the global drive to improve palm oil sustainability, as consumers increasingly demanded for sustainable palm oil, influenced by NGO campaigns (Khor, 2011), (Von Geibler, 2013).

"If you are eating out in Delhi or Mumbai, go to the owner and ask [what oil] *they are using as a frying medium. They will never accept that they are using*

palm oil. There is not matter of pride [in saying that] *I am using sustainable certified palm oil" (CS)*

"Everyone sitting here [urban international coffee chain], they may not know that they are consuming palm" (CS)

In the last decade, packaging, labelling, distribution and advertisement of edible oils have been the object of several regulations and prohibitions, aimed at combating adulteration and increasing consumer awareness. These include the prohibition of sales of oil blends which are not clearly labelled as such, as well as a general ban on the sales of lose oil (FSSAI, 2011a). A strict ban on sales of unpackaged oils, however, cannot be implemented without harming small local producers, who often market their product in this form. The regulation, therefore, includes a special provision for individual States to exclude any specific oil from this regulation, which has de facto undermined effective implementation.

Following the rise in health-oriented advertising, health claims have also been regulated to avoid potential consumer misinformation. Current regulations include a specific list of forbidden expressions, such as *"soothing to the heart"* (FSSAI, 2011b), in addition to a general prohibition of unsupported, misleading or exaggerated health claims.

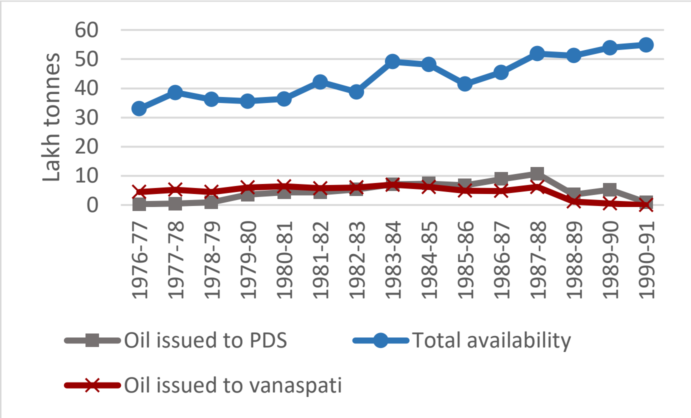
The positioning of palm oil as an inferior product has been historically reinforced by the distribution of subsidized imported palm oil to low-income households through fair price shops. Public distribution between 1974 and 1990 represented around 5% and up to 10% of total oil consumption (Aneja, 1992), (see Figure 5-3). Several interviewees commented on how this historical link to food security interventions had contributed to the negative perception of palm oil among consumers, who *"perceived, in the back of the mind, that this oil is for poor people" (IN).*

Since the early nineties, central distribution is only occasional (FAO, 1994)[19], while only some States have continued to distribute palm oil on a more regular basis. The most recent central scheme for distribution, between 2008-2013, allowed for the distribution of the substantial volume of 1 million MT of imported oil per year (see Table 5-1) at a substantial subsidy (DFPD, 2009)-(DFPD, 2014), sufficient to soften domestic oil prices and allegedly undermine incentives for local producers

[19] http://www.fao.org/docrep/x0172e/x0172e06.htm

(Commission for Agricultural Costs and Prices, 2012) while potentially contributing to adulteration of local oils through leakages (Dreze and Khera, 2015)[20].

Figure 5-3. Edible oil imports and public distribution before liberalisation



Source: (Aneja et al., 1992)

Table 5-1. Scheme for public distribution of edible oils

Year	Oil issued to PDS (imported)	Total availability	Imports	Oils imported as percentage of total oils	Share of PDS oil out of imports	Share of PDS out of total available oils for food
2008-09	2.54523	134.89	78.02	57.84%	3.26%	1.89%
2009-10	1.69498	138.41	78.19	56.49%	2.17%	1.22%
2010-11	3.8377	138.5	71.91	51.92%	5.34%	2.77%
2011-12	4.00558	157.99	97.17	61.50%	4.12%	2.54%

Source: Own elaboration based on data from (Commission for Agricultural Costs and Prices, 2012) and USDA PSD database. Quantities in Lakh Tonnes. Palm oil was distributed mainly to the States of Andhra Pradesh, Goa, Gujarat, Maharashtra, Tamil Nadu, Uttar Pradesh and Himachal Pradesh.

[20] Subsidized oil distribution in the last decade has been relatively small from a quantitative point of view. Moreover, due to lack of data on subsidized oil distribution at the household level as well as in the database for our model (SAM database) which corresponds to the period immediately preceding the scheme for distribution, we do not analyse the impacts of PDS in our quantitative analysis.

5.2.5 Food processing

"Out of home" consumption of vegetable oil refers, in the context of this study, to any indirect intake in addition to cooking oil purchased by households for their own use. This includes oil consumed as part of meals eaten out of the house, in restaurants or cafeterias, but also as part of street food, snacks or packaged processed food. Unless otherwise specified, the general term "processed food" as a synonym. The rapid increase in out of home consumption has been identified as a key driver of increased vegetable oil demand. Over 30% of edible oils is used in processing of packaged food products, or by restaurants, cafeterias, snack shops and street vendors. This sector tends to favour palm oil, mainly due to its low price as well as its desirable physical properties, associated to its high content in saturated fat (such as stability and high smoking point) which can increase the shelf life of processed foods. In the case of palm oil, although it is hard to get precise estimates, according to interviewees, *"out of full consumption* [of palm oil]*, 50%, 60% will be outside the home" (IN).*

The food processing and food services sector in India is characterized by an important informal segment, which supports the livelihoods of around 10 million workers and plays an important role in Indian food culture (NASVI, 2017), (Bhowmik, 2005). This segment coexists with rapidly growing sales of packaged foods, strongly promoted by government policies including investment in infrastructure (processing Mega Parks), tax breaks and incentives for foreign investors (MOFPI, 2017c). Increased incentives for the processed food sector have been accompanied, to a certain extent, by stricter health-oriented regulation of packaged food, including compulsory labelling of saturated and trans fatty acid content (FSSAI, 2013a).

The informal sector, in general, poses important challenges for regulation and policy implementation, and oil procurement is no exception. Interviewees highlighted existing challenges in terms of lack of transparency and pervasive adulteration in this segment. One expert described oil procurement and distribution for food services in the following terms:

> *"[They are] supplying two qualities of oil, one that I buy in the market, and the other one is a little inferior, so that sets much lesser cost. […] It's packaged, but not stringent to the standards. it could be a blend of oils, we don't know the nature of the oil that's being supplied to not just vendors but all the dhabas, the hotels, restaurants, canteens" (AD/R)*

Out of home food consumption is not necessarily associated to urban households or higher socioeconomic groups but is increasing throughout the population. Survey data indicate that specific groups of households, such as non-agricultural rural households or waged urban workers tend to be more reliant on processed foods (NSSO, 2014). Policies aimed at improving oil use in "out of home" food environments, therefore, have the potential to reach large segments of the population. Overall, out-of-home food environments are recognised as an important area of intervention for the promotion of healthier oil consumption (Downs et al., 2014a), (Downs et al., 2014b).

Although large, integrated processing companies are currently the most powerful actors in the edible oils supply chain, these companies are losing some power to multinational processed food firms, which are acquiring an increasing role in the Indian food system, aided by incentives to foreign investment in the sector (MOFPI, 2017c), (GAIN, 2017b). Multinational food processing companies tend to establish long-term contracts with edible oil suppliers, contributing to a shift towards "relational" or "captive" networks (Gereffi et al., 2005), where there is increased explicit coordination between suppliers and producers (Nestle, 2010). Despite the lack of consumer-based premium for sustainable products in the Indian market, multinationals have made global sustainability commitments, which also apply to Indian subsidiaries (Hindustan Unilever, 2017). Domestic companies which supply for these global brands, therefore, face increased pressure to be able to supply certified sustainable oil (CSPO). Increased access to multinational buyers is business opportunity, but also comes at a cost. As one interviewee commented, global brands are *"asking* [domestic firms] *to pay a price to keep their* [the multinationals'] *house clean" (IN).*

5.2.6 Household demand patterns

Consumption of edible oils has been partially driven by increases in household income, as households shifted from staple cereals to other food groups. Income elasticity of edible oils is higher than that of pulses and cereals, although lower than that of milk, sugar or vegetables (Kumar et al., 2011). In addition, overall increases in oil consumption over the past two decades can be partly explained by the relative decrease in the price of imported oils with respect to other food categories (Ministry of Finance, 2016). Indian consumers are highly sensitive to price, and cross-price elasticities across edible oil types are also high (Pan, Mohanty, and Welch 2008).

Differences in consumption patterns persist across regions, particularly for traditional oils (GAIN, 2017a),. This is related to production patterns and to the use of specific oils in the preparation of traditional regional dishes. Nowadays, however, all major oils are consumed throughout India. Coconut oil is most widely consumed in the south, while groundnut oil is more highly valued in the south and western regions. In the northern, eastern and north-eastern regions there is, traditionally, more of a preference for mustard/rapeseed oil. Vanaspati is typically more frequently consumed in northern states. Soybean oil is most consumed in central and northern states where most of the production takes place. Palm oil is consumed throughout the country, being the preferred oil for the "out of home" sector. Households in the southern States have accepted palm oil better as a cooking oil, because of its similarities with coconut oil, which is also highly saturated.

Table 5-2. Value chain key characteristics and incentives

Technological

- Low access to quality agricultural inputs (oilseeds), lack of rural infrastructure. Climate and water-related constraints for oil-palm expansion.
- Palm oil characteristics make it desirable for food processing and close substitute for vanaspati / PHVO.

Organizational

- Emergence of modern import-oriented processing infrastructure, coexisting with traditional oil processors.
- Increased market consolidation in oil processing and distribution. Increased vertical integration.
- Large oil processing companies are losing power to multinational food processing companies.

Financial

- Barriers to small-holder entry: High risk for oilseeds. High up-front costs for oil palm.
- Imports based on price advantage, not differentiation.
- Under-utilized capacity in the processing industry, low efficiency and low margins.
- Rapid growth in the branded oils segment, fuelled by competition for market, based on health-oriented advertisement.
- Price-based marketing of palm oil. Demand fuelled by rapid increase in price-sensitive "out of home" food consumption.

Policy

- Increased policy support for oilseed and oil palm extension and yield improvement. Increased emphasis on sustainability.
- Active oil import policy. Restrictive policy for exports and oilseed imports
- Policy support to oil processing industry
- Increasingly restrictive regulation of oil and food processing but unlabelled blends de facto allowed.
- Reliance on imports for food security interventions.

Table 5-3. Impacts of key characteristics on mediating variables and on nutrition and sustainability outcomes

Value chain characteristics (see Table 5-1) create the following incentives:	Impact on mediating variables	Barriers for both nutrition and sustainability improvement
• Reinforcing the cost advantage for palm oil imports versus domestic oils • Reducing consumer awareness and visibility for palm oil • Situating palm oil as a low-margins product • Reducing incentives for local oilseed producers • Directly affecting domestic sustainability (in the case of domestic agricultural constraints)	**Availability** • Reduced availability of local "healthier" oils. • Increased availability of saturated fats. **Price** • Price fluctuations for local oils. • Price advantage for imported oils. **Marketing** • Increased market segmentation, with healthier oils marketed towards middle classes, unlabelled palm oil sold to lower income households, food service providers. **Sourcing** • Low but increasing incentives for oil processing companies to source sustainable palm oil. **Agricultural practices** Low incentives for private investment in sustainable agricultural practices in oilseed sector.	• Shift towards saturated fat consumption. • Increased inequalities access to healthier oils (dietary "convergence-divergence") • Chronic dependence on cheap, non-sustainable palm oil. Contribution to global environmental degradation • Contribution to local environmental degradation.

5.3 Impacts on nutrition, sustainability and mediating factors

We find that some of the structural characteristics in the edible oils sector which contribute to unhealthy oil consumption patterns also reduce the incentives to import sustainable palm oil and invest in sustainability.

Some emerging trends are creating incentives for leading companies in the sector to engage with sustainability initiatives. These include the growing power of multinationals, who have acquired global sustainability commitments, exerting pressure on "captive" or relational suppliers, a tendency towards direct sourcing from supplying countries (facilitated to a certain extent by vertical and horizontal integration) and the involvement of large processors in domestic oil palm. Progress in this direction, however, is hampered by the structural constraints discussed in the above sections and summarised here.

Overall these constraints affect nutrition and sustainability outcomes through the following mechanisms:

- Reinforcing the cost advantage for palm oil imports versus domestic oils
- Reducing consumer awareness and visibility for palm oil
- Situating palm oil as a low-margins product
- Reducing incentives for local oilseed producers
- Directly affecting domestic sustainability (in the case of domestic agricultural constraints)

These factors lead to reduced availability of local healthier oils and reduced investment in the oilseed sector, increased price differential with imported palm oil, increased market segmentation and reduced incentives for product differentiation for palm oil.

This can contribute, not only to increased consumption saturated fats, but also potentially to a pattern of "convergence-divergence" (Hawkes, 2006) where there are increased inequalities in the access to healthier domestic oils. At the same time, these constraints impose significant barriers for a shift towards sustainable imports.

We have identified the following structural characteristics reinforcing these patterns:

Agricultural practices in the sector including low seed quality and inefficient use of water and fertilizer create direct challenges in terms of domestic environmental sustainability and climate adaptation (Jha et al., 2012). Moreover, technological, organizational and environmental constraints in the oilseeds sector have so far reduced the availability of healthier local edible oils (Downs et al., 2015), led to increased oil prices, price fluctuations and reduced efficiency in processing (Persaud et al., 2006). Price and output fluctuations act as a barrier to entry for small-holder farmers and reduce incentives for private investment in the sector. Policy interventions in the sector are increasingly trying to fill in this gap, addressing yield improvement, sustainability and, in particular, water conservation (Ministry of Agriculture, 2014). However, discouraged farmers have turned to commercial crops instead.

Domestic cultivation of oil palm, although growing, remains a small segment, with around 98% of palm oil coming from imports (USDA). Direct nutritional impacts, therefore, are likely to be small, even if production was entirely consumed domestically, adding to current imports. There is also no clear evidence of large direct environmental impacts so far, and expansion has so far taken place mainly on cultivated land. However, and although regulation and corporate commitments encourage sustainable practices, water use remains an important challenge for sustainable commercial expansion. Palm oil promotion efforts and increased involvement of oil processing companies in domestic cultivation, however, could have relevant indirect impacts, potentially increasing the incentives of domestic processing companies to acquire sustainability commitments, in order to position domestic palm oil produce at a premium in export markets, or encouraging import substitution strategies (these issues are discussed more in depth in Chapter 6).

The emergence of a highly efficient import-oriented processing infrastructure (Adani Enterprises, 2015), can further increase the price advantage of imported oils with respect to domestic production, perpetuating import dependence. The low margins and capacity under-utilization in the local processing sector create incentives for the replacement of local oils with cheap imports, particularly of crude oil, whose price and supply tends to be more stable. The need to protect a large number of small domestic processors which operate alongside the emergent modern industry poses important challenges for implementation and enforcement of packaging and labelling regulations, contributing to the conditions for widespread adulteration and continued distribution of unlabelled oils and blends. It is these dynamics, paradoxically, that undermine the profits of small domestic producers.

With respect to marketing and distribution, a process of rapid market segmentation has been fuelled by competition in the growing branded segment (GAIN, 2017b), coexisting with a large sector distributing unbranded oils and adulterated oils. Interviewees described how, while healthier oils are increasingly branded and marketed for the middle classes, palm oil is channelled towards the large segment of unbranded or loose distribution, used to blend or adulterate other oils and sold to lower-income households. This reduces the incentives for product differentiation, positioning palm oil as a low-margin product marketed towards lower income groups and unaware consumers.

Increased "out of home" food consumption has been identified as a key driver of increased per capita consumption of oils across population groups. Particularly, a large proportion of palm oil is consumed by the "out of home" sector, in the form of unlabelled blends or adulterated oils. Demand for oils in food processing is largely price-driven, and the price differential between imported and domestic oils in this context constitutes a crucial advantage, with food processors often finding barriers for sourcing healthier domestic oils (Downs et al., 2014a). The importance of the unorganized sector in food processing constitutes an additional challenge for regulation.

In addition, subsidized distribution of imported palm oil through PDS, although occasional, has potential effects beyond its direct impacts on consumption. Distribution of imported palm oil can reduce incentives for domestic oilseed producers (Commission for Agricultural Costs and Prices, 2012) while potentially contributing to adulteration through leakages (Dreze and Khera, 2015). Furthermore, interviewees argued that historical distribution programs might have had an indirect impact by altering consumers' perception about palm oil and reducing desirability for middle-class consumers, reinforcing the position of palm oil as a product with low margins.

Policies addressing key characteristics in the value chain which have negative impacts on both nutrition and sustainability outcomes could contribute to a shift towards smaller import volumes and product differentiation based on sustainability, involving more transparent sourcing and distribution. This could perhaps reduce the negative impacts of import competition on domestic producers, increase consumer awareness and reduce inequalities in access to healthier oils, leading towards healthier, more sustainable oil consumption patterns.

5.4 Discussion: Potential areas of intervention for sustainable nutrition

Table 5-4. Potential areas of intervention for sustainable nutrition

Potential areas of intervention for sustainable nutrition	**Potential impacts on mediating factors for nutrition and sustainability outcomes**
Sustainable, nutrition-sensitive agricultural interventions (oilseeds), climate adaptation.	• Increased availability of domestic oils • Reduced price and output fluctuations • Improved domestic sustainability • Reduced import dependence
Differential tariffs to promote sustainable, healthy oil imports	• Incentives for product differentiation (palm oil) • Improved incentives for domestic oil producers (longer term) • Reduced price differential
Targeting "out of home" food environments to promote healthier oil consumption (Eg: compulsory labelling SFA, support transparent oil sourcing)	• Incentives for product differentiation (palm oil), consumer awareness, reduced adulteration • Improved incentives for domestic oil producers
PDS (Eg: Inclusion of local edible oils in PDS)	• Improved incentives for domestic oil producers • Incentives for product differentiation (palm oil), reduced adulteration
Other: Fortification of edible oils, deregulation of GM soybean imports	• Unclear/ Potential trade-offs

In the previous section we have identified some structural characteristics which contribute to unhealthy oil consumption patterns, while also reducing the incentives to source sustainable oil, and generally to invest in sustainability. In this section, we briefly discuss some potential interventions which, by targeting these characteristics and their effects, could potentially promote healthier, more sustainable oil consumption. This discussion is not meant to be prescriptive, or exhaustive, however. We focus our discussion on areas of intervention identified as relevant by interviewees (by at least three interviewees, from different backgrounds).

First, agricultural policy interventions aimed at extension and intensification have been recognised as a key area of intervention, which can address structural constraints and improve the domestic availability of healthier oils (Downs et al., 2015). Particularly, improved access to agricultural inputs, including high quality seeds, drip irrigation infrastructure or training to support sustainable production practices in the oilseed sector can increase yields, reduce climate-related fluctuations in output volume and incentivize local production. Increased output from small producers, which is often consumed locally, can also address inequalities in edible oil intakes. At the same time, improved agricultural practices in the oilseed sector can have direct positive impacts on sustainability, leading to more efficient use of water and fertilizer. Given the margin for sustainable intensification and expansion in marginal areas (Ministry of Agriculture, 2014a), (Jha et al., 2012)., or replacement of commercial crops like sugarcane, climate-sensitive domestic agricultural interventions and partial replacement of imports with sustainably produced crops has the potential to improve nutrition and sustainability outcomes, creating important synergies. However, given the magnitude of the edible oil deficit, as well as the advantage of imported oils in terms of price and cost of processing, agricultural interventions alone are unlikely to address the current dependence on unsustainable palm oil imports.

Second, import policy has also been identified as playing a crucial role. Particularly, tariff levels affect incentives throughout the sector. Given the high cross-elasticity of oil demand (Pan, Mohanty, and Welch 2008), tariffs can have an immediate impact on the composition of imports in the short term, and can, at least in theory, be used to incentivize imports of certain types of oils, such as sustainably produced oil, or to achieve a balanced oil supply for health reasons. Given the pressure faced by domestic processing companies to comply with sustainability standards, even a relatively small price differential could perhaps provide the necessary incentives for a shift towards sustainable oil. Secondly, in the longer term, changes in tariff levels can support or undermine interventions in other areas, including agricultural interventions to support domestic oil producers. The inclusion of nutrition and sustainability concerns in the tariff agenda could contribute to aligning incentives along different segments of the value chain to promote sustainable nutrition goals.

The deregulation of GM oilseed imports was also discussed as a potentially crucial intervention. Deregulation of oilseed imports could involve some important trade-offs in the value chain context, generating gains in processing efficiency that could potentially positively affect incentives throughout the value chain, but potentially also discouraging oilseed farmers through strong competition, as well as through reduced values of India's (currently non-GM) soybean meal exports. Furthermore, a shift in India's approach to GM crops could have potential environmental and socio-economic impacts beyond the scope of our analysis (Pengue, 2005).

Third, interviewees discussed out of home food environments as a key driver of oil demand, and an important approach to rationalising consumption (Downs et al., 2014a).. Given the current patterns of consumption and the use of palm oil for food processing and foods services, in blends or to adulterate other oils, this approach can reach broad segments of the population. In this sense, this type of approach can potentially be more effective than interventions focussing directly on nutritional labelling or advertising of consumer-packaged oils, which mainly address middle-class consumers who purchase branded oils. Approaches to promote healthier oil consumption out of the house can include labelling of fatty acid content in packaged food products (FSSAI, 2013a) guidelines to improve food environments in schools, (HFSS Working Group, 2015) or interventions supporting improved oil supply and cooking practices of street vendors and eateries (Soon et al., 2008). Consumer-oriented sustainability labelling is likely to be hampered by a lack of demand, at least in the short term. However, to the extent that these interventions rationalise palm oil demand and support more transparent sourcing and reduced adulteration, they can help curb imports of unsustainable oil and promote accountability as the industry shifts towards sustainable practices.

Fourth, subsidized distribution of palm oil can have impacts beyond the immediate or intended quantitative effects on prices and consumption, affecting also demand patterns, while reducing incentives for domestic producers (Aneja et al., 1992), (Commission for Agricultural Costs and Prices, 2012). A shift towards distribution of local edible oils could incentivize domestic producers and reduce dependence on palm oil imports, while promoting healthier oil consumption among lower-income consumers. This approach could also potentially avoid the disincentives associated with leakages and adulteration of domestic oils with palm oil. The scattered and unreliable production of oilseeds in many region, however, could pose an important challenge for this type of intervention, at least in the short term. Alternatively, improved monitoring to reduce leakages could also minimize potential negative-side effects of distribution interventions (Khera, 2011).

Finally, interviewees also highlighted the promotion of edible oil fortification as a relevant intervention. We cannot comment here on the potential effectiveness of this approach in reducing vitamin A and D deficiencies, which is beyond the scope of our study. However, there are economies of scale involved, not so much in fortification itself, but in the process of testing, labelling and compliance with associated regulations. This could potentially reinforce the competitive advantage of larger import-oriented processing plants. If this is the case, improvements in vitamin A and D consumption could come at the cost of further increases in saturated fat consumption and increased palm oil imports.

Table 5-5. Key policies and corresponding documents. Policy mapping

VC Segment		Year	Main Policies and corresponding documents
Domestic production of oilseeds and oil palm, pricing of oilseeds and FFB	1	2014 2017	**National Mission on Oilseeds and Oil Palm** (NMOOP). (Ministry of Agriculture, 2014a), (operational guidelines), (Ministry of Agriculture, 2017c) p(43-48)
	2	2017	**Measures to increase oil palm area and production in India** (Press Information Bureau, 2017)
	3	2017	**National Mission for Sustainable Agriculture** (NMSA) (Ministry of Agriculture, 2017c) (p. 49-64)
	4	2017	**Price support and price fixation schemes** (Ministry of Agriculture, 2017c) Sections 12.27-12-29
	5	2013	**Pricing of Fresh Fruit Bunches of Oil Palm** (Ministry of Agriculture, 2013)
	6	2017	**Indian Palm Oil Sustainability Framework** (Solidaridad, 2017)
Foreign Trade and Investment	7	2016	**FDI restrictions (100% FDI for palm oil)** (Effective from June 07, 2016) (Department of Industrial Policy and Promotion, 2016)
	8	2012-16	**Tariff setting and commodity price and output monitoring for oils** DFPD (DFPD, 2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009)

	9	2008-2017	**Ban of exports of edible oils, lift of ban**. (Director General of Foreign Trade, 2008). Amendment notifications N0 43/2015-20
Oil processing	10	2015	**End of Small-Scale Industry reservation policy** (MCI, 2015)
	11	2013	**Regulation of Trans Fatty Acids (TFA) in Partially Hydrogenated Vegetable Oils (PHVO)** (FSSAI, 2013b)
	12	2016	**Fortification of essential food commodities**. (FSSAI, 2016a)
Labelling, advertising	13	2011	**Regulations on packaging, labelling, health claims for edible oils. Ban on sales of loose oil** (FSSAI, 2011b), (FSSAI, 2013c)
Processing	14	2017	**Promotion of food processing** (MOFPI, 2017c)
Street food	15	2016	**Clean Street Food in Delhi** (FSSAI, 2016b) Section 8.6
School food environments	16	2015	**Initiative to address the Consumption of Foods High in Fat, Salt and Sugar (HFSS)** and Promotion of Healthy Snacks in Schools of India. (Working Group on HFSS, 2014), (HFSS Working Group, 2015)
Public Food Distribution	17	2013	**"Right to Food", Targeted PDS** (Ministry of Law and Justice, 2013)
	18	2008-14	**Central Scheme for distribution of edible oils**. DFPD annual reports 2008 to 2014 (DFPD, 2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009) .

5.5 Conclusion

In this first part of our qualitative analysis we have examined the structure of the edible oils value chain, with focus on imported oils and palm oil.

We have found that key structural characteristics in different segments of the value chain contribute to unhealthy and uneven oil consumption patterns, while also undermining the incentives to import sustainable, certified oil and, in general, to invest in sustainability.

Key constraining factors affecting both nutrition and sustainability outcomes can be found in agricultural production, processing, marketing and distribution, as well as in patterns of out-of-home use of oils. These factors act by generating an identifiable set of effects and incentives:

- Reinforcing the cost advantage for palm oil imports versus domestic oils
- Reducing consumer awareness and visibility for palm oil
- Situating palm oil as a low-margins product
- Reducing incentives for local oilseed producers
- Directly affecting domestic sustainability (in the case of domestic agricultural constraints)

Policies addressing these common factors, which have negative impacts on both nutrition and sustainability outcomes could contribute to a shift towards smaller import volumes and product differentiation based on sustainability, involving more transparent sourcing and distribution. This could increase consumer awareness and reduce inequalities in access to healthier oils, as well as perhaps protecting domestic producers to an extent from damaging competition, leading overall towards healthier, more sustainable oil consumption patterns.

In our last section we have discussed potential areas of intervention for sustainable nutrition. Potential interventions could include: agricultural input and production policies to achieve sustainable expansion, climate adaptation and yield improvement in the domestic oilseed sector; differential tariffs to promote healthier, sustainable oil; policies targeting "out of home" food environments to support transparent oil procurement and use of domestic oils, and inclusion of domestic edible oils in the PDS. Interventions in these areas could support each other, enhancing policy coherence. For example, improved yields and reduced output fluctuation would facilitate local procurement for public distribution, which would in turn incentivize local production.

This chapter has served to analyse the main characteristics and incentives in the value chain and discuss potential areas for intervention to promote sustainable, healthy oil consumption. Additionally, the value chain analysis sets the context for the next step in our study. In the next chapter, we will discuss how the space for the promotion of sustainable, healthy oil consumption is shaped by context, policy process and the characteristics of policies themselves.

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
www.lshtm.ac.uk

Registry
T: +44(0)20 7299 4646
F: +44(0)20 7299 4656
E: registry@lshtm.ac.uk

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Soledad Cuevas Garcia-Dorado
Principal Supervisor	Marcus Keogh-Brown
Thesis Title	The nutritional and economic effects of palm oil trade liberalisation in India: A policy analysis

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
When was the work published?			
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*		Was the work subject to academic peer review?	

**If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.*

SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Public Health Nutrition
Please list the paper's authors in the intended authorship order:	Soledad Cuevas, Shauna Downs, Suparna Ghosh-Jerath, Aafrin, Bhavani Shankar
Stage of publication	Submitted

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	SC is the main contributor and has designed the study, carried out the research and written the manuscript. SGJ and A have assisted in data collection. SD and BS have advised on study design, and all authors have reviewed the final manuscript.

Student Signature: [redacted] **Date:** 20/May/2018

Supervisor Signature: [redacted] **Date:** 25/05/2018

Improving health worldwide www.lshtm.ac.uk

Chapter 6. Analysing the policy space for the promotion of healthy, sustainable edible oils in India

Soledad Cuevas[1,2], Shauna M Downs[3], Suparna Ghosh-Jerath[4], Aafrin[4], Bhavani Shankar[5 2]

[1] London School of Hygiene and Tropical Medicine, Department of Global Health and Development, Tavistock Place, London, WC1H 9SH, United Kingdom.

[2] Leverhulme Centre for Integrate Research on Agriculture and Health, 36 Gordon Square,
London WC1H 0PD, United Kingdom.

[3] Columbia University, Institute of Human Nutrition & Earth Institute New York, NY, USA 10027-6902

[4] Public Health Foundation of India, Indian Institute of Public Health-Delhi Plot No 47, Sector 44, Institutional Area Gurgaon, IN

[5] School of Oriental and African Studies, Thornhaugh Street, Russell Square, WC1H OXG

Corresponding author: soledad.cuevas@lshtm.ac.uk

6.1 Introduction

In this chapter we analyse the "policy space" as it is shaped by the context, the policy processes or agenda setting circumstances and the characteristics of existing interventions (Grindle and Thomas, 1991). Based on this analysis, we identify opportunities and challenges for the promotion of sustainable, healthy oil consumption.

For the purpose of this analysis, the *policy context* is given by broader historical, socio-economic and international factors which are not part of the policy process itself but can constrain or shape policy decisions and approaches.

The *policy process or agenda-setting circumstance* is determined by the priorities, perceptions and influence of different state and non-state actors, including economic interest groups, social actors and experts. We also distinguish the different modes through with decisions are made or implemented, distinguishing between, for example, business-as-usual processes and crisis decision-making. These processes can manifest themselves in different ways, govern different areas to a different degree and alter the prevailing order of priorities and actor influence.

Finally, *policy characteristics* refer to those aspects of existing or proposed policy interventions which pose opportunities and barriers for intervention. These include stated goals, the nature of policy impacts (geographical and social distribution of impacts, whether the impacts are long-term or short-term, whether an intervention has highly visible impacts on organized stakeholders or whether the impacts are more diffuse), implementation costs etc. In this section we focus mainly on potential areas for synergistic intervention as they are identified, based on our characterization of the value chain.

This chapter relies both on policy documents and interviews with experts and value chain actors. The methodology and theoretical approach have been described in Chapter 4. The final section in this chapter provides a more normative discussion of sectoral policy intervention considered as a complex policy mix or portfolio, where combinations of interventions can be used to address key policy goals

Table 6-1. Policy context, process and characteristics

Policy context	Policy process/circumstance	Policy characteristics
Opportunities • Emergence of multisectoral approaches to NCD, including explicit goals for reduction of SFA, trans fats. • Increasing recognition of climate adaptation as national priority, framing sectoral interventions as part of broader strategic plans (NAPCC, NMSA). **Barriers** • International agreements increasingly constrain the trade policy space for oils. • Historical commitment to food security understood as calorie provision and price stability • Division of powers across central and State governments can affect implementation of key policies.	**Opportunities** • Structures for policy coordination at sectoral level (through former DVVO) support policy coherence. • Increased role of health policy actors in the sector. • Supportive environment for translation of nutrition evidence into policy. Precautionary approach to debate around health impacts of SFA. • Increased engagement of sustainability-oriented social actors in the sector (through corporate actors) • Potential civil society support for inclusion of local edible oils in PDS, shifting away from reliance on imported palm oil for food security interventions. **Barriers** • Pursuit of sustainable nutrition constrained by broader sectoral priorities: reduced import dependence, food security. Protection of domestic producers (industry). • Nutrition and sustainability advocates focus on different segments of the value chain. • Debate over calorie focus vs. fatty acid/NCD focus perceived as a barrier for policy influence of nutrition advocates.	**Opportunities** • Explicit inclusion of sustainability goals in current agricultural interventions. • Interventions targeting oilseed small-holders provide opportunities for the inclusion of nutrition-sensitive approaches. • Growing number of interventions explicitly aimed at promoting healthy fats address edible oil processing, labelling or use in food processing. **Barriers** • NCD prevention not explicitly included in agricultural interventions/policies targeting the informal sector. • Key policies (eg. tariff-setting, oil distribution) directly affect economic interests of organized stakeholders (domestic producers) or exhibit regional inequalities in impact, complicating design and adoption.

6.2 Context

In this section we discuss international factors, as well as broad, national-level policy trends and priorities which are not directly related to policy-making in the edible oils sector, but which can shape the space for intervention.

Since liberalisation of the sector in the early 1990s, trade policy in the oils sector has been shaped by participation in the WTO. Although the agreements establish high bound tariffs for palm oil and other oils (300%), the scope for effective overall protection has been limited by the relatively low bound tariff agreed for soybean (45%), which is a close substitute product. More recently, palm oil bound tariff reductions (to 45%) have been negotiated with the ASEAN countries (Francis, 2011) (see Section 3.4 for a brief historical overview of liberalisation in the oils sector). Additionally, close relationships with supplying countries, as part of India's "Look East" (now "Act East) geopolitical strategy (Singh, 2015) and, have also played an important historical role in facilitating the liberalisation of palm oil imports, actively promoted by the Malaysian Palm oil Council (Rasiah, 2006).

Although liberalisation has been driven to an extent by international geopolitical and economic concerns, the commitment to national food security has played an important role throughout India's participation in trade agreements (Chang, 2009). This priority has recently been reinforced, both nationally, with the approval of the National Food Security Act (2013), and internationally, with the leading role of India in the G33 group of countries, demanding greater flexibilities to defend food security in the context of WTO (Grant, 2009). Although food security policy has mainly focussed on cereals, oils are also considered an essential food commodity and oilseed and oil markets are monitored and intervened as such. (again, see 0 for a more complete discussion).

NCD prevention is also increasingly recognised as a growing concern at a national level, requiring multi-sectoral coordinated efforts (Ministry of Health and WHO, 2016). Within the current National Action Plan, diet is identified as the main risk factor and reduced saturated fat consumption is explicitly included as a policy goal (Bachani, 2017), which can be a supportive factor for nutrition-oriented policy intervention in the edible oils sector.

Efforts to improve sustainability in the oilseed sector are framed within the National Action Plan for Climate Change (NAPCC), which reflects the recognition of India as one of the nations most vulnerable to climate change. The National Mission on Sustainable Agriculture (NMSA) is one of the eight missions within the NAPCC and reflects a strong focus on climate adaptation and water resource management. In the case of palm oil, the recent launch of a national sustainability framework (IPOS) follows similar earlier initiatives in Indonesia and Malaysia, referring explicitly to alignment with these countries' policies (Solidaridad, 2017).

Finally, policy-making in all areas needs to be understood in the context of a strong division of powers across central and state governments. We refer in our analysis to priorities, processes and actors operating at the central level, but these priorities might conflict with those of specific state governments, and implementation and dynamics can vary greatly across states.

6.3 Policy process and circumstance

6.3.1 Main institutions

The Department of Food and Public Distribution, under the Ministry of Consumer Affairs, Food and Public Distribution has as its main objective, inherited as a historical mandate, the promotion of food security, with a primary focus on food grains21. Since 2000 the Directorate of Sugar and Edible Oils and, within this, the Oil Division, are included within the Department of Food and Public Distribution. This division monitors prices, demand and availability of oil commodities, implements the relevant policies and serves a function of coordination to promote coherence across policies (DFPD, 2014). The implementation of National Food Security Act (NFSA) through the Public Distribution System as well as the management of grain support prices and procurement are also the responsibility of the Department of Food and Public Distribution. State governments also have responsibilities for the implementation and monitoring of NFSA, through the State Commissions and relevant state and local government bodies.

The regulation and promotion of food safety and quality standards, is the responsibility of the Food Safety and Standards Authority of India (FSSAI), created in 2006 as an autonomous body within the Ministry of Health and Family Welfare. Its duties include regulation, monitoring and awareness raising and concern import, processing, storage and distribution, packaging, labelling and promotion. Since 2011, responsibility for license, safety and standard parameters in the edible oils sector were transferred to the FSSAI, Procurement and market monitoring, however, are still controlled by the Oil Division.

[21] See http://dfpd.nic.in/index.htm accessed 30/06/2017 and Department of Food and Public Distribution Annual Report, 2016-17 for a statement of current mission.For a summary of the origins and history of DFPD see Department of Food and Public Distribution Annual Report, 2016-17

Other institutions with relevant responsibilities are the Ministry of Agriculture, and the Oilseeds Division within this, responsible for agricultural policy implementation, and the Ministry of Food Processing Industries and the Directorate General of Foreign Trade, within the Ministry of Commerce and Industry.

6.3.2 Main priorities and processes driving sectoral policy

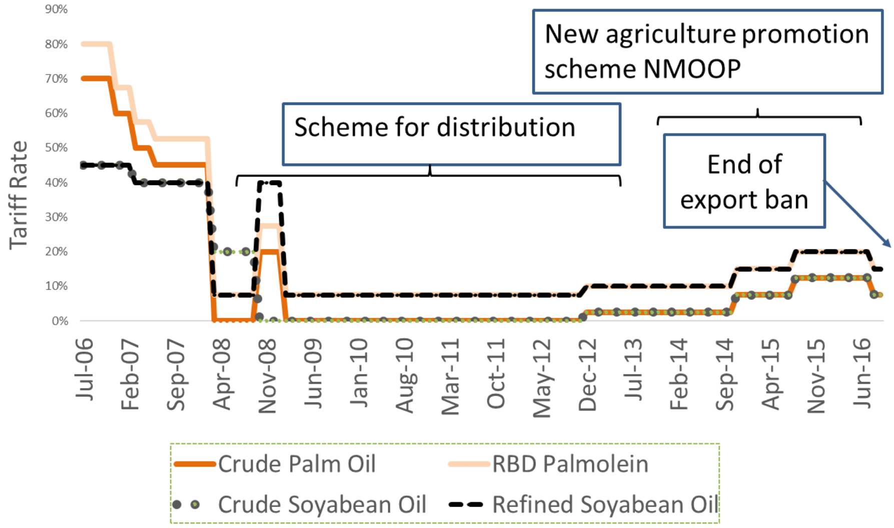
The increased involvement and responsibilities of the Food Safety and Standards Authority of India (FSSAI) in the edible oils sector since 2011 has been followed by a number of health-oriented policies and regulatory measures in this area, including compulsory labelling of trans fatty acid and saturated fat content, stricter regulation of health claims and tighter norms for sales of blended oils (FSSAI, 2011b), (FSSAI, 2011a), (FSSAI, 2013b). Sustainability in the domestic oilseed and oil palm sector is also increasingly recognised as an important concern, with particular emphasis on water conservation as a crucial element for expansion of domestic production (Ministry of Agriculture, 2014a).

However, health and sustainability goals are pursued in the context of wider sectoral priorities which often take precedence. Policy sources identified reduced import dependence as the main goal for sectoral policy, explaining: *"We have to reach self-sufficiency […] we don't know when the international market is going to become costly […] then we will have to depend on our local oil" (P).* Self-sufficiency is largely associated to food security, understood as price stability of essential food commodities, which different actors identified as the main policy priority in this sector. However, palm oil imports are large enough to become also an economic concern or, in the words of an interviewee, is also *"about how much our country currency goes outside the country to import" (CS).* In addition, sectoral policy aims to protect domestic producers, with the oil processing industry being perceived as an influential and organised actor in the sector. Both civil society and industry interviewees referred to this influence as exerted directly, through explicit demands and associated to access. Farmers, on the other hand, are an important voting segment which can also be negatively affected by import competition. Production, however, is geographically localized. For example, most soybean is grown by small farmers in Maharashtra and Madhya Pradesh, while palm oil is mainly grown in Andhra Pradesh. Therefore, farmers can exert more influence over policy at a state level, compared to central policy processes.

A history of intervention in the oils sector has created structures for market monitoring and policy coordination, operating through the Directorate of Vanaspati and Edible oils (now oils division), which support policy coherence at a sectoral level.

Figure 6-1 shows some of the main policies in the sector, illustrating the coordinated sectoral approach, as well as the interaction of competing priorities. Progressive tariff reductions before the international food crisis are reinforced by the coordinated introduction of an export ban, and the approval of the scheme for distribution. In the last three years of the decade, progressive increases in tariff rates coincide with the implementation of the agricultural promotion scheme for oilseeds and oil palm (NMOOP). Throughout the period, a gap is maintained between crude and refined oil, in order to protect the domestic refining industry.

Figure 6-1. Policy coordination in the edible oils sector.



At a risk of oversimplifying, policy at a sectoral level can be described as an exercise in balancing out key priorities and interests as part of a business-as-usual approach, with policy makers acting to a certain extent as agents of social stakeholders. This process is illustrated, for example, in the frequent tariff adjustments and overall combined use of policy instruments to manage prices and supply, as shown in Figure 6-1 above. One interviewee summarized this approach in the following terms: *"the consumer, […] the farmers, as well as the industry, we are at the centre, so we have to keep a balance" (P*).

Despite a certain degree of sectoral policy coordination, however, the relative influence of the priorities described in the above section will depend on the specific policy process.

In particular, we can identify a crisis approach where narrower interpretations of food security tend to be prioritized. This is the case of edible oil distribution which, unlike grains and sugar, is not covered by the main PDS distribution scheme (Ministry of Law and Justice, 2013) (DFPD, 2013), (FAO, 1993). In the context of crisis interventions, food security in a relatively narrow sense tends to be a priority, with a focus on affordable calories and macronutrients. One interviewee commented on this approach:

> *"What happens in India is, the moment the prices peak, the government steps up, imports, through [public] procurement, and then flushes it into the PDS as a market intervention operation (P)."*

The 2007 edible oil export ban is another example of a "crisis intervention", mainly driven by concerns over consumer prices and food security.

In addition, the pursuit of medium to long-term strategic goals including, for example, self-sufficiency, regional development or water conservation, is typically articulated through strategic plans, defining sectoral policy goals in a three to five year period (Ministry of Agriculture, 2014a). Both crisis interventions and what we can call "strategic" policy-making can alter the business-as-usual balance of priorities in the sector.

We have provided here an overview the main policy priorities and processes driving policy intervention in the edible oils sector, which necessarily involves a degree of simplification. A detailed analysis of individual interventions, however, is beyond the scope of this study.

6.3.3 Influence of non-state actors on nutrition-related policy

The overall direction of nutrition-oriented interventions in the edible oils sector, introduced by the FSSAI, were perceived as being largely driven by expert and technical advice. However, experts commented on how

Implementation, specific limits, timing, or the voluntary character of certain measures, however, are often adjusted in order to minimize negative economic impacts on domestic producers. Examples of this pattern include the regulation to reduce "junk food" in schools or the implementation of the ban on trans fatty acids or. An academic expert and policy advisor on the latter case, for example:

> *"There is a pressure on government, as the regulation on the products like vanaspati is affecting small domestic manufacturers. Therefore, their livelihoods have to be protected. So […] there might be a pressure on the government to protect the domestic manufacturers by going slow on implementation" (AD/R).*

Scientific evidence on nutrition and health regarding edible oils is translated into policy through close contact between regulatory bodies and scientific experts, who regularly take on advisory roles. There is a high degree of awareness and knowledge relating to NCD prevention among policy makers in key departments, creating a supportive environment for translation of evidence into practice.

Nevertheless, there are some challenges for the successful adoption of nutrition-oriented policies in the edible oils sector.

The controversy around the health impacts of fatty acid consumption (Mozaffarian, 2011), (Wang et al., 2016) has been identified as an important challenge for the adoption of nutrition-oriented policies for palm oil in other contexts. (Shankar et al., 2017), found that interviewees in Thailand frequently alluded to the influence of vested interests against palm oil. We find that, to a certain extent, scientific evidence is perceived as being unclear and instrumentalized. As one expert put it, following the shift towards an emphasis on dietary fats to an emphasis on sugar as a cause for chronic disease, policy makers are more likely to be sceptical about dietary guidelines, perceiving that *"nutrition has been misleading you all along, for 50 years they have been based on fake science"* (AD/R).

However, the nutrition experts and advisors interviewed generally adopted a precautionary attitude with an emphasis on promoting balanced diets and making context-appropriate recommendations. Examples of this approach are the recommendations to consume "one spoon of different types of oil a day", or the promotion of traditional cooking practices using a specific oil or fat for each type of dish: *"[If you] say this particular type of meat or this particular type of fish should be cooked in this particular type of oil, overall over a week you will get a reasonable mix of oil"*

In the Indian context the debate seems to focus more on whether to focus on calorie intake, from a food security perspective, or to prioritize a balanced fatty acid consumption. Interviewees highlighted this perceived conflict, arguing that there are there are clearly two distinct approaches or that *"the main problem with this is, that when you say high fat, high sugar, they should be restricted, […] but that is the kind of food we are serving in the mid-day meal and ICDS, because we want to overcome malnutrition" (AD/R).* This controversy was perceived as problematic to a certain extent, given the increasing divergence in terms of quality consumption of edible oils across socio-economic groups.

One interviewee summarized the debate in the following terms:

> *"[the] nutrition community itself is fairly divided on this. They would look at the point of view on undernutrition and say that calories are important, and fats can give higher amounts of calories, so why not have fats. The other*

[approach] *[…] the emphasis is shifted to the quality of fats rather than the quantity of fat." (AD/R)*

This corroborates findings by (Thow et al., 2016) regarding the broader policy space for policy for the dual burden of malnutrition, who find that NCD and undernutrition tend to be perceived as separate and potentially conflicting agendas.

Finally, nutrition experts tend to advocate for downstream policies aimed at processing (regulation of TFA, fortification), or food environments (including packaged food, schools and street food), focusing on advertising, labelling and consumer awareness. Although experts generally supported increased consumption of local oils, up-stream policies were discussed as potentially impractical to deal with urgent concerns, with one expert commenting *"Our agriculture policy has to be reconfigured to have greater production of healthier oils […]* [but] *at the moment, we cannot move in that direction " (AD/R)*

Another interviewee argued for the recent policy focussing on edible oil fortification, which is likely to rely to a large extent on imported oils, referring to the limitations of up-stream approaches:

> *"Ultimately, we have to go for fortification, and that is the only solution that we have. At one of the conferences, a scientist said [to] grow green vegetables at the doorstep, so someone asked where is the door, and where is the step. Because it is very easy to say, but people living in slums, they cannot grow vegetables to eat at doorsteps" (AD/R)*

Aside from experts and nutrition advocacy coalitions, since 2001, food-security policies have been strongly influenced by a network of civil society organizations and activists campaigning for the recognition of food and nutrition-security as an economic and fundamental right (Hertel, 2015), which has been reflected in the National Food Security Act (NFSA) in 2013. This movement has argued for a broad approach to nutrition security, with a focus on dietary quality, beyond caloric intake.

A prominent leader of the campaign and policy adviser commented on the potential support for the inclusion of oils as a regular supply within PDS:

> *"We had insisted that edible oils should be part of the public distribution system, under the National Food Security Act. That unfortunately has not been the case, and we couldn't incorporate it into the act. But there is a lot of discussion in the government of India, even today, around whether edible oil should be a part of the National Food Security Act." (CS)*

This movement has generally supported local provision and production as part of their approach to nutrition security as a fundamental and economic right, linked to labour and gender rights (Hertel, 2015), highlighting up-stream approaches as part of an agrarian

6.3.4 Influence of non-state actors on sustainability-related policy

Although sustainability concerns have typically been relatively low in the policy agenda for edible oils, sustainability as a priority is gaining traction. This is partly related to the overall increased urgency around climate adaptation and conservation of water resources, as discussed in the context section, and which has been reflected in the National Mission of Sustainable Agriculture.

In the case of palm oil, however, industry influence is also playing an important role in this respect. In recent years, the edible oil processing industry has become increasingly interested in sustainability, for two main reasons: Firstly, domestic firms have been faced with increased pressure to adopt global sustainability certification schemes, such as RSPO. This is increasingly a necessary condition in order to supply multinational food processing firms, which have acquired global commitments for sustainability. Seeing this to a certain extent a business opportunity but lacking a consumer-based premium for sustainable products, the industry has started to demand policy support. In particular, companies have focussed on demanding tariff incentives for imports of sustainable oil, so that Indian firms will face *"less duty on green oil, and higher duty on not so green oil" (IN).*

One interviewee from industry commented on their proposal to the government:

"[We have proposed that the government should] *make the import duties cheaper by 1 or 2 percent so that* [we] *have more incentive to import sustainable palm oil. If normal duty is 7.5% CPO, if it is sustainable, you make it 6%" (IN)*

Both industry and civil society viewed this as a realistic possibility, provided enough interest from domestic processors, but one that might take time to happen. As a source from industry put it, *"The government is very sensitive. It is possible, […], but government is like [an] elephant, they walk very slow" (IN).*

Apart from the sourcing policies of multinational companies, the increased involvement of large processing firms in domestic cultivation of oil palm has also led to growing interest in sustainability initiatives. These companies perceive a comparative advantage with respect to Indonesia and Malaysia for cultivation of palm, which in India has mainly taken place on previously cultivated land. In order to realise this competitive advantage, domestic companies have sought policy support to focus on the production of high value-added sustainable certified products, mainly for the export market, including duty incentives "[The government should] *reduce the export duty for the sustainable palm oil, then once they do it* […] *we will request our government to reduce the import duty" (IN).*

Social actors advocating for sustainability mainly exert their influence through engagement with corporate actors, which is perceived as the most effective or feasible route to improved sustainability, given industry incentives and influence.

In the case of import policy, potentially conflicting interests were also identified as a barrier for direct engagement with policy and for short-term policy action to promote sustainability.

Civil society actors pointed in particular to the policy inertia created by the historical mandate to protect food security and control prices: *"I don't expect the government of India to implement any kind of regulations* [to promote sustainable imports], *because their primary concern is to ensure food security" (CS).* Only domestic producers, it was perceived, have sufficient influence to overcome this inertia and broaden the agenda for tariff-setting.

In the context of domestic production, on the other hand, government involvement has been more direct, which was perceived as a positive development, leading to the creation an Indian Palm Oil Sustainability framework (IPOS) (Solidaridad, 2017). The IPOS, although focussing mainly on domestic production, is also meant to include oil imports and has involved a collaboration between civil society, industry and government.

The interaction between government and social actors in this case, however, is still to an extent mediated by corporate actors. One interviewee described the relationship of sustainability advocates with one large oil processing company, saying

> *"[They are] like our business partner. We have a common concern to work for the sustainability prospects of palm oil. Whatever is the issue, water, efficient irrigation systems, the appropriate varieties, government regulations, policies. Export and import of edible oils also" (CS).*

Social actors commented on the implementation of national sustainability standards as a matter of national sovereignty, suggesting that global standards might be insufficiently sensitive to the national context and priorities:

> *"It will become a problem when there is a policy or a regulation* [or a] *norm, where they forcefully look that the oil is sustainable only. […] [If] we do not have any sustainability framework in India for the edible oils, or palm oil, […] we follow some other norms from other countries" (CS*).

Similar arguments have been used in the Indonesian context, where the creation of national sustainability standards has been advocated as a measure to ensure context-sensitive approaches, avoiding a situation where, in the words of Indonesian chief resources minister *"consumers from the developed countries set the standard"* (Jakarta Globe, 2015).

Sustainability advocates, overall, tend to focus on up-stream segments of the value chain (import and domestic production practices), while consumer-based approaches such as labelling, advertising, or consumer-oriented awareness campaigns are considered ineffective, given the patterns of demand including high price sensitivity and low visibility and desirability of palm oil for final consumers.

6.4 Policy characteristics

In addition to context and circumstance, which have been discussed in the previous two sections, specific characteristics of policy can also shape the space available intervention. In particular, relevant characteristics of a policy include not only the goals and criteria explicitly included, but often concern the distribution of costs and impacts across social groups, stakeholders and regions, since these can elicit reactions to policy in social or bureaucratic arenas (Grindle and Thomas, 1991).

6.4.1 Explicit inclusion of nutrition or sustainability criteria

Although stated goals can differ from de facto priorities and impacts, these are a result of previous policy processes and the explicit inclusion (exclusion) of specific goals can facilitate (constrain) further policy action in the stated direction. In Table 6-2 we summarize our results regarding the explicit inclusion of sustainability and nutrition goals within existing policies in different segments of the oil sector.

Table 6-2 Explicit inclusion of sustainable nutrition goals in current policy

Sectoral segment	**Explicit inclusion of sustainable nutrition goals in current policy**
Agricultural interventions: Oilseeds and oil palm	Sustainability explicitly included (National Mission on Oilseeds and Oil Palm, NMOOP): Water and soil conservation, climate adapted varieties (Ministry of Agriculture, 2014a). NCD prevention/healthy fat consumption not explicitly addressed.
International trade	Sustainability, nutrition/NCD prevention/healthy fat consumption not explicitly addressed. Food security goals included, price stability and availability (DFPD, 2009), (DFPD, 2014)
Oil processing, packaging, labelling and distribution	Nutrition/NCD prevention/healthy fat consumption explicitly addressed in various policies and regulations (FSSAI, 2011b), (FSSAI, 2011c), (FSSAI, 2013b).
Out of home food environments and use of edible oils in food processing.	Nutrition/NCD prevention/healthy fat consumption explicitly included in various initiatives targeting the formal sector. Initiatives targeting the informal sector mainly address food safety (FSSAI, 2013c), (HFSS Working Group, 2015).
Public distribution	Edible oils not included regular PDS and limited to emergencies. NFSA provides mandate for improved nutrition through *"progressive diversification of commodities distributed under the Public Distribution System" […] "ensuring access to adequate quantity and quality of food at affordable prices"* potentially supporting the future inclusion of edible oils. Sustainability criteria not explicitly included. (Ministry of Law and Justice, 2013)

6.4.2 Distribution of impacts and costs

Socioeconomic gradient

Although their main aim is not re-distributional, some important interventions in the edible oils sector have a socio-economic impact gradient, which needs to be taken into account when assessing the space for policy reform and the potential reactions and support in social and policy spheres. In particular, state-led agricultural input and production interventions in the oilseed sector directly engage with small-holders, which can potentially facilitate the introduction of nutrition-sensitive components aimed at vulnerable groups. Nutrition-sensitive components could be included, for example, in the promotion of intercropping, oil crop rotation schemes, provisions for strategic land conversion, farmer training or investment in seed variety improvement (Ministry of Agriculture, 2014a).

The recent move towards a corporate-led approach in the oil palm component of the National Mission on Oilseeds and Oil Palm (NMOOP), however, can shift subsidies and policy focus towards larger producers, while potentially facilitating farmers' access to funding from private investors.

The rationale for this shift is explicitly stated in an official press release from the Government of India:

> *"The waste land/degraded land/cultivable land in the oil palm growing states can be given on lease/rent or bought by private entrepreneurs/ cooperative bodies/ joint ventures for oil palm plantation. However, financial assistance under NMOOP is available for 25 hectares. Therefore, there is a need for relaxation of restrictions under NMOOP to attract corporate bodies towards oil palm and derive maximum benefit of 100% FDI. A combination of individual farming, contract farming and captive plantation (by relaxing land ceiling norms) can only boost oil palm cultivation in the country.*" (Press Information Bureau, 2017)

With respect to tariff changes or other policies directly affecting prices, palm oil being the cheapest oil in the market, the effects of price increases are most likely to be felt by lower-income households. However, palm oil is often consumed in blends or used for food processing, which can reduce consumers' awareness of price fluctuations and the consequent potential for reaction in the social sphere. Distributional impacts are more visible in the case of public distribution, leading to increased civil society engagement (Pande and P Houtzager, 2016), as discussed in the previous section.

Beyond direct social support for the inclusion of domestic edible oils, the resulting revitalization of PDS (Khera, 2011) can mitigate leakages, inefficiencies and the surrounding controversies, indirectly supporting the expansion to additional food products beyond grain, including edible oils.

Geographical distribution

Perhaps more importantly, key sectoral interventions have marked geographical impact patterns which shape the space for intervention, agricultural interventions and public distribution being the clearest examples. Oil palm development schemes in North-Eastern States, for example, have a strong component of regional development (Ministry of Agriculture, 2014a), which can take precedence over health or sustainability goals. More generally, the costs of NMOOP are shared across central and State governments at a rate 60:40, (with the exception of North-Eastern States, where the central government contributes 90% of the cost) implying the need for a substantial degree state-centre coordination (Ministry of Agriculture, 2016). The impact of palm oil distribution on producers at a regional level is also important. State governments have sought to protect local producers from the impact of palm oil distribution at subsidized rates, (Commission for Agricultural Costs and Prices, 2012), leading to unequal geographical adoption of the latest distribution scheme. One policy maker identified this factor, along with reductions in domestic prices, as one of the reasons for irregular adoption of the scheme*:*

> *"The different States wanted to distribute different oil. Gujarat wanted to distribute groundnut oil, and Kerala said they wanted to distribute coconut oil instead of palm oil. In 2013 only two states were taking oil, so the Scheme was terminated in September 2013"* (P).

Impact on organized stakeholders

Finally, in addition to broader socio-economic or geographical impact patterns, policy impacts on organised stakeholders can crucially determine the space for intervention. In this case, some policies directly affect the economic interests of key stakeholders and, in particular, domestic producers including oil and food processing companies. For example, interventions targeting food environments, such as compulsory initiatives to promote healthier processed food, can directly affect processing companies, typically requiring a degree of compromise with organised actors in the food industry. This has been the case with the implementation of the ban on trans fats (Downs et al., 2013) or "junk food" in schools (HFSS Working Group, 2015). This has also been identified as an important factor in the case of import tariffs, whose direct impacts on domestic producers are a key constraining element of the current policy space, as discussed in previous sections.

6.5 Policy instruments and goals in the sectoral portfolio: The Tinbergen principle and beyond

Our analysis of the policy space in the preceding sections of this chapter has focussed on the constraints and opportunities for the promotion of healthy, sustainable edible oils, as posed by context, process and policy content.

The resulting analysis suggests that potential approaches to this issue require a complex policy mix (Howlett and Rayner, 2007)or policy portfolio involving various policy areas across the sector, as well as various goals including NCD prevention, environmental sustainability and food security as well as other economic and social objectives.

Policy space analysis departs from the recognition that in a "real world" context, policy is not exclusively, or even primarily driven by theoretical considerations such as welfare maximisation but is to a large extent conditioned by the interaction of societal and organisational factors.

However, for the purpose of our discussion, as well as to frame our quantitative analysis, it is useful to discuss this "policy mix" from the point of view of more normative policy design theory, both as originally proposed by (Tinbergen, 1952) as well as through the lens of more recent developments on the topic (Del Rio and Howlett, 2013).

In order to do this, we theoretically characterize the policy mix, identify the main potential instruments in this portfolio and match them to the relevant goals, discussing the importance of interactions, secondary goals or side-effects and boundary conditions.

Main theoretical concepts in the analysis of complex policy mixes

Number of policies versus number of goals: The Tinbergen principle establishes that in order to achieve the desired goals, the number of instruments needs to be at least equal to the number of goals ($N_{instruments} \geq N_{targets}$) (Tinbergen, 1952). As Tinbergen pointed out in his seminal work, however, there is no reason why the number of policies would be equal to the number of targets. The use of several instruments to achieve a specific objective can help distribute "pressure" or costs, and it can also mean that each parameter requires smaller changes, which can be more feasible or efficient. Tinbergen (1952) provides the example of deficit reduction, where the objective is often best achieved through reductions in expenditure combined with small increases in a number of taxes, rather than exclusively through changes in a single instrument. It is also worth bearing in mind that, as with all formal policy analysis, the identification and matching of goals and objectives requires simplifying assumptions, so the number of policies and the number of goals in any given context is subject to interpretation and will depend on how we choose to define objectives and interventions (Del Rio and Howlett, 2013). In this case, we have separately identified policies attending to their main goal as well as separating across sectoral segments.

Primary goals: Even after we have clearly defined policies and goals, matching each policy to an objective might not be straightforward for several reasons. Firstly, in "real life" policy-making stated goals might not correspond to actual goals, or the real goals might be unclear or shift with time. Restrictive sanitary and phytosanitary policies or other regulations applied to food imports are a good example of this ambiguity. While governments often argue that these regulations are imposed for health reasons, critics frequently claim that the actual goal is the protection of domestic producers (Becker, 2010), (Barlow et al., 2018). Another interesting example in this context was the tax on palm oil proposed by the French government. French policy-makers initially argued that the goal of the tax was health promotion and NCD protection (Scott-Thomas, 2012), (Hawkes, 2016). Later on, a smaller tax was proposed citing environmental concerns. Supplying countries, on the other hand, have strongly contested the measure, questioning its true objectives and threatening to initiate a formal dispute within WTO (Michail, 2016), (WTO, 2016, 2016), (WTO, 2018). In this section we match policies to current stated goals, understanding that these could change with time.

Secondary goals or side-effects: Many policy instruments have side-effects beyond their intended target. This can require additional instruments to mitigate these impacts, if they are negative, or can contribute to important interactions (synergies, complementarities or conflicts) across policies (Del Rio and Howlett, 2013).

Boundary conditions: In addition to instruments and goals, boundary conditions are an important element to consider in policy analysis. Boundary conditions are restrictions that limit the number of alternatives available. These restrictions might relate to previous policy commitments, policies of higher-order governmental bodies (or international agreements), or to socioeconomic or cultural restrictions that determine what is considered feasible or acceptable. For example, in some contexts policy alternatives that involve reduction of prices or nominal wages are excluded, or more in general, alternatives that breach in some way the "social contract" or can have a high electoral cost (Tinbergen, 1952). It would be impractical to attempt to identify implicit boundary conditions for the different policies discussed in our study. However, this notion is relevant for our analysis because it can help us describe the relationship across policies and goals in some cases where the main goal of some interventions (eg. Food security, or environmental sustainability) can act as an important boundary condition for other policies (eg. import tariffs or agricultural extension policies).

Interactions across policy interventions: Conflict, complementarity, synergy and trade-off

When analysing complex policy mixes it is important to consider the existence of interactions across policies (Howlett and Rayner, 2007), where the implementation of a specific intervention reduces or enhances the effects of another. These interactions can make it very difficult in practice to assess the optimality of specific policy mixes. (Del Rio and Howlett, 2013) classify interactions into four categories:

> *Weak conflict* arises when the effect of two policies implemented jointly is less than the sum of the effects of each policy implemented separately, but more than the sum of a of these policies. Strong conflict arises when the introduction of two policies jointly results in a worse result than the introduction of either of them separately.
>
> *Complementarity* is defined as the situation when the effect is additive
>
> *Synergies* arise when the effect of two jointly implemented policies is larger than the sum of the effects of these policies when individually implemented.

This classification is relatively simple when applied to a single goal. In complex policy mixes, however, interactions can also occur across goals, with one policy mitigating the negative side-effects of another, enhancing its positive side-effects or affecting boundary conditions of another policy, thus restricting or broadening the policy alternatives available.

It would be infeasible to attempt to identify all potential conflicts or synergies across the policies discussed in this study. However, we discuss some of the most relevant potential interactions, based on our analysis so far.

Characterisation of sectoral policy portfolio for the promotion of healthy, sustainable edible oil consumption

When considering the main broad goals relevant to our question, we are in a situation where the number of instruments exceeds the number of goals, implying that there are potentially infinite optimal combinations of policies (Tinbergen, 1952).

We can classify the primary objectives of the sectoral policies discussed into four main goals: NCD prevention, environmental sustainability, food security and socioeconomic goals (mainly the protecting the economic interests of domestic producers, as well as regional development goals for specific States)

Table 6-2 matches the main sectoral policies discussed to the key policy goals in our study.

Matching policies and Goals

Agricultural policies: We distinguish between specific sustainability-oriented interventions and broader policies aimed at extension and intensification of oilseed and oil palm crops (see Chapter 5) (Ministry of Agriculture, 2014). While in the former case, environmental sustainability can be considered the primary goal, in the latter case, socioeconomic goals related to regional development and the protection of domestic producers prevail. Dietary drivers of NCD, environmental sustainability and food security can all be affected by agricultural promotion policies. Environmental impacts, in particular, can be considered to act as a boundary condition (eg. policies promoting palm oil expansion are constrained by considerations related to water conservation and protection of forested areas).

Trade policy: The main foreign trade policies in the edible oils segment are import tariffs and export restrictions (quotas and total or partial bans) (DFPD, 2009), (DFPD, 2014). Socioeconomic goals (the protection of domestic producers) can be considered the main goal when imposing import tariffs. Food security can be understood as a boundary condition, and sustainability and dietary drivers of NCD (consumption of fats and saturated and trans fatty acids) are secondary impacts of this intervention. It is worth noting, however, that although this reflects the current set-up, the primary goals of tariff setting can change. For example, we have discussed earlier in this chapter how differential tariffs for sustainable oils are actively promoted and discussed by some stakeholders, which would explicitly incorporate sustainability as a goal. In a different context, the government of Fiji recently imposed a 32% import duty on palm oil with the explicit aim of reducing diet-related NCD burdens (Coriakula et al., 2018). Export restrictions are the second key trade policy instrument and are mainly oriented towards the protection of food security, with economic impacts on domestic oil producers act as a boundary condition, limiting the conditions and duration of these restrictions.

Regulation of processing, marketing, packaging and distribution; Restrictions on health claims, banning oil blends: This type of policy includes a range of interventions from banning misleading health claims in oil marketing to restricting the sales of unlabelled blended oils, whose main purpose is the protection of health. In particular, these measures are often explicitly aimed at reducing NCD burdens (FSSAI, 2011) (FSSAI, 2013). Both environmental sustainability and food security can be indirectly affected if these policies affect demand, production incentives and prices of different oils in a significant way. The protection of domestic producers acts as a boundary condition. For example, as discussed in Chapter 5 and earlier in this chapter, the potential impacts on small and informal edible producers of traditional oils can restrict the implementation of stricter regulation for labelling, packaging and blend sales.

Targeting "out of home" use: Supporting healthy oil provision for restaurants, canteens and vendors, saturated fat labelling in processed food. As with the above policies, these type of interventions are primarily aimed at reducing NCD burdens (HFSS Working Group, 2015), while sustainability, food security and socioeconomic concerns can be understood as potential secondary impacts or, in the latter case as a boundary condition. (Eg. the potential negative impacts on the livelihoods of street of street vendors or the profitability of the processed food industry can restrict the alternatives available for regulating oil use in the "out of home" segment).

Sales taxes on less healthy oils and subsidies on healthier oils: Another hypothetical intervention would be the imposition of sales taxes on less healthy oils and/or subsidies on healthier oils. This policy instrument would be specifically oriented towards the promotion of healthier oil consumption and the reduction of dietary risk factors for NCD. As in the case of tariffs, food security could act as a boundary condition, as could economic considerations including the impact on government budgets, limiting both the level of taxes and subsidies, as well as the gap between both.

Public Distribution: Public distribution of edible oils is primarily a food security intervention. Public distribution policies can have an impact on NCD burdens and environmental sustainability. Socioeconomic goals such as the impacts on domestic producers as well as on government expenditure can act as boundary conditions, restricting the volume distributed as well as the distribution prices (Ministry of Law and Justice, 2013).

Awareness campaigns aiming to directly promote the demand for healthier oils are mainly concerned with reducing NCD burdens (Bachani, 2017), but could affect environmental sustainability and the economic impacts of domestic producers if they promote demand of healthier, sustainably produced local oils to replace imported palm oil.

Taking into account interactions across policies:

Based on our analysis, in chapters 5 and 6, we can give some examples of potentially relevant synergies across policies in the sectoral policy portfolio. This is not meant to be an exhaustive list, but merely an illustration of how interactions can operate across goals and interventions in a complex policy mix such as the one we are analysing.

Policies to incentivise oilseed producers including support prices, and investment and training for intensification and extension of oilseeds can reduce the food security impacts of edible oil import tariffs.

Interventions promoting climate-adapted varieties and efficient irrigation can reduce the environmental impacts of domestic expansion and intensification of oilseed and oil palm production.

Stricter regulation of oil blends, banning the sales of unlabelled or loose blends could mitigate the impact of public distribution programs on domestic producers, if it reduces the scope for leakages and adulteration of local oils.

Targeted public distribution of oil could mitigate the food security impacts of increased import tariffs or sales taxes.

Table 6-3. Matching policies and goals in the sectoral portfolio. The Tinbergen principle and beyond

	Goals			
Policies and instruments	NCD prevention	Environmental Sustainability	Food security	Socioeconomic goals: regional developments, protection of domestic producers, other
Agricultural policy				
Sustainability-oriented interventions (drip irrigation, crop rotation, land use regulation)	Secondary impact	Primary Goal	Secondary impact	Secondary impact/Boundary condition
Promotion of agricultural extension and intensification/ Minimum Support Prices	Secondary impact	Secondary impact/Boundary condition	Secondary impact	Primary goal
Trade policy				
Import tariffs	Secondary impact	Secondary impact	Secondary impact/Boundary condition	Primary goal
Export restrictions	Secondary impact	Secondary impact	Primary goal	Secondary impact
Regulation of processing, marketing, packaging and distribution: Partial ban on trans fats, restrictions on health claims, banning oil blends				
	Primary goal	Secondary impact	Secondary impact	Secondary impact/Boundary condition
Targeting "out of home" use: Supporting healthy oil provision for restaurants, canteens and vendors, saturated and trans fat labelling in processed food				
	Primary goal	Secondary impact	Secondary impact	Secondary impact
Sales taxes on less healthy oils and subsidies on healthier oils				
	Primary goal	Secondary impact	Secondary impact/ boundary condition	Secondary impact/ boundary condition
Public Distribution				
	Secondary impact	Secondary impact	Primary goal	Secondary impact/boundary condition
Directly targeting household demand: Public health education and awareness programs				
	Primary goal	Secondary impact		Secondary impact

6.6 Conclusions

In this study we have analysed the policy space for the promotion of healthy sustainable oil consumption in India, as shaped by the historical, international and political context, the agenda-setting circumstances or policy processes and the characteristics of existing interventions. Our analysis highlights important opportunities for the promotion of sustainable, healthier oil consumption, which we briefly summarize here. We will first discuss key opportunities and then discuss the main barriers identified in our study.

Opportunities

Overall, the implementation of a sectoral agenda for sustainable nutrition is supported by the emergence of multisectoral approaches to NCD prevention (Ministry of Health and WHO, 2016), with explicit emphasis on saturated and trans fat reduction, as well as by the increasing recognition of climate adaptation as a national priority, with sectoral policies being framed by broader strategic schemes (Ministry of Agriculture, 2014b). Moreover, the existence of structures for sectoral policy coordination, a product of a history of market monitoring and intervention, can support the adoption of coherent, synergistic policies across segments and goals. The increased participation of health actors in the sector (FSSAI), has also resulted in an increased focus on NCD prevention, with policies addressing oil processing, labelling, distribution and utilization in food processing. We also find a supportive environment for the translation of nutrition evidence into policy. Although existing debates around health impacts of saturated fat have been identified as a challenge in other contexts (Mozaffarian, 2011), (Shankar et al., 2017), experts and advocates tend to adopt a precautionary approach to this issue. Additionally, emergent rights-based civil society movements, although mainly focussed on food security and livelihoods (Pande and Houtzager, 2016) could provide an important support for the inclusion of local edible oils into PDS, shifting away from reliance on palm oil for food security interventions. We also find increased engagement from sustainability-oriented social actors in the sector, where we find that policy influence is exerted mainly through collaboration with corporate actors in the oil processing industry. Finally, although current agricultural policies in the oilseed sector do not explicitly incorporate goals related to the promotion of healthy oil consumption, the characteristics of these interventions, which directly engage with small-holders, provide opportunities for the adoption of nutrition-sensitive approaches in the promotion of inter-cropping, crop rotation or variety-improvement.

Challenges

However, our analysis also identifies some important challenges. These are, to a certain extent, determined by contextual issues. In particular, the space for trade policy is increasingly constrained by international agreements, while overall sectoral policy priorities are shaped by a history of intervention prioritizing food security, understood as calorie provision and price stability. Additionally, the pursuit of sustainability and nutrition goals is constrained by broader policy priorities including reduced import dependence, price stability and the protection of domestic producers. Furthermore, we find that nutrition and sustainability-oriented social actors tend to focus on different segments within the sector, with sustainability advocates generally addressing up-stream issues while nutrition actors tend to focus on downstream segments. Up-stream supply-side policies, while viewed positively, are considered impractical as a solution to urgent nutrition-related concerns in the short term. Moreover, the debate between those arguing for a focus on calories from fat and those arguing for a focus on fatty acid quality is perceived as a barrier for the policy influence of nutrition experts in the oils sector. This corroborates previous findings regarding he split policy space for the dual burden of malnutrition in India (Thow et al., 2016). With regards to sustainability, perceived trade-offs with food security objectives are understood as a barrier for policy influence. Finally, it is worth noting that key policies in the sector, including tariff-setting, or regulation of oil-processing and "out of home" food environments can directly affect the economic interests of domestic producers, who act as organized stakeholders. In the case of tariff-setting, for example, this leads to a highly contested policy space, where the inclusion of concerns perceived as non-urgent can be challenging. Other interventions, such as agricultural promotion or public distribution also have marked geographical patterns of impact, which need to be taken into account as regional development goals interact with nutrition or sustainability concerns.

Implications

Overall, our analysis finds important opportunities as well as some challenges for the promotion of sustainable, healthy oil consumption in India. We highlight, in particular, the opportunities to incorporate approaches sensitive to sustainable nutrition outcomes within currently existing interventions.

We have discussed how perceived trade-offs across key nutrition and sustainability outcomes, are viewed as a barrier for policy influence and change. Systematic efforts towards identifying synergistic approaches, from agricultural production to distribution of edible oils, could potentially increase the policy influence for advocates of both sustainability and nutrition. For example, increased involvement of nutrition advocates with up-stream policies in the edible oils sector (such as trade policy or agricultural interventions) could potentially enhance coherence across policy goals and interventions in different segments of the value chain.

The dynamics surrounding advocacy for sustainability illustrate the changing role of an organised corporate sector. The concerns and strategy of this sector increasingly align with those of global brands, as firms become more consolidated and internationally integrated, becoming active in the corporate social responsibility arena. This represents an important transformation in a sector traditionally dominated by small producers exclusively concerned with domestic or even local markets. Whether in terms of leveraging the corporate sector, or contending with its influence, this is a factor to take into account when advocating for policies to promote healthier oil consumption, as it is likely to further re-shape the policy space.

Additionally, given the existing degree of intervention and sectoral policy coordination, our analysis highlights the importance of considering the alignment of proposals aimed at promoting sustainability and healthy fat consumption with broader sectoral priorities. In particular, the interaction with goals relating to self-sufficiency, food security (understood as price stabilization and calorie availability) and regional development can be determinant for policy acceptability and successful implementation.

Chapter 7. Quantitative methodology in context: The use of CGE models for research on diets and nutrition

7.1 Introduction

In this chapter we briefly review and discuss the application of CGE models to the analysis of diets and nutrition.

This serves to illustrate the applications, advantages and limitations of CGE to analyse the interaction between economic factors and diets. It also sets the context for our CGE analysis of the nutritional and economic outcomes of palm oil tariffs in India, framing our methodology, its contributions and limitations within the existing literature. In order to support our discussion, we include a brief review of studies using CGE models which analyse diets and nutrition. Our modelling approach which is then described in detail in Chapters 8 and 9.

In Section 7.2 we briefly explain the main characteristics, advantages and limitations of CGE applications to diet and nutrition-related topics, from a theoretical point of view. In Section 7.3 we describe the search strategy, inclusion and exclusion criteria for our brief review. 7.3 comments on the results from our brief review 7.5 discusses the application of CGE to diet-related issues based on the findings from our literature search, and briefly discusses the main limitations and contributions of this body of research. Section 7.6 concludes. The main characteristics of the studies reviewed in this chapter are summarized in Table 7-1.

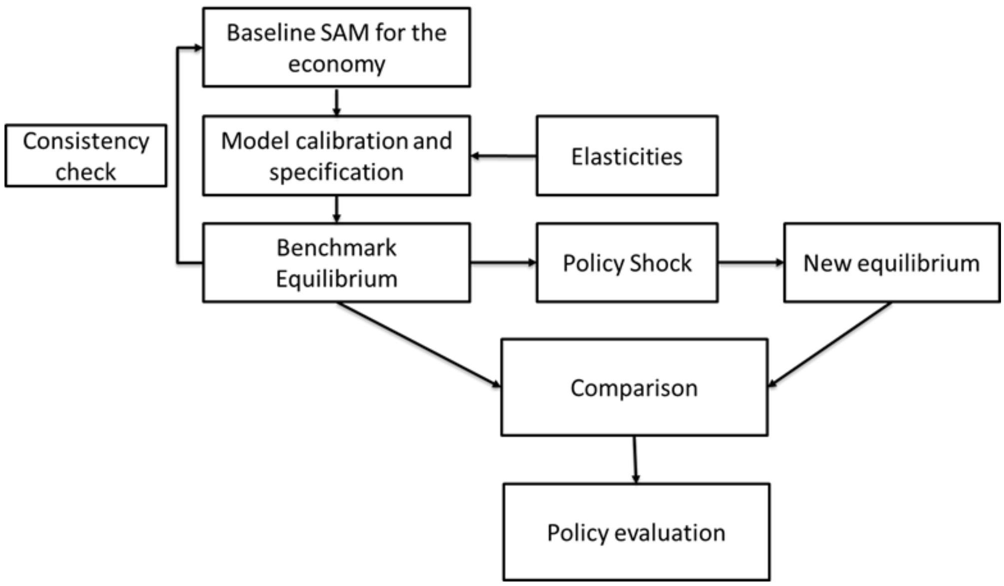
7.2 Main characteristics, advantages and limitations of CGE applications to diet and nutrition topics: theoretical discussion

A CGE model is a complete system of equations that describes an economy as a whole and the interactions among its parts. The equations describe the behaviour of consumers, producers in different sectors and government. They also include macroeconomic identities and constraints (Lofgren et al., 2002).

CGE models provide an internally consistent framework for the analysis of policy issues or economic phenomena that affect multiple economic sectors and actors. For example, changes in the global price of a food commodity will not only affect consumers but will also affect the income that households receive from agriculture, including returns to land, labour and capital production factors. If the changes are large enough, the effects can also extend beyond the agricultural sector. Linkages across sectors in CGE models can be mediated by various interacting effects including input use, use of labour, capital and land as production factors, household budget allocation across commodities, and changes in household income among others. For instance, if the returns to land, capital and labour in a specific agricultural sector diminish, land and capital can be re-allocated to other commodities, and labour can migrate to other sectors, potentially involving rural-urban migration. Thus, CGE analysis can provide valuable information for policy makers, highlighting potential effects of certain policies which might be missed by partial equilibrium models or other approaches to policy analysis.

Additionally, this methodology can analyse several simultaneous external and internal shocks to an economy, providing quantitative information based on real-world data, in contrast to theoretical equilibrium models. This can provide policy makers with relevant information in contexts where an econometric analysis would not be feasible or would require large volumes of longitudinal data which are often unavailable. The effect is derived from the comparison of the new equilibrium and the benchmark equilibrium.

Figure 7-1 shows a diagram explaining the calibration and use of a CGE model for policy analysis.



The model parameters are calibrated to fit the baseline data, with some key parameters such as demand elasticities typically estimated based on external data (Arndt et al., 2002). Exogenous parameters in the model are then modified to simulate a policy shock, and the equations are solved for the new equilibrium. The evaluation of the policy effect is derived from the comparison of the new equilibrium and the benchmark equilibrium.

Neoclassical CGE models, however, also have some theoretical, empirical and practical limitations which need to be taken into account during study design, analysis and interpretation. In the first place, these models are based on the neoclassical principles of demand and supply and assume that prices clear all markets of factors and commodities and that excess demand functions are homogeneous of degree zero in prices. Consumer preferences and producer technologies are assumed to be given.

Although these assumptions can often provide a reasonable approximation of the reactions of an economy and its agents to policy interventions and other shocks they are, like all models, a simplification of reality, and can have difficulties capturing some phenomena that are relevant in the context of food policy. Many of the assumptions regarding the behaviour of producers, consumers and markets can be relaxed or altered and adapted to the context. For example, (Mujeri and Khandaker, 1998) adapt their model to include monopolistic or oligopolistic behaviour. However, modifications of the basic assumptions often require additional modules or add complexity to the model. Examples of phenomena that are not easily captured by CGE models include dynamics within vertically integrated value chains, or rapidly changing preferences and technologies.

In addition, criticism of the CGE approach has often focussed on the impossibility of statistically testing and the difficulty in validating the models. which rely on sensitivity analysis to assess the validity and role of calibrated parameters. Criticism has also been directed at other empirical issues including the choice of parameters which have not been statistically estimated or the quality of the data (McKitrick, 1998).

Finally, some economists have criticized the use of CGE models as a "black box", arguing that the large number of assumptions involved can obscure the interpretation of the results (Devarajan and Robinson, 2002). In this respect, several authors have argued that CGE models should be understood as approximate quantitative policy planning tools, or tools for approximate "quantitative thought experiments" (Taylor, 2016), Krugman (2011). These policy planning tools can provide information about the sign and relative size of different policy effects or illustrate potential unforeseen effects on an intervention that arise as a result of general equilibrium effects or inter-sectoral links. Experts have insisted, however, that interpretation, intuition, experience and insight into the context are key components of CGE analysis. We will conclude this section with a quote from Velupillai and Zambelli (2010), who argue that the results of SAM-based simulations are useful only to the extent to which they are *"conjoined to those intangible non-formal concepts like (the modeller's) intuition, experience and insight"*.

7.3 Search strategy, inclusion and exclusion criteria for review of CGE applications to nutrition

We have performed a search in three databases, Web of Science, Econlit and Scopus for the terms shown in Table 7-1. We have included both the peer reviewed articles found in this search as well as grey literature. We have included only those articles including assessing nutritional intake, or some measure of overall dietary quality. We do not include articles that focus on food prices, food expenditure or demand of particular food commodities. This review is not meant to be systematic or exhaustive, but to illustrate the range of topics and approaches in this area.

Table 7-1. Search terms

Concept 1	Computable General Equilibrium	"Computable general equilibrium" OR
	CGE	"CGE"
Concept 2	nutrition	"nutrition*" OR
	diets	"diet*" OR
	calories	"calor*" OR Kcal* OR "energy intake" OR
	proteins	"protein*" OR
	Nutrients	"nutrient*" OR "micronutrient*" OR "macronutrient*"
	vitamins	"vitamin*" OR

7.4 Results

We found 17 articles meeting our inclusion criteria of which ten were published in peer reviewed journals and the remaining seven were grey literature, including working papers, reports and contributions to conference proceedings. A summary of the characteristics and findings of these studies is provided in Table A2-1.

Most of the studies focussed on low and middle income countries in either Asia or Africa, while only one study was global in scope (Rutten et al., 2014) and three others looked at high income countries (UK and US) (Lock et al., 2010), (Mulik and O'Hara, 2015), (Jensen et al., 2013). The topics covered are diverse but can broadly be classified into three categories: eight out of the 17 studies analyse the impact of macroeconomic factors including policy, crisis and growth pathways, on nutrition; four articles have used a CGE framework to analyse the nutritional impacts of climate change and environmental factors; and five articles analysed the economic impacts of dietary changes. Furthermore, Rutten et al. (2013), (2014) have used a CGE modelling framework and its underlying input-output structure to trace nutrient origins and channels of consumption (direct consumption versus processed food or food services) and identify "entry points for action". Although a climate-related simulation is presented as an application Rutten et al. (2014), the model is presented as a multi-purpose tool for nutrition-sensitive analysis.

7.4.1 Studies analysing the impacts of macroeconomic factors and policies on nutrition

Within the first category, several studies have focussed on issues directly related to globalisation and trade liberalisation. In this context, CGE models have been used to analyse how nutritional outcomes can be affected by economic growth patterns in large trading partners, which affect relative prices and factor returns (Hertel et al., 2007). A related topic of analysis has been the effect of food price volatility and associated fluctuations in output on calorie intakes, with and without Special Safeguard Mechanisms (Verma and Hertel, 2009).

Others have analysed the nutritional impacts of tariff reductions in different contexts (Panda and Ganesh-Kumar, 2009a), (Mujeri and Khandaker, 1998), (Cockburn et al., 2014) The differences in context and approach do not allow for direct comparison of the results. These studies illustrate how tariff reductions can be associated to improved calorie intakes in some contexts (Mujeri and Khandaker, 1998), (Cockburn et al., 2014), but can also have regressive nutritional impacts (Mujeri and Khandaker, 1998), and even reduce calorie and protein intakes for the poorest households (Panda and Ganesh-Kumar, 2009a), through their combined impacts on prices and incomes. In addition to their effects on calorie intakes, Panda and Ganesh-Kumar, (2009a) find that tariff reductions in India in line with the Uruguay round on negotiations would lead to increased fat consumption for all household categories.

CGE models have also been used to simulate the potential nutritional effects of sectoral growth trends and macroeconomic reforms contexts (Mujeri and Khandaker, 1998), economic crisis (Balma, 2010), (Breisinger and Ecker, 2014) or recovery strategies (Balma, 2010) (Cockburn et al., 2014), in general with a focus on macronutrient and particularly calorie intakes, calorie deficiencies or "calorie poverty". Several of these studies highlight how the sectoral composition of growth can affect nutrition, mainly through its impacts on the relative prices of staple crops, as well as on income distribution. This can contribute to explaining counter-intuitive results such as the weak association of agricultural growth with calorie intake in Tanzania (Pauw and Thurlow, 2011), or the potentially positive effect of economic crisis on child caloric poverty in West and Central Africa (Balma, 2010), as staple crop prices decline relative to other commodities.

7.4.2 Studies analysing the impacts of climate change on nutritional indicators

The analysis of climate change and environmental policy impacts has been an important area of application for CGE, increasingly incorporating health "co-benefits". Most studies in this area, however, have tended to focus on air pollution and its association with chronic disease (Dessus and O'Connor, 2003),(Thompson et al., 2014).

A comparatively small number of studies has analysed the nutritional impacts of climate change using CGE models. These studies incorporate assumptions regarding changes in crop yields due to increased temperatures (Hasegawa et al., 2014), (Rutten et al., 2014), (Banerjee, 2015) and have also analysed the effects of floods on the availability of land and livestock (Wiebelt et al., 2011).

As in the case of the studies discussed above, the primary focus is on calorie intakes or "risk of hunger" (Banerjee, 2015), (Hasegawa et al., 2014), (Wiebelt et al., 2011). Effects are driven by changes in crop prices as yields and cropped area fall, as well as by changes by reduced returns to land. (Rutten et al., 2014) analyse also changes in nutrient origin and in regional consumption of processed foods.

7.4.3 Models analysing the economic impacts of dietary changes

All of the studies discussed so far have analysed the impacts of policy, macroeconomic or environmental shocks, where nutritional intake is treated as an outcome. In addition, we have identified four articles that analyse the effects of dietary changes on the economy. Two of these studies focus on the adoption of genetically modified Golden Rice (Anderson and Jackson, 2005) and (Anderson, 2005). These studies consider the impacts of reduced morbidity on the economy through increases in unskilled labour productivity, which is found to lead to economic gains larger than the direct gains perceived by producers. Other studies have focussed on the economic impacts of the adoption of healthy diet recommendations, including reduced meat consumption and increased vegetable consumption which are shown to have economic impacts through their effects on the labour force (Lock et al., 2010) and on land use (Mulik and O'Hara, 2015).

7.5 Discussion: CGE models for food policy; towards nutrition-sensitive analysis

The articles reviewed in the above section illustrate the applications of CGE modelling to integrated analysis of economic variables and diets or nutritional outcomes. These studies address a variety of topics including the nutritional impacts of globalisation, liberalisation, economic crisis, climate change and a range of mitigating and adjustment policies. In other cases, CGE models have been used to analyse the economic and environmental effects of exogenously imposed dietary changes.

In general, CGE analysis is used as a coherent framework for the analysis of multi-sectoral linkages and phenomena that result from the interacting behaviour of different actors, including producers, consumers and government. Moreover, several of the studies discussed in the above section highlight the importance of inter-sectoral linkages in determining relative price changes, as well as the interaction between price and income pathways in determining nutritional outcomes (Mujeri and Khandaker, 1998), (Pauw and Thurlow, 2011), exploring also the role of factor endowments (land, labour and capital) and relative factor intensity as mediators of impact from economic or climate shocks (Hertel et al., 2007), (Wiebelt et al., 2011).

Additionally, recent applications have highlighted the increased importance of food processing and the opportunities of using multi-sectoral CGE models to trace nutrient origins and nutrient intakes through different channels (agricultural commodities and processed food or food related services), identifying potential "entry points for action" Rutten et al. (2014).

Despite the relevant contributions discussed above, we have identified some limitations in the existing literature. In the first place, most of the applications reviewed focus only on macronutrients and, in many cases, exclusively on calorie intakes. The only exceptions are (Lock et al., 2010), who analyse the impacts of changes in fatty acid intake and (Anderson and Jackson, 2005) and (Anderson, 2005) who focus on vitamin A deficiency. The nutrition transition has contributed to an increase in chronic disease prevalence in low and middle-income countries, however, leading to growing dual burdens of malnutrition, where persistent undernutrition coexists with increasing burdens of non-communicable disease (Wahlqvist, 2006). Analysis of this phenomenon requires more detailed inclusion of nutritional patterns, going beyond macronutrient intakes.

Furthermore, many studies have used satellite modules, which are coupled to the CGE model. These include household microsimulations and climate or air-dispersion models among others (Thompson et al., 2014). This approach has undeniable advantages, offering additional sophistication, detail and realism. However, the use of coupled modules also adds complexity to the analysis and can make it difficult to trace the impacts of specific assumptions. This type of approach can, in some cases, lead to "spurious precision" in the results (Noland et al., 2001), where the additional detail of the coupled modules does not counter-act some of the underlying strong assumptions of the CGE model. In this regard, it is perhaps worth bearing in mind the recommendations by (Devarajan and Robinson, 2002), who observe that the insights obtained from CGE models have been most useful when they have been corroborated by other approaches, and when the simplest model possible has been chosen to fit the analysis.

An additional limitation which is, to a certain extent, related to the use of satellite modules, is the lack of complete integration of the modelling frameworks that incorporate health or nutritional impacts. That is, some of the models reviewed analyse the economic impact of health effects dietary changes, while others analyse the nutritional effects of economic and environmental factors. None of the studies reviewed provides a fully integrated framework capable of capturing the feedback from the economy to diets to and back into the economy through health effects. This is not necessarily a limitation in all cases, since, in many contexts, feedback effects are likely to be negligible, or the focus is on illustrating specific dynamics which are not altered by these feedback mechanisms. However, in some cases, the development of fully integrated economy-nutrition-health frameworks could be of interest.

Finally, food systems are often characterized by non-perfect markets including economies of scale, oligopolistic competition and product differentiation. However, only (Mujeri and Khandaker, 1998) reflect these dynamics. Again, this approach is not necessarily recommended in all cases, given the additional complexity it entails. However, the incorporation of market imperfections can, in some cases, provide a more accurate and appropriate depiction of policy transmission in food systems and deserves further attention

Like several studies in this review, we use our model to analyse the impacts of tariff changes. Our focus, however, is more specific than most studies reviewed, analysing changes in a single commodity.

We do not address all the limitations described in this chapter in our study. Some are beyond the scope of our analysis for practical reasons, while others are not applicable or relevant in our case. In particular, we do not quantify the health effects of nutritional changes, and we do not consider the introduction of market imperfections in our model.

However, we address some issues which remain understudied in the literature. Like Rutten et al. (2014), we capture nutrient consumption through different channels, exploring the growing role of processed food in mediating economic and nutritional impacts. Like (Anderson, 2005) and (Lock et al., 2010) we go beyond calories, macronutrients and food security, analysing nutritional outcomes related to NCD.

7.6 Conclusion

In this chapter we have reviewed and discussed the application of CGE models to the analysis of nutrition and diet-related topics.

The studies identified analyse the nutritional impacts of a range of economic shocks, including trade liberalisation (Panda and Ganesh-Kumar, 2009), economic crises, cash transfers, food subsidies (Balma, 2010), (Cockburn et al., 2014), or price volatility with and without the implementation of Special Safeguard Mechanisms (Verma and Hertel, 2009). Other CGE applications have simulated the nutritional impacts of climate change, mediated through economic variables (Wiebelt et al., 2011), (Hasegawa et al., 2014), (Banerjee, 2015) or the economic and environmental impacts of dietary changes (Anderson, 2005), (Anderson and Jackson, 2005), (Lock et al., 2010), (Mulik and O'Hara, 2015). In general, the studies retrieved have contributed to the joint analysis of economic and nutritional impacts of policy interventions, and to the understanding of the interactions between economic and nutritional variables in contexts where there are relevant links across different economic sectors or actors, or where a policy intervention simultaneously affects incomes and food prices. With few exceptions (Anderson, 2005), (Anderson and Jackson, 2005), (Lock et al., 2010), the literature focuses on undernutrition and includes only energy and macronutrient intakes.

In our study we adopt a standard approach in the literature, in the sense that we analyse tariff changes, integrating nutritional and economic impacts. However, we address some issues which are understudied in the literature on CGE for nutrition, including NCD-related nutrition outcomes, (Lock et al., 2010), or the role of the processed food sector Rutten et al. (2014).

Chapter 8. The Social Accounting Matrix of India and nutritional coefficients

8.1 Introduction

In this chapter we describe the Social Accounting Matrix for India (2007/08) (SAM) and the nutritional content database. We also describe the disaggregation of the edible oils sector.

A social accounting matrix is a representation of the flows of payments within an economy which includes payments between economic sectors, households, governments and the rest of the world. All actors and institutions are both payers and receivers, and payments balance out (Lofgren et al., 2002). The construction of a SAM relies on a number of databases, but the main source of data is usually the National Accounts Statistics.

We use a nutrition-sensitive disaggregation for the edible oils sector in the SAM, alongside nutritional coefficients adapted for their use within our CGE model, in order to analyse nutritional and economic impact of food policies in the edible oils sector. A diverse range of databases are combined and triangulated to disaggregate the edible oils sector into four activities producing five commodities[22].

The disaggregated Social Accounting Matrix and associated nutritional coefficients have been constructed for their use in a comparative static analysis of policies affecting imported edible oils, with the aim of capturing links with the processed food and PHVO sectors.

The rest of this chapter is structured as follows. Section 8.2 introduces the concept of a Social Accounting Matrix. Section 8.3 describes the structure of the India SAM, focusing on those aspects that are more relevant for our analysis of food policy interventions. Section 8.4.2 describes the adaptation of the original IEG SAM (Pradhan et al., 2013) for use with the IFPRI standard CGE model (Lofgren et al. 2002), and the disaggregation of the edible oils sector in the SAM, explaining the purpose, databases used and the main assumptions involved. Section 8.5 describes the nutritional content database and the derived nutritional weights for use within the CGE model.

[22] Oil meal is produced as a by-product of oil

8.2 What is a Social Accounting Matrix?

A Social Accounting Matrix or SAM is the main database underlying a CGE model. It reflects the circular flow of income and spending in an economy over the course of a year and provides an intuitive understanding of the linkages across economic agents and sectors. The structure of a SAM generally differs across CGE models. In this section we explain the main characteristics an interpretation of a generic SAM, based on Lofgren et al. (2002), with reference to the main characteristics of our India SAM, based in the IEG SAM (Pradhan et al., 2013). A more detailed description of the India SAM is provided in Section 8.3. Table 8-1, at the end of this section, shows the overall structure of a SAM and the interpretation of each account entry.

Rows represent payments into an account, and columns represent payments out of it, such that every cell in the SAM represents at the same time a payment and a receipt. The SAM must always be balanced, meaning that the sum of each column must equal the sum of the corresponding row, following a standard double-entry bookkeeping principle. The main accounts in the SAM include producers in different economic sectors (sometimes referred to as industries), factors of production (eg. labour, capital and land), households, the government, tax accounts, a government account, a savings-investment account and a "rest of the world" or RoW account.

Production and retail are represented in the SAM by activities and commodities. The columns for activities reflect payments in return for inputs (to commodity rows) and in return for factors of production, as well as producer taxes. The total of payments made to factors of production amounts to the value added at factor cost in the economy for the relevant period, and the payments in return for inputs correspond to intermediate consumption. The output of activities is sold to commodity accounts, generally of the same name, reflected as a payment from the activity row to the commodity column. Transaction costs can be disaggregated and reflected as payments between commodities. The India SAM, however, does not include disaggregated transaction costs. Each activity generally produces one commodity but can produce several commodities as by-products. This is the case, in our SAM, with edible oils and oil meal. Commodities are consumed by households and government, dedicated to investment, or exported.

Factors of production receive payments from activities, pay taxes, and also pay income to households and enterprises who own them, as well as to foreign owners. Although natural resources are sometimes included as a factor of production, our SAM only includes labour, capital and land.

Households can be represented by a single account, or can be split into categories, which, in the case of our SAM, are classified according to occupation of the head of household and rural/urban residence. Households receive their income from the factors of production they are endowed with, as well as from transfers from the government and from the rest of the world (foreign remittances). They pay income taxes and allocate their remaining disposable income to consumption of different commodities and services (paying to the relevant accounts) and to savings.

The government receives payments from all of the tax accounts and spends it on public services, commodities and transfers, as well as to savings. Enterprises are often represented by a single account which receives income from capital and pays it into a savings-investment account. Our SAM includes two "enterprises" accounts, differentiating between private and public enterprises.

The payments from households, enterprises and government to the savings row are then invested. Investment is reflected in the form of commodity purchases in the savings-investment column and, in a dynamic model would lead to overall capital accumulation in the economy. The rest of the world account reflects transactions with other countries. The sum of payments for imports and net factor payments to/from foreign nationals (mainly to foreign investors) is balanced out with payments on exports and unrequited transfers. The India SAM includes unrequited transfers only to households.

Table 8-1. Basic SAM structure.

Basic SAM structure. Adapted from IFPRI standard CGE model										
	Expenditures									
Receipts	Activities	Commodities	Factors	Households	Enterprises	Government	Taxes	Savings-Investment	Rest of World (ROW)	Total
Activities		Marketed outputs								Activity income (gross output)
Commodities	Intermediate inputs	Transaction costs		Private consumption		Government consumption		Investment	Exports	Demand
Factors	Value-Added								Factor income from RoW	Factor Income
Households			Factor income to households			Transfers to households			Transfers from Row	Household income
Enterprises			Factor income to enterprises						Transfers from RoW	Enterprise income
Government							All taxes		Transfers from RoW	Government Income
Taxes	Producer taxes	Import, export and sales taxes	Factor taxes	Direct taxes						Tax income
Savings-Investment				Household savings	Enterprise savings	Government savings				Savings
Rest of World (ROW)		Imports	Factor income to RoW							Foreign exchange outflow
Total	Activity	Supply expenditures	Factor expenditures	Household expenditures	Enterprise expenditures	Government expenditures	Tax expenditure	Investment	Foreign exchange outflow	

Source: Own elaboration based on Lofgren, Harris and Robinson (2002)

8.3 Description of the India Social Accounting Matrix for 2007/08

The SAM for India as used in our model includes 70 sectors producing 71 commodities (oil processing activities produce oil meal as a by-product). It also includes 5 productive factors, 9 household categories and 3 additional domestic institutions (government, public enterprises and private enterprises). Finally, it includes a savings-investment account, six differentiated tax accounts and an aggregated account representing the Rest of the World (RoW).

GDP is of 4581422 Crore (2007 current INR[23]), of which agricultural GDP is around 18%. Most marketed outputs are used by enterprises as intermediate input (44%) or consumed by households (25%). Around 17% are invested and 10% exported. Table 8-2 shows the aggregated Macro SAM of India, presenting flows of income between sectors, productive factors and institutions.

Import tariffs are an important source of government income. While the government receives most of its income from direct taxes, import taxes are the second largest source contributor, amounting to around 23% of government income. The country imports commodities worth 27% of the annual GDP. Food represents more than 2% of overall imports and around 18% of total household expenditure. Edible oils and, in particular, palm oil, are the main food import.

Table 8-2. Macro SAM of India

Macro SAM of India 2007/2008. Billion Indian Rupees (INR)										
	Expenditures									
Receipts	ACT	COM	FAC	HH	ENT	GOV	TAX	S-I	ROW	TOTAL
ACT	0	95836	0	0	0	0	0	0	0	95836
COM	49333	0	0	27829	0	5130	0	19019	10311	111622
FAC	45814	0	0	0	0	0	0	0	0	45814
HH	0	0	35706	0	0	5612	0	0	1675	42993
ENT	0	0	8916	0	0	0	0	0	0	8916
GOV	0	0	0	0	0	0	8760	0	0	8760
TAX	689	3361	987	3724	0	0	0	0	0	8760
S-I	0	0	0	11441	8916	-1981	0	0	644	19019
ROW	0	12425	205	0	0	0	0	0	0	12630
TOTAL	95836	111622	45814	42993	8916	8760	8760	19019	12630	0

[23] INR stands for Indian Rupees. Rupees can also be abbreviated as Rs. 1 Crore = 10 million.

Source: Own elaboration. Based on IEG 2007/08 SAM of India (Pradhan et al., 2013). ACT= Activities, COM=Commodities, FAC=Factors, HH=Households, ENT=Enterprises, GOV=Government, TAX= Taxes, S-I=Savings-Investment, ROW= Rest of the World.

The sectors in the SAM can be grouped into *Agriculture and Forestry, Mining*, *Industry and Manufacturing*, and *Services*. Table A3-5 in the appendix provides a list of the main classifications in the India SAM. Table A3-3 in the appendix presents the full sector classification including the correspondence with sectors and commodities in the Input Output tables (Central Statistical Organisation, n.d.) and 66th round of NSS household consumption and expenditure survey data (NSSO, Government of India, n.d.) . Agriculture and forestry sectors are classified into 22 activities (codes a001 to a022), which contribute around 19% of GDP. Most commodities that have undergone primary processing such as wheat flour, flattened rice or rice noodles are aggregated with their corresponding primary agricultural commodity. Agriculture is the most labour-intense sector. In particular, unskilled labour receives almost 40% of the payment from Agriculture and Forestry activities.

Mining is aggregated into a single sector (a0023) which contributes almost 3% of GDP and is relatively capital intensive. This sector, which includes crude petroleum, coal and natural gas, represents around 27% of total imports.

Industry and Manufacturing is classified into 36 activities. These activities produce 37 commodities, because the edible oil manufacturing activities produce oil meal as an additional by-product. Edible oil activities keep the original code a026 and are differentiated with letters (eg a026P for palm oil). Aside from edible oils and vanaspati, there are four other manufacturing activities that produce food. These include: sugar and khandasri (a024), tea and coffee (a027), beverages (a029) and an aggregated "food processing" sector (a028). The sector encompasses all food production beyond primary processing. As a whole, manufacturing activities contribute around 32% of GDP and are also relatively intense in low-skilled labour.

Finally, 11 service-providing sectors (a058 to a068) represent 47% of GDP at factor prices and are relatively intensive in skilled labour with respect to agriculture and industry. This includes one aggregate

All activities that directly produce food commodities are marked with an (F) in the appendix. There are 21 food-producing activities in total. We do not include the Hotels and Restaurants sector (a060), since it mainly produces non-food related services[24]. Food represents 18% of overall household expenditures.

There are five productive factors in the SAM. Labour is divided into three categories (F01 to F03) according to skill level. Capital and Land are each represented by a single account. Capital and Labour each receive almost half of the total value added, with remunerations to Land ownership representing barely over 1% of value added.

Households are classified into 9 categories based on main occupation of the head of household and rural-urban location (See Table 8-3). This is the original classification provided in the IEG SAM, and which has been maintained[25]. Payments from capital and land represent 45% of factor income for rural households. Urban households are more dependent on labour income, which represents 71% of factor payments to urban household categories.

Government budget represents around 23% of GDP. More than 1% of this budget is spent on direct purchases of food commodities, of which 25% is spent on paddy and wheat. This includes purchases for public distribution system (PDS) and other government programs. Our SAM does not reflect direct government purchases of edible oils[26]. The government receives around 46% of its tax income from direct taxes, and around 23% from import tariffs. Import tariffs on food constitute around 2% of total tariff income, with palm oil being the single largest contributor among food commodities. In fact, tariff income from palm oil and soybean oil (and other food commodities) are partially compensated by import subsidies to healthy foods including fruits, vegetables and pulses.

---

[24] The Hotels and Restaurants sector (a060) is matched, in the IEG SAM to the to the item reflecting household payments for "hotel lodgings" in NSS round 66. Payments for cooked meals purchased out of the house are allocated to the processed food sector (a028).

[25] Although other household classifications, based on income levels or region, might have provided interesting information, disaggregation of SAM households according to these criteria was not feasible due to lack of data. In particular, NSS is a consumer expenditure survey and does not include income or wealth, which would be needed for an alternative disaggregation. Income data for the original IEG SAM relied on private databases which are not accessible. Even if this disaggregation had been possible, detailed data on edible oil consumption by household income or region are not available, reducing the added value of any potential alternative disaggregation.

[26] Although the Central Government Scheme for Distribution of Edible oils was approved in 2008, as discussed in previous chapters, payments for this scheme were yet not reflected in the National Account Statistics for 2007/08 on which our SAM is based.

Table 8-3 SAM structure summary table

Sectors	Factors	Households	Other domestic Institutions
Agriculture and Forestry (22 sectors), Mining (1 sector), Industry and Manufacturing (40 activities producing 41 commodities), Services (11 sectors)	Unskilled labour (F01), Semi-skilled labour (F02), Skilled labour (F03), Capital (F04), Land (F05)	Self-employed in non-agriculture (RH1), Agricultural labour (RH2), other labour (RH3), Self-employed in agriculture (RH4), Others (RH5), Self-employed (UH1), regular wage/salary earning (UH2), Casual labour (UH3), Others (UH4)	Private enterprises (ENT1), Public enterprises (ENT2)

Source: Own elaboration. SAM based on IEG 2007/08 Social Accounting Matrix (Pradhan et al., 2013)

8.3.1 Household food expenditure patterns in the SAM

It is relevant to note the important differences in food expenditure patterns across household categories. While food represents 21% of total expenditure for urban households, it amounts to 38% of total expenditure for rural household categories. Differences within rural and urban categories are equally striking, reflecting differences in income and socioeconomic status. Agricultural labourers dedicate the largest percentage of their total expenditure to food (48%). On the opposite extreme, for urban households receiving income from capital (coded as UH4, Urban-Other) food only represents 15% of total expenditure. The occupational classification of households does not directly correspond to income level or socioeconomic status, but we do observe that the percentage of total household expenditure dedicated to food is inversely correlated to household socioeconomic status, approximated by monthly per consumption expenditure (Leser 1963).

Over 10% of food expenditure is dedicated to the consumption of processed food overall. While the proportion of food expenditure dedicated to edible oils is relatively constant across household categories, there are large differences in the proportion of expenditure dedicated to the consumption of processed food. As for the remaining food categories, there are also important differences in food expenditure patterns across household categories, particularly in the case of cereals and animal source foods. Cereals represent between 16% and 30% of food expenditure across household categories, while animal source foods represent between 25% and 16%. Expenditure on other food categories, such as pulses, nuts of fish is comparatively more stable across household types.

Table 8-4. Household expenditure on main food groups

	RH1	RH2	RH3	RH4	RH5	UH1	UH2	UH3	UH4
Cereals	29%	31%	28%	29%	22%	22%	20%	25%	15%
Gram and	5%	6%	5%	5%	5%	5%	5%	6%	4%
Nuts and	3%	3%	3%	3%	3%	3%	3%	4%	3%
Fruit and	14%	14%	12%	13%	13%	15%	15%	13%	13%
Animal hu	20%	16%	18%	25%	20%	24%	22%	18%	16%
Fishing	5%	4%	5%	3%	5%	3%	4%	4%	4%
Sugar	3%	3%	3%	3%	3%	3%	2%	3%	2%
Vanaspati	7%	8%	7%	7%	6%	7%	7%	8%	5%
Processed	11%	11%	13%	9%	21%	13%	18%	14%	36%
Beverages	4%	4%	5%	3%	3%	4%	5%	5%	3%

Source: India SAM 2007/08. Own elaboration

8.4 SAM adaptation and disaggregation procedure

8.4.1 Adapting the IEG SAM for use with the IFPRI standard model

Some changes were made to adapt the structure of the IEG SAM(Pradhan et al., 2013) for use with the IFPRI standard model (Lofgren et al., 2002).

The adjustments include the establishment of separate activity and commodity accounts. Furthermore, adjustments include the disaggregation of the aggregate Indirect Tax (IT) account between production taxes, sales taxes, import tariffs and export taxes. Disaggregation of the tax accounts was necessary to allow for separate modelling of individual indirect tax types, as well as to ensure compatibility with the SAM matrix structure required by IFPRI's 'standard model' CGE model framework.

The adjustments to the 2007-08 IEG India SAM are based on the structure of tax payments in the GTAP India SAM (GTAP9.1 database). Payments from production sectors into the IT account correspond to production taxes and import tariffs. We assume that the taxes paid by institutions to the Indirect Taxes account correspond to sales taxes, except for the ROW account, where we assume they correspond to export taxes.

In order to deal with some minor inconsistencies in the tax structure, we aggregate the different mining activities into a single sector and do the same for different modes of transport. This results in a simplified structure with 67 activities producing 67 commodities, instead of the 78 sectors in the original database. A more detailed account of the procedure followed to disaggregate the tax accounts is given in Section A 3.1 of the appendix

8.4.2 Disaggregation of the edible oils sector

We have disaggregated the edible oils sector in the SAM into four different activities which produce five commodities. This includes three different categories of edible oils, partially hydrogenated vegetable oils (PHVO/vanaspati) and oil meal or cake, which is obtained as a by-product of oil extraction from oilseeds.

This simplified disaggregation allows us to carry out an analysis of nutritional and economic outcomes of trade and other policy interventions in the edible oils sector, while taking into account key intersectoral links between edible oil manufacturing and food processing activities.

We combine and triangulate a number of databases in order to approximate the structure of the edible oils sector. Throughout the process, the totals from the original SAM are respected. We only use shares from different data sources to distribute these total amounts across the new accounts. In our final classification we distinguish between PHVO/vanaspati, the main two imported edible oils (soybean and palm oil) and the remaining edible oils. The latter category includes the main local oils (Mustard/rapeseed, groundnut, coconut, and a residual category which incorporates cottonseed, sunflower, rice bran and other minor or emerging oils) Table A3-4 provides a summary of data sources and data use.

This section describes our disaggregation of the edible oils sector. We begin by describing the main steps involved in the disaggregation, then proceed to describe the resulting sector structure, and the sources of data used in this process as well as the assumptions involved.

8.4.2.1 Main steps involved in the SAM disaggregation and re-balancing process

The IEG SAM includes 9 different household categories, and only one category representing all hydrogenated and non-hydrogenated edible oils. In order to improve the accuracy and transparency of the disaggregation process, we carried out this process in two steps. We at first worked with a single-household SAM, disaggregating the edible oil activities, commodities imports and exports, in order to obtain an approximate representation of the edible oils sector structure

After disaggregating the edible oils sector, the SAM was re-balanced using GAMS software (Jensen, 2000), which was adapted to include the 70 activities, 71 commodities, 3institutional accounts, 6 tax accounts, and the savings-investment and rest of the world accounts in our SAM. The balancing method in this program is based on the principle of minimum cross-entropy (Golan et al., 1994), (Robinson et al., 2001).

The cross-entropy method is based on information theory (Shannon, 1948). This theory states that the cross-entropy distance (Equation 4.1) between the prior and posterior probability distribution functions of a set of n events provides the expected information value of additional data.

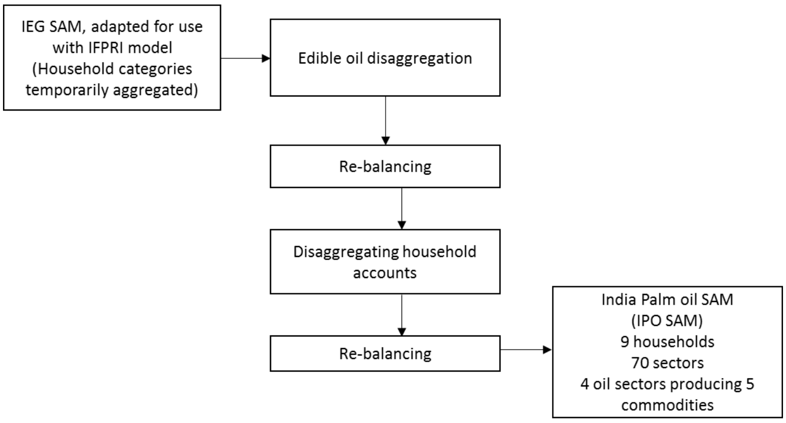
$$-CE\ (p:q) = -\sum_{i=1}^{n} p_i \log\left(\frac{p_i}{q_i}\right) \quad .\ (8.1)$$

Where CE is the cross-entropy distance, q is the prior and p the posterior distribution.

The activities disaggregation process produced some very small values for oil commodities that were mainly imported or where the physical amount of oilseed crushed domestically was very small. Small input values were manually corrected by proportionally allocating to other edible oil activities. Shares from NSS and ASI were obtained using statistical software Stata/IC 14. We obtained a single-household balanced SAM. In order to estimate the SAM, this method finds a set of coefficients that minimizes the entropy between the prior and the estimated matrix of coefficients.

We then proceeded to split the household categories, according to the original IEG classification, while disaggregating edible oil consumption into the main categories in our SAM. In doing so, we respect the total amounts consumed at a national level and share out the consumption of different oil types across household categories based on NSS data. The shares for household disaggregation are provided in the appendix Table A3-8. Carrying out the disaggregation and re-balancing of our SAM in two steps allows us to prioritise estimates of aggregate production, consumption, imports, exports and intermediate use, which are more reliable and crucial for the coherent representation of the overall sector structure, while allowing for a reasonable approximation to household expenditure and consumption patterns of edible oils for which data are limited. This process, therefore, allows us to better trace our assumptions and their impact on the results. After splitting households, we re-balance manually, correcting the resulting minor imbalance by re-adjusting direct tax payments from households to balance each household account.

Figure 8-1. Main steps in the disaggregation and re-balancing process



8.4.2.2 Imports and exports of edible oils

Shares for Imports are based on data from the Government of India import export data bank (GOIEIDB[27]) (Department of Commerce, GOI, n.d.). This resource provides data on quantities and prices, available in Rupees and USD, for different commodities. HS codes were used to identify commodities (See Table A3-6). Export shares for edible oils were also based on Government of India export data. In the case of oil cake exports, however, this data source showed an important discrepancy when compared to both USDA and FAOSTAT data, which reported significantly larger amounts of soybean cake exports. Estimates of oil cake exports are based on FAOSTAT data, therefore[28]. Edible oil exports during the 2007-2008 period were affected by the introduction of the export ban on edible oils which was announced on the 17th of March 2008 (Director General of Foreign Trade, 2008). Table 8-5 shows the shares used for disaggregation of imports and exports in the SAM. Table A3-6 details the HS codes used for matching GOIEIDB data to their corresponding commodities.

[27] Government of India Import export database

[28] Both FAOSTAT and USDA report similar figures, and these can include corrections to the initial official reports by the government. For this reason we choose FAO data. The use of USDA data would not have significantly altered the sectoral structure.

Table 8-5. Imports and exports from the edible oils sector in India (2007/08). Value shares

Commodity code	Commodity label	Import shares	Export shares
c025V	PHVO/Vanaspati	5.92%	0.72%
c026L	Mustard/rapeseed, Groundnut, Coconut, others*	0.32%	1.48%
c026L	Others: cottonseed, sunflower, safflower, rice bran	3.97%	9.17%
c026P	Palm oil	65.10%	0.03%
c026S	Soybean	24.69%	0.43%
c026O	Oil Cake	0.00%	88.16%

Source: Government of India Import Export database, FAOSTAT.

8.4.2.3 Indirect consumption of edible oils

In the IEG SAM, around 16% of edible oils are indirectly purchased for food processing out of the house. Industry sources consulted in our qualitative research indicate that, in out of home consumption in the case of palm oil is much higher than for other oils. A proportion of edible oils are also partially hydrogenated to produce vanaspati. We use input data from the Annual Survey of Industries 2007-08 to estimate mix of different types of edible oils used as inputs in food processing and for hydrogenation. We apply the same inputs obtained for the processed food sector to the hotels and restaurants (060) sector, which uses around 10% of edible oils, since this is not included in the ASI, which only includes manufacturing industries. The Annual Survey of Industries collects yearly industrial statistics on a nationally representative sample of all industries, including units employing ten or more workers using power (or 20 or more for those not using power). These data are used in the elaboration of National Account Statistics and Input Output tables and therefore, are one of the databases underlying the Social Accounting Matrix. We use data from 2007/08 to obtain approximate shares of edible oil inputs use by the processed food and PHVO sectors, as well as to corroborate and double-check across data sources. The ASI does not include data on the unorganized sector, which includes informal food processors and those with fewer than 20 workers or which do not use electricity. This could introduce a bias on input shares if the unorganised and organised sectors used significantly different types of edible oil inputs and needs to be taken into account when interpreting our data[29].

Table 8-6. Edible oil inputs into food processing

Commodity code	Commodity	Edible oil inputs into food processing and food services	Edible oil inputs into PHVO/vanaspati
c025V	PHVO/vanaspati	22.34%	NA
c026L	Mustard/rapeseed, Groundnut, Coconut, Others*	15.46%	8.14%
c026L	Others: cottonseed, sunflower, safflower, rice bran	13.81%	15.47%
c026P	Palm oil	62.97%	53.16%
c026S	Soybean	7.75%	23.24%
c026O	Oil Cake	0.00%	0.00%
Indirect consumption of edible oils as a proportion of total household consumption		16.70%	

Source: Annual Survey of Industries,

8.4.2.4 Non-food consumption

According to USDA PS&D data, around 4% of palm oil is dedicated to non-food uses (USDA, US Department of Agriculture, n.d.). We allocate this percentage to non-food uses. According to published reports (WWF, 2013) as well as industry sources consulted in our qualitative research, the main sector consuming palm oil for non-food purposes is the chemicals industry. Within the chemicals sector, palm oil is used in the production of cosmetics and industrial surfactants among other applications. Due to the lack information about relative oil use in non-food sectors, we proportionately split edible oils in non-food sectors, and assign the remaining share of non-food palm oil to the chemicals sector. Given the relative size of oil input values for non-food sectors, the impact of this assumption on the overall results is likely to be negligible.

8.4.2.5 Household direct consumption of edible oils

Direct household consumption of edible oils is reflected in the SAM as a payment from the household accounts to the corresponding commodities. Edible oils, including vanaspati, represent almost 7% of household expenditure on food in the IEG SAM. This share is similar across household categories.

[29] From our qualitative research, we can deduce that it is likely that the informal/unorganised food industry will rely to a larger extent of palm oil, which is used in blends, to adulterate other more desirable oils and whose use is often un-reported. This implies that we are likely to underestimate the relevance of the processed food sector as a mediator of nutrition and economic outcomes.

In a first step, we calculate household consumption shares for different types of oils, at a national level, for a single representative household category. [30] These national level shares are calculated combining NSS and USDA data. The largest expenditure share corresponds to mustard/rapeseed oil, followed by groundnut oil and imported edible oils (palm and soybean). Palm oil, soybean oil and other edible oils, however, are aggregated into a single category in the NSS survey. Since we have already estimated the amount of palm and soybean oils available from production and imports, as well as the amount used as input for food and non-food producing activities, we can derive household consumption residually. Therefore, we split the "other edible oils" category into different types of oil by residually allocating to direct household consumption the amount of palm oil and soybean oil that is used for food but not dedicated to the non-food, food processing, PHVO or food services industry[31]. As a result of this methodology, 43% of the total supply of palm oil and 61% of soybean oil is allocated to direct consumption by households[32]. The remainder of the NSS "other edible oils" category is made up of residual oils including mainly cottonseed and sunflower/safflower oil (USDA ps&d), but also rice bran oil and some other less important sources of edible oil. These are added to the edible oils main category including "local" and residual edible oils.

Table 8-7. Household consumption expenditure shares

Commodity code	**Commodity**	**Household expenditure share**
c025V	PHVO/vanaspati	8.05%
c026L	Mustard and Rapeseed, Groundnut, Coconut	54.79%
c026P	Palm	9.45%
c026S	Soybean	17.98%
c026L	Others. Cottonseed, Sunflower, safflower, rice bran	9.73%
Total		100%

Source: Own elaboration based on NSSO Round 66, USDA domestic consumption data, India 2007/08 Input-output tables and SAM of India 2007-2008. C026L corresponds to the "Local/residual" edible oils category.

[30] National Sample Survey Organisation of India, Household consumer expenditure survey, round 66. The IEG SAM household consumption data are based on this survey.
[31] Industry sources interviewed in our qualitative estimate the proportion of edible oils consumed out of the house currently being somewhere around 30%, and up to 50 or 60% in the case of palm oil.
[32] Palm oil represents a relatively small proportion of direct household expenditure on edible oils in our data. This is partly due to the lower relative price compared to other oils, as well as to the proportion dedicated to other uses. However, imports have considerably grown since 2007/08, and current data would reflect larger shares.

In a second step, after re-balancing the single household SAM as described in Section 8.4.2.1 we split out households based on the IEG SAM data, and re-balance manually, using the direct tax account to adjust for the small resulting imbalances. We respect the aggregate expenditure for each type of edible oil and distribute the consumption of each oil type across household categories based on NSS data.

Table 8-8. Household direct expenditure on edible oils

	RH1	RH2	RH3	RH4	RH5	UH1	UH2	UH3	UH4
Vanaspati	9%	6%	10%	9%	8.94%	8%	6%	6%	7%
Local/other oils	68%	60%%	63%	65%	66%	59%	57%	56%	61%
Palm oil	7%	10%	8%	8%	7%	10%	11%	12%	10%
Soybean oil	15%	24%	19%	18%	17%	23%	25%	27%	22%

Source: Own elaboration based on various sources India SAM 2007/2008.

8.4.2.6 Domestic production of edible oils

Domestic production of edible oils is represented in the SAM as a payment from each activity to the corresponding commodities (Column ACT to row COM in Table 8-1). The Input Output Transactions tables, on which the India SAM is based, include an aggregate account for edible oils and a separate account for partially hydrogenated vegetable oils. Based on the India SAM, PHVO represents 16% of the production value of the edible oils sector. The PHVO sector also processes small amounts of other edible oils representing in total 12% of production in the sector. We assume that, apart from the PHVO sector, each edible oil activity produces only the corresponding commodity and oil cake. We know that most oil meal (or cake) is either exported or used domestically as animal feed (Persaud et al., 2006). We assume that the total amount of oil meal produced is equivalent to the sum of the oil meal exported and the value of products sold to the animal husbandry sector by the edible oils sector. We then approximately distribute the oil meal values across specific edible oil activities, taking into account the differences in oil meal contribution to total output across different types of oil, based on USDA and GOIEIDB data. Oil cake represents around 20% of the overall value of the oil sector.

Shares for domestic production of edible oils are based on USDA production, supply and distribution data (ps&d). USDA ps&d database provides yearly quantities for edible oils and oil cake production. These are used together with unit value rates obtained from the Government of India Import Export data bank. The values in this database are expressed in INR Lakh and are based on wholesale f.o.b.[33] prices. We use import values for those commodities that are mainly imported (palm and soybean oil) and export values for the remaining commodities including oil cake. These unit rates are checked against producer unit rates obtained from the Annual Survey of Industries (2008) and average prices based on world-wide transactions and available through IndexMundi, as well as with FAOSTAT. For the category reflecting production of "rest of edible oils" (Table 8-9), we use the value for sunflower oil, provided by USDA, and add estimates of production of other types of edible oil including rice bran oil, castor oil, linseed, mahua and maize oil. Of these products, rice bran oil is the only one that plays a significant role from a nutritional point of view in the Indian context. [34]

[33] F.o.b stands for "free on board" prices, which exclude the cost of marine transportation, insurance and off-loading at the port of destination.

[34] Although rice bran oil still plays a minor role in the Indian context, there is increasing interest in increasing the production of this oil as a by-product of rice processing, which is increasingly being marketed and exported as a healthy option (Nayik et al., 2015).

Finally, we use output shares based on the Annual Survey of Industries in order to split the residual processing of non-hydrogenated edible oils by the PHVO sector into different types of edible oils The resulting shares for overall edible oils production, oil cake production and residual non-hydrogenated edible oils processing in the PHVO sector are provided in Table 8-9.

Table 8-9. Domestic production of edible oils and oil cake, value shares

Category label	Description	Domestic production of edible oils	Oil Cake	Residual processing of non-hydrogenated oils, PHVO sector
c026L	Mustard	14.30%	16.36%	13.91%
c026L	Groundnut	24.99%	14.27%	8.31%
c026L	Coconut	4.62%	1.77%	1.29%
c026L	Cottonseed	14.52%	7.68%	5.37%
c026L	Rest	13.55%	1.71%	41.04%
c026P	Palm	0.08%	0.00%	2.55%
c026S	Soybean	13.40%	58.21%	27.52%

Source: USDA production, supply and distribution database, 2007/08, wholesale unit rates from Government of India, EIDB. See Table 8-5 for commodity labels.

8.4.2.7 Activities producing edible oils

We split out the production of edible oils into specific edible oil production activities. This is partly for technical reasons related to modelling input substitution in food processing. There are limited data available on the production function of each oil producing activity, however. The National Industry Classification includes a separate category for PHVO but all other edible oil production is captured in a single activity. Moreover, in practice, a single plant often processes different types of edible oils. The disaggregation of different edible oil activities involves some strong assumptions, therefore. We assume that different oil processing activities differ in terms of extraction rates (Aradhey, 2016) but otherwise have the same production structure. We split inputs, therefore, in proportion to the physical amount of oilseed crushed for each type of oilseed. We obtain these aggregate amounts from USDA ps&d (see Table 8-10). This implies that labour productivity and skill composition is constant across different edible oil manufacturing activities. Although skill composition is likely to be similar, there might be variations in labour productivity across sectors that will not be captured.

We assume that each edible oil production activity uses only the corresponding type of edible oil as an input. This corresponds to crude edible oil imports that are refined by the domestic industry. Shares are based on imports of crude oil based on GOIEIDB. We also allocate the inputs of oilseeds that are produced by a separate activity in the SAM (coconut, groundnut, cotton), to their corresponding edible oil processing activity. Finally, we allocate the category other edible oilseeds residually to balance the edible oil activities. This is because we lack appropriate data on values or prices of oilseed crushed to construct the relevant shares. Detailed analysis of impacts on oil and oilseed producing activities would require additional information regarding potential differences in skill mix and labour intensity, and is beyond the scope of this study.

Table 8-10. Oilseed Crush. Physical quantities. 2007/08

Commodity codes	Commodity labels	Shares
c026L	Mustard and Rapeseed	18.77%
c026L	Groundnut	18.15%
c026L	Coconut	2.42%
c026P	Palm oil	0.06%
c026S	Soybean	30.25%
c026L	Cottonseed	26.70%
c026L	*Rest	3.66%

Source: USDA ps&d 2007/08. *To obtain the share for this residual category we impute the value of sunflower/safflower oilseed crush

8.5 Nutritional Coefficients

The impacts of changes in the diet are introduced in the model using nutritional coefficients or "weights" which are attached to each commodity in the SAM. We include coefficients for energy content (Kcal), total amount of fat, as well as different fatty acids (saturated, unsaturated, and trans).

Nutritional values per 100g are first obtained for food items in the NSS survey. Subsequently, these are aggregated to the level of SAM categories and converted to "SAM units" to be used with the model. These units correspond to nutrients per rupee in the counterfactual. The saturated fatty acid content in processed food and PHVO is approximated within the model, based on input use of oils and other food commodities by the corresponding industry (see Chapter 9).

Table 8-11 and 8-12 provide the contribution of major food groups to nutrient intake based on our counterfactual consumption values and nutritional weights. Edible oils are the main source of fat followed by animal products and cereals.

We observe that, apart from cereals, the main sources of calories are animal source foods, vegetable oils and processed foods. Cereals contribute a higher proportion of calories for rural households, while urban diets are more diverse, obtaining a larger proportion of calories from pulses, nuts, fruits and vegetables, animal source foods and vegetable oils, as well as processed foods.

The main sources of saturated fats are animal source foods, vegetable oils and processed foods, while vanaspati and processed food contribute to total fat intake. Table A3-7 and Table A3-9 provide the nutritional coefficients per unit for NSS commodities and per rupee for aggregated SAM categories. Although there are some discrepancies, attributable to differences in data sources and methodology, the resulting data are consistent with NSS estimates and other sources (NSSO, Government of India, 2012a)[35]. We underestimate average Kcal intake by 5% in the counterfactual, compared to official estimates based on NSS Schedule 1 questionnaire (from 1918 to 2020 Kcal per capita per day), and fat represents around 20% of daily energy intake, which is also consistent with NSS estimates. We diverge more from the FAO estimates (2343 Kcal per capita per day). This is, again, attributable to differences in methodology and data sources across databases.

[35] See NSSO, (Government of India, 2012a), Table 5S State-wise percentage break-up of calorie intake over different food groups, and average intake of calorie, protein and fat per consumer unit per day. (Quantities provided per Consumer Unit need to be multiplied by a conversion factor to convert to per capita amounts)

Table 8-11 Contribution of major food groups to nutrient intakes (grams)

	Fat	SFA	MUFA & PUFA	Trans
Cereals	11.70%	7.63%	10.74%	0.00%
Nuts and pulses	4.48%	2.56%	4.80%	0.00%
Fruit and vegetables	0.95%	0.60%	0.85%	0.00%
Sugar	0.00%	0.00%	0.00%	0.00%
Animal source foods	18.00%	36.90%	9.42%	0.00%
Vegetable oils and vanaspati	50.79%	36.22%	61.51%	73.37%
Processed food and beverages	14.09%	16.10%	12.67%	26.63%

Source: Own elaboration based on counterfactual model results for 2007/08

Table 8-12 Contribution of major food groups to daily KCal intake across household categories

	RH1	RH2	RH3	RH4	RH5	UH1	UH2	UH3	UH4
Cereals	62%	62%	60%	62%	53%	53%	50%	56%	42%
Pulses and nuts	4%	4%	4%	4%	4%	5%	5%	5%	4%
Fruits and vegetables	4%	4%	4%	4%	4%	5%	5%	4%	4%
Animal source foods	8%	7%	8%	10%	10%	12%	11%	8%	10%
Sugar	3%	3%	3%	4%	3%	4%	3%	3%	3%
Vegetable oils	10%	11%	10%	10%	10%	12%	11%	11%	9%
Processed foods	9%	9%	11%	7%	16%	11%	15%	12%	29%
	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Own elaboration based counterfactual model results for 2008/08

We adopt a procedure in three steps to estimate the nutritional coefficients for our model.

In a first step, we obtained nutritional content per 100g of food item for food Items in NSS. Total fat content was available from the nutrition composition tables "Nutritive Value of Indian Foods" (Gopalan et al., 1989) (reprinted, 2011). This database is used by the NSSO in their regular reports on nutritional intake (NSSO, Government of India, 2012a). Fatty acid profiles are also available for most of the main sources of dietary fat, including edible oils, cereals and pulses. For those items where fatty acid profiles (differentiating saturated, unsaturated fatty acids) were not available in our nutritional composition table, we attempted to find equivalent items in USDA nutritional composition database (USDA, US Department of Agriculture, n.d.). These include different types of meat, fruits and vegetables (See Table A3-7).

For those items that were not available from USDA, we imputed the fatty acid profile of a similar product (for example, for different wheat products (maida or wheat flour, semolina, wheat noodles). Finally, some items are residual categories ("other vegetables" etc.), for which we cannot obtain fatty acid content. For these, we impute a weighted average of all other items in the same food group (vegetables, cereals, roots and tubers). This average takes into account the contribution of each item to total fat intake from each food group.

In a second step we convert nutritional coefficients to nutrients per rupee based on NSS unit rates and we obtain aggregate nutritional coefficients for food commodities in the SAM. These nutritional weights are used as fixed coefficients within the CGE model, with the exception of the "processed food" and PHVO commodities. For steps 1 and 2, we have used statistical software Stata/IC 14. For oils not included in NSS, prices from external sources were used[36]. Nutritional weights for the local/other edible oils category are obtained as a weighted average including all oils except for palm and soybean (see Table A3-9 in appendix). For the residual oil category not identified in NSS we impute the nutritional content for cottonseed which, according to USDA ps&d makes up most of this category. Given that cottonseed is relatively high in saturated fat compared to other "residual" domestic oils such as sunflower, this represents a pessimistic scenario with respect to the possibilities for substitution, setting a lower bound for tariff impacts.

Finally, in a third step, the saturated fat content of processed foods and PHVO are calculated within the model. The content of saturated and unsaturated fats in processed foods is based on the edible oil inputs into this sector in the model. A similar procedure is followed for the PHVO sector, where TFA content is adjusted as an exogenous parameter subject to sensitivity analysis. This allows us to obtain consistent, although rough, estimates of aggregate fatty acid intakes both through foods directly purchased and in processed food (See Chapter 8 for a more detailed explanation of how we approximate fatty acid profiles in the processed food sector). For the baseline, we make the simplifying assumption that the price per Kcal of processed food is twice the average price per Kcal of food prepared at home. This assumption is based on estimates from the literature using NSS data (Subramanian

[36] Prices obtained from ASI, after triangulation with other sources (IndexMundi, GOIEIDB). Palm oil= 49.6, Soybean oil=55.0, Cottonseed oil = 50.5, Sunflower oil=74.7.

and Deaton, 1996), (Tandon and Landes, 2012). We do this to obtain more realistic nutritional weights for processed food for the different household types.

There are two technical aspects regarding units and aggregation that should be taken into account when interpreting nutritional coefficients.

In the first place, the nutritional coefficients are included in the model as estimates of grams of nutrient per rupee spent on that item in the counterfactual. In the policy run, these are best interpreted as re-scaled parameters, measured in the units of the CGE model Although we are using a static model, it is worth pointing out that, if the model was ran over several periods, however, these nutritional coefficients should be interpreted as grams of nutrients per physical unit of commodity, measured in the units of the CGE model.

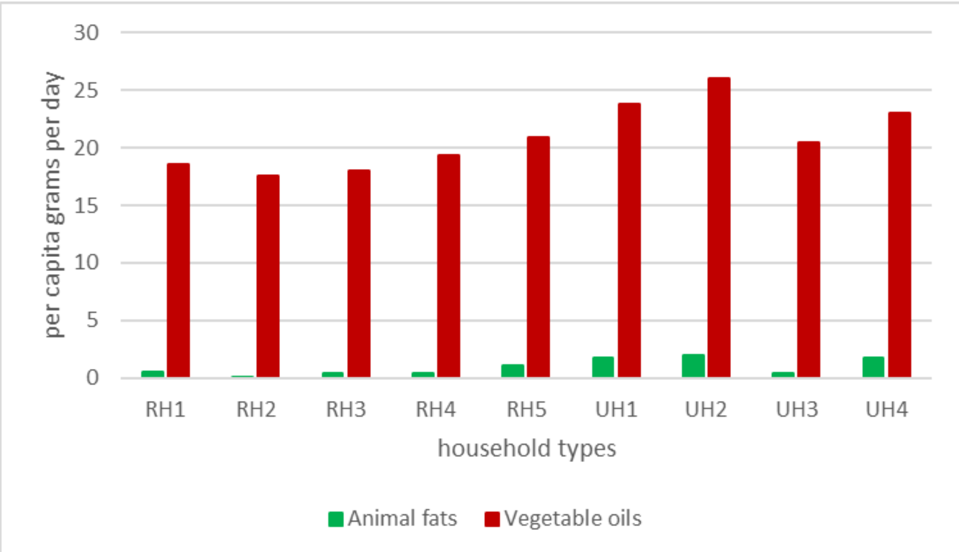
Although it is important to bear in mind the issue of units, this should not affect the interpretation the results.

In the second place, there is a technical issue of aggregation. The SAM includes 21 food categories (see Table A3-2). Each of these categories is an aggregate of other commodities. The fat content per unit of each of these aggregated commodities is calculated as a weighted average of the items included in it. The weights reflect the average contribution of different items to household expenditure on each category, where we use monetary expenditure rather than physical quantity because the nutritional coefficients are estimated as nutrients per rupee. In principle, we use one set of common coefficients for all household types. It is relatively straightforward, however, to use different sets of nutritional coefficients for different household types (rural and urban, for example), if the composition of specific SAM categories is observed to vary substantially across household types in a way that affects their average fat content. This method can capture broad changes in nutritional intake at a country level and for broad household categories and is not designed to obtain precise estimates of changes in nutritional status at a household level We should note, however, that the more disaggregated categories used by the underlying NSSO household survey often do not add relevant information from a nutritional point of view (the SAM category corresponding to "processed food", for example, aggregates NSS categories like "prepared sweets", "cooked meals", "salted refreshments" or "other processed food"). In these cases, a greater level of disaggregation at the food item level would not add further precision.

In general, it is important to bear in mind that the model focuses on fats and saturated, unsaturated and trans fatty acids. While it is theoretically possible to include a wider range of micronutrient coefficients, this would require assessing the suitability of the approach on a case by case basis. The assumptions involved and the SAM commodity classification and use of nutritional weights are adapted for our analysis and might not necessarily be the most appropriate for analysing other nutritional impacts. For example, if we were analysing the impact of policies focusing on the animal husbandry sector, we would have to disaggregate this sector further, distinguishing between different types of meat and dairy products. Furthermore, in the case of micronutrients such as vitamins, whose content and bioavailability depends to a large extent on the storage and cooking or preparation, a different approach might be needed, focussing on specific preparations.

A different approach would also be needed to analyse the consumption animal fats across household categories. In our model, animal fats such as ghee and butter are included within the animal source foods sector. This implies that we cannot analyse potential substitution across animal fats and vegetable oils in response to policy shocks. Although the consumption of animal fats is relatively low compared to that of edible oils. This could affect the estimates of policy impacts, particularly for household categories which exhibit higher animal fat consumption. In our models, urban households (other than those whose livelihoods depend on casual labour) present higher consumption of animal fats (See Figure 8-2)

Figure 8-2. Consumption of animal fats and vegetable oils across household categories in our model



Source: NSS household consumption and expenditure survey round 66

8.6 Summary and limitations of the data

By adopting a multi-sector general equilibrium approach, we are trying to obtain a consolidated picture of commodity flows and linkages between sectors. This provides additional information and can reveal important mechanisms for the transmission of nutritional and economic impacts of policy that are not captured by other approaches. However, this is a data intensive task. Moreover, there is a lack of accurate data concerning production, imports, processing and consumption of different edible oil products in India. A number of different datasets are used for triangulating, completing and double-checking our disaggregation, in order to arrive at a coherent and complete approximation of the edible oils sector for the purpose of our study. The use of different data sources provides a valuable input but can introduce inconsistencies or discrepancies. We should bear in mind, however, that different databases are always used to generate shares, rather than absolute values, minimizing discrepancies that are due to differences in criteria or definition across datasets.

In addition to the limitations related to potential discrepancies across data sources, we have made a number of assumptions in order to reconcile estimates from different datasets and the original SAM structure, or wherever there are insufficient data. We have mentioned the limitations associated to these assumptions in the above section. We summarize here the main limitations and highlight their implications when it comes to interpreting model results. With respect to commodity structure, in particular, there is a lack of data on production and value of different types of oil meal. Our estimates, described in Section 8.4.2.4 are approximated, and we might be slightly underestimating the total amount of oil meal produced if oil meal is not only sold as feed to the animal husbandry sector but also used significantly by other domestic sectors. Another limitation concerns the lack of data on the productive structure of different edible oil activities. We therefore distribute productive factors and inputs other than edible oil and oilseeds based on fixed shares, in proportion to oilseed crush quantities. While this disaggregation avoids biases due to different extraction rates and prices of edible oils, it assumes constant productivity of labour and other factors across edible oil categories. It also imposes the same input use structure, assuming that different oils are processed in plants of similar characteristics. Therefore, there might be differences in productivity across sectors that would not be reflected in this disaggregation. In addition, according to our qualitative research, palm oil is an important input in informal food processing, meaning that the use of data from the organized sector might underestimate the overall share of palm oil used in food processing.

With respect to household classification, we have maintained the original IEG classification, based on main occupation of the head of household, partly due to a lack of data to carry out an alternative disaggregation. Although this disaggregation is informative, other alternative classifications could also add relevant information.

For example, a classification based on income deciles would allow us to reflect the income gradient in palm oil consumption, incorporating this distributional dimension in our analysis. As discussed in previous chapters, this is potentially important because palm oil, which is cheaper than other edible oils, is more likely to be consumed by lower income households. The current household classification and modelling strategy, therefore, do not reflect the socio-economic gradient of impact for policy shocks affecting palm oil prices, and do not allow for the analysis of potential food security impacts. These limitations should be taken into account when interpreting the results of our quantitative analysis (see chapters 10 ad 11), which should be used as a complementary tool, together with other approaches. For these reasons, and provided further data were available, an alternative household classification reflecting income deciles would be highly relevant.

The resulting SAM has been designed for use with our model, which captures economic and nutritional impacts of policies in the edible oils sector, taking into account key downstream linkages with food processing sectors. Detailed analysis of other effects, such as land use or labour market impacts resulting from re-adjustments within the oilseeds or edible oils sectors, would require additional data and increased attention to these aspects of the model.

With respect to our use of nutritional coefficients, these are meant to capture broad impacts at a national level, rather than estimate precise nutritional outcomes at a household level. Technical issues of unit definition and aggregation should be taken into account but should not bias our relevant conclusions in terms of changes in fatty acid consumption. The nutritional contents are included for the purpose of assessing changes in fatty acid intakes. The appropriateness of this approach for the inclusion of other nutrients would have to be assessed case by case.

Finally, our SAM is based on the IEG social accounting matrix for 2007/08. We use data from the corresponding periods for NSS, ASI and other databases. The resulting benchmark dataset, therefore, does not reflect the latest changes in the sectoral and economic structure. This is a frequent limitation for CGE analysis, especially in specific regions or for low and middle-income countries[37]. The use of expert interviews and qualitative analysis of policy documents allows us to incorporate recent changes in the sector, which are not reflected in the model data, into our discussion.

[37] See for example top countries missing and most in need of updating in GTAP database (Walmsley 2008)

Chapter 9. The CGE model structure and equations

9.1 Introduction

We use a static, multi-sector CGE model of India for this study. The India SAM and model equations are adapted to carry out a nutrition-sensitive analysis of policies in the edible oils sector, with a focus on fatty acid consumption patterns, which have been linked to incidence of cardiovascular disease (Mozaffarian et al., 2010).

Our model is based on the IFPRI Standard model (Lofgren et al., 2002). This is a neoclassical, static general equilibrium model, developed by the International Food and Policy Research Institute. The CGE model is linked to the SAM of India 2007/08 and to a set of coefficients reflecting the nutritional content of food commodities in the SAM. A full description of the SAM and nutritional coefficients and the procedure followed to obtain and adapt the relevant data has been provided in the previous chapter.

Since the late nineties, there has been an increased recognition of the need for nutrition-sensitive analysis of food value-chains and food policies (Haddad, 2000). A number of studies have incorporated nutritional information associated to household food expenditure in CGE models. Most of these applications (Minot, 1998), (Pauw and Thurlow, 2011), (W et al., 2007) focus on macronutrient intakes and, in particular, on energy intake. (Lock et al., 2010) focus on fatty acid intake in relation to a move towards healthier, more sustainable diets. More recently, (Rutten et al., 2013), (Rutten et al., 2014) develop a methodology for the incorporation of nutritional information in an economy-wide CGE model, capturing not only direct household purchases of food commodities but also nutrient flows from primary commodities through food processing and food services to households. We adopt a similar approach to the latter studies, capturing nutrient intake through the consumption of non-processed food items (or primary-processed), as well as through food processing, reflected in an aggregate "processed food" category. As elsewhere in this thesis, "processed food" refers to food that has been ultra-processed (Monteiro, 2011) or cooked out of the house. In our study, we focus on saturated, unsaturated and trans fatty acid intakes.

The rest of the chapter is structured as follows: Section 2 will provide a brief theoretical explanation of impact pathways of food policy in our multi-sectoral framework. Section 3 will describe the model equations and parameters. Section 4 will summarize the main features of the model and conclude. Throughout the chapter, we use *UPPERCASE* for variables, *lowercase* for parameters and $\overline{UPPERCASE}$ with an overbar to denote variables whose value has been exogenously fixed. Where possible, we follow the notation used by (Lofgren et al., 2002). For simplicity, and given the large number of equations in this chapter, they are identified with a single number, without including the chapter number (eg, equation (1) instead of Equation (9.1))

Table 9-1. Key points. Model description

• This is a CGE model of India for **comparative static analysis** of food policy interventions in the edible oils sector. • **Household demand** is modelled through a nested demand model which combines an **LES** at the top level with a **CES** at the second-stage. • The government savings are defined as a flexible residual. Real exchange rates are flexible, while foreign savings are fixed and the savings-investment closure is savings-driven. • The model employs production specifications with a top Leontieff nest of composite intermediate and factor input aggregates, middle CES and Leontieff nests for, respectively, factor and intermediate inputs and a bottom CES nest for edible oil intermediate inputs. The bottom nest intermediate input specification allows **for imperfect substitution between edible oils in food processing, thereby allowing for changes in nutritional composition as a response to policy interventions**. • The model includes nutritional weights and a set of **equations to incorporate changes in intake of key nutrients through direct household consumption and through processed food, as a response to policy shocks**. • Imports are imperfect substitutes for domestic products, and domestic products are imperfectly transformed into exports, allowing for two-way foreign trade.

9.2 Impact pathways and transmission mechanisms of food policy in a multi-sector macroeconomic modelling framework

In this study we analyse the impacts of edible oil import tariffs. Food policy can affect nutritional and economic outcomes through a number of pathways (Kanter et al., 2015). These include market and own production pathways, as well as intra-household dynamics including gender and inter-generational relationships. Our focus is on market pathways and we do not model own production or intra-household dynamics. This focus reflects the most relevant mechanisms in our case and is also a reflection of the limitations and assumptions of our model. It is important to bear in mind that we are using a large scale, low-resolution macroeconomic model, and that we do not explicitly model household own production or intra-household social structures. Figure 9-1 shows a simplified representation of the main transmission mechanisms in our model. We will now briefly discuss each of these pathways and their relation to the equations in our model.

In the first place, imposing a tax on one food commodity will increase its price with respect to other commodities. This affects the food purchasing decisions of households, which are represented by a nested demand system including a top level LES and CES at the bottom level (Stone, 1954). A full explanation of the equations and their interpretation is provided in Section 9.3.2.

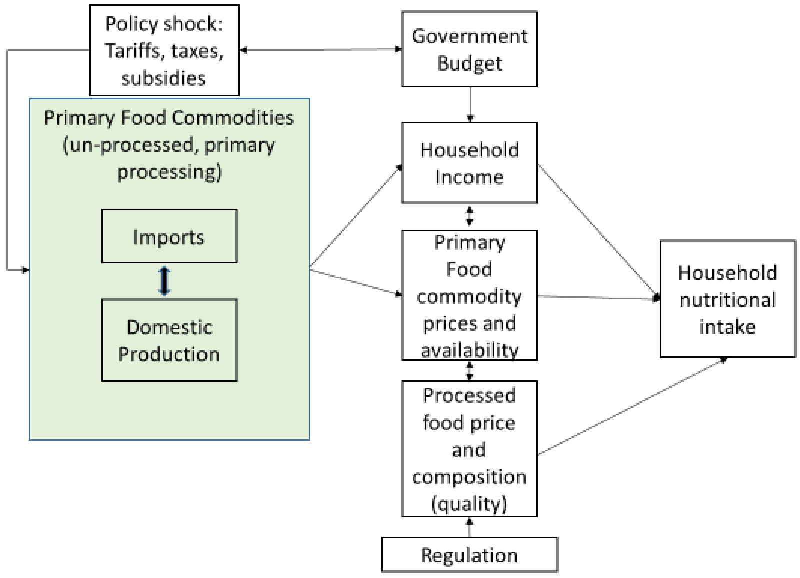
This demand system describes the impact of price changes in direct household purchases of food items. Primary food commodities, however, are increasingly used as intermediate inputs in food processing[38]. An increase in the prices of primary commodities, therefore, will also affect the costs incurred by producers in the food processing sector, who will respond by increasing prices. In addition, the industry can also respond to changes in input prices by changing the composition of their products. The standard CGE model structure, however, is based on Leontief production technologies, which assume fixed production structures, where inputs are perfect complements. In particular, food processors are likely to substitute across vegetable oils in response to relative price changes. In order to account for this effect, we introduce a nested CES production function for the processed food sector, which allows for substitution between edible oil inputs (see equations (6) and (7)). One key

[38] Commodities that have undergone primary processing such as wheat flour, flattened rice or rice noodles are aggregated with their corresponding primary agricultural commodity. Whenever we use the term processed food we refer food that has been ultra-processed (Monteiro, 2011) or cooked out of the house.

difficulty is the uncertainty about the values of elasticities of substitution between inputs. In order to address this issue, we carry out sensitivity analysis on these parameters. This also provides an insight into the role of processed food as a mediating factor between food policy interventions and nutritional outcomes.

In addition to the intended impacts on food prices, food policy can affect household incomes, which can also have an impact on food purchases. The net impact of a specific policy intervention on household income levels will depend upon the interaction of a number of factors. For example, tariffs affect the prices of imports relative to domestic production, increasing the demand for domestically produced edible oils. An increase in domestic production, in turn, can increase wage payments or other factor returns to households, at least in nominal terms. On the other hand, tariffs can lead to real exchange appreciation, hurting the export sectors. The impact of a tariff or another kind of food policy intervention on household incomes and consumption behaviour will also depend upon our assumptions regarding government behaviour and budget. The government could choose to use the extra revenue from tariffs to subsidize other food or non-food commodities, or could transfer the revenue to households, or invest it. Given our focus on single-commodity tariffs (for palm oil), impacts on household incomes are small in our study. It is also worth noting that the top level of our demand system is linear in expenditure (or income). This is a simplifying assumption which should be taken into account when interpreting the results of the study (Banks et al., 1997). A more complete discussion of this issue is provided in the following section.

Figure 9-1. Impact pathways and transmission of food policy shocks in a multi-sector macroeconomic model.



9.3 Model description

The CGE model of India is a set of simultaneous equations that represent the behaviour of different actors in the economy. Agents' behaviour is based on neoclassical economic theory (Dervis and Robinson 1982), (Robinson, 1991). The model includes equations that represent the behaviour of households, producers and government. We assume that representative households maximize their utility subject to a budget constraint, producers maximize profits in competitive markets and the government collects taxes and re-distributes, spends or invests its revenues.

A set of national accounts and institutional budget constraints are specified to ensure a consistent solution at the aggregate macroeconomic level. These include constraints on material balances and the government budget, and the current and capital accounts of the balance of payments with the rest of the world.

The model finds a solution where all commodity and factor markets are in equilibrium. It is the interaction of the decisions of different actors that determines macroeconomic aggregates at the equilibrium (GDP, prices). The model equations are adapted from the IFPRI standard model (Lofgren et al., 2002) and numerically solved using the General Algebraic Modelling System (GAMS).

9.3.1 Production

The CGE model for India includes 70 productive activities, which represent producers. Activities maximize profits subject to a given production technology (see

Figure 9-2). Producers make their decisions in competitive markets and cannot individually affect price levels. With the objective of maximizing profits, activities purchase inputs at market prices and employ labour, capital and land. Factor use determined endogenously in the model at observed values and wages, returns to capital and returns to land adjust to ensure equilibrium in factor markets. The model distinguishes between activities and commodities. This is an important feature, since it allows each activity to produce more than one commodity, and each commodity to be produced by several activities. The yield coefficients for each activity are fixed and the model assumes constant returns to scale.

The production technology depicted in Figure 9-2 is a nested structure. At the top level, each activity produces output combining aggregate value added and total input use. These are combined using a Leontief technology function.

The profits for each activity are defined by Equation (1).

$$\pi_a = PA_a(1 - \mathrm{ta_a})\mathrm{QA_a} - \sum_c PQ_c QINT_{a\,c} - \sum_f WF_f\, wfdist_{f\,a} QF_{f\,a} \qquad (1)$$

Where π_a are the profits for activity a, and $\mathrm{QA_a}$ and PA_a are, respectively, the output of activity a and the price of such output[39]. The second term of the equation represents the costs associated to intermediate inputs, where $QINT_{a\,c}$ is the use of input c by activity a, and PQ_c is the price of such input. The last term represents factor remuneration, where $QF_{f\,a}$ is the quantity of each factor (land, capital, skilled, unskilled and semi-skilled labour) used in production and WF_f is the economy-wide remuneration rate of the corresponding factor and (wage, returns to capital, returns on land). As for the parameters, $\mathrm{ta_a}$ represents the producer tax rate for activity a, $wfdist_{f\,a}$ and is a fixed distortion rate for factor remuneration in each sector.

Producers maximize benefits as defined by equation (1) subject to a number of constraints and first order conditions for maximization, represented by equations 2-5

$$QINTA_a = \ inta_a\, QA_a \qquad (2)$$

$$QA_a = iva_a QVA_a \qquad (3)$$

[39] Prices at the activity level, PA_a are defined as a straightforward average of the prices of commodities produced by activity a, weighted by the respective commodity yield coefficients. See equation (29) in the price block.

Equations (2) and (3) are the first two constraints for profit-maximising producers. These equations show the demand for total intermediate consumption and aggregate value added at the activity level (top nest).

QVA_a is the aggregate value added for activity a, and $QINT_a$ is the total input use for activity a. As for the parameters, iva_a is the quantity of value added per unit of output in activity a, and $inta_a$ is the total input use per unit of output.

Producers are also constrained by the existing technology, given by Equations (4) and (5). These constitute the second level, or nest, in our production technology structure.

In Equation (4), aggregate value added is obtained by combining factors of production according to a Constant Elasticity of Substitution or CES production function.

$$QVA_a = e_a \left(\sum_f \delta_{f\,a} QF_{f\,a}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad (4)$$

Where e_a is an efficiency parameter and $\delta_{f\,a}$ is a share parameter for factor f use in activity a. ρ_a is a transformation of the elasticity of substitution between factors[40] .

A Leontief technology function, shown in equation (5) defines the existing technology that determines how intermediate inputs, including an aggregate edible oils category, but excluding individual edible oil sectors, enter the production function.

$$QINT_{c\,a} = ica_{c\,a}\, QINTA_a \quad (5)$$

Leontief production functions assume that inputs are perfect complements and have to be combined in fixed proportions in order to produce each quantity of output.

We modify this assumption for the food processing activities. This includes "processed food" and the production of partially hydrogenated vegetable oils (PHVO/vanaspati). We implement instead a bottom-level nested CES function for the intermediate edible oil inputs, which allows for substitution between them as a response to price changes.

---

[40] ρ_a is a transformation of the elasticity of substitution between factors such that $\varepsilon_a = \frac{1}{1+\rho}$ where ε is the elasticity of substitution.

This allows us to analyse the impact of changes in both price and composition of processed food on specific nutritional outcomes at a population level. Equations (6) and (7) show the structure of the nested CES for intermediate input demand.

$$QINTC1_{a} = inte1_{a}\left(\sum_{cesc\in(CESC)} \delta^{int}_{cesc\,a}\, QINTC2^{-\rho^{int}_{a}}_{cesc\,a}\right)^{-\frac{1}{\rho^{int}_{a}}} \quad (6)$$

$$QINTC2_{cesc\,a} = inte2_{a}\left(\sum_{c\in(C|CESC)} \delta^{2int}_{c\,a} QINT^{-\rho^{2int}_{a}}_{c\,a}\right)^{-\frac{1}{\rho^{2int}_{a}}} \quad (7)$$

Where *CESC* is the set of intermediate input aggregates for the CES function for activity a and *cesc* refers to the set index.

$QINTC1_{a}$ and $QINTC2_{cesc\,a}$ are intermediate composite inputs. $QINTC1_{a}$ represents a higher level of aggregation and is obtained by combining lower-level composite goods according to a CES technology function. $QINTC2_{cesc\,a}$ are obtained by combining intermediate inputs according to a CES technology function. As for the parameters, $inte1_a$ and $inte2_a$ are the efficiency parameters respectively at the higher and lower levels of the nested production function. $\delta^{int}_{c\,a}$ and ρ^{int}_{a} are the share parameters and the CES exponents. $\delta^{2int}_{cesc\,a}$ and ρ^{2int}_{a} are the equivalent at the lower-level nest.

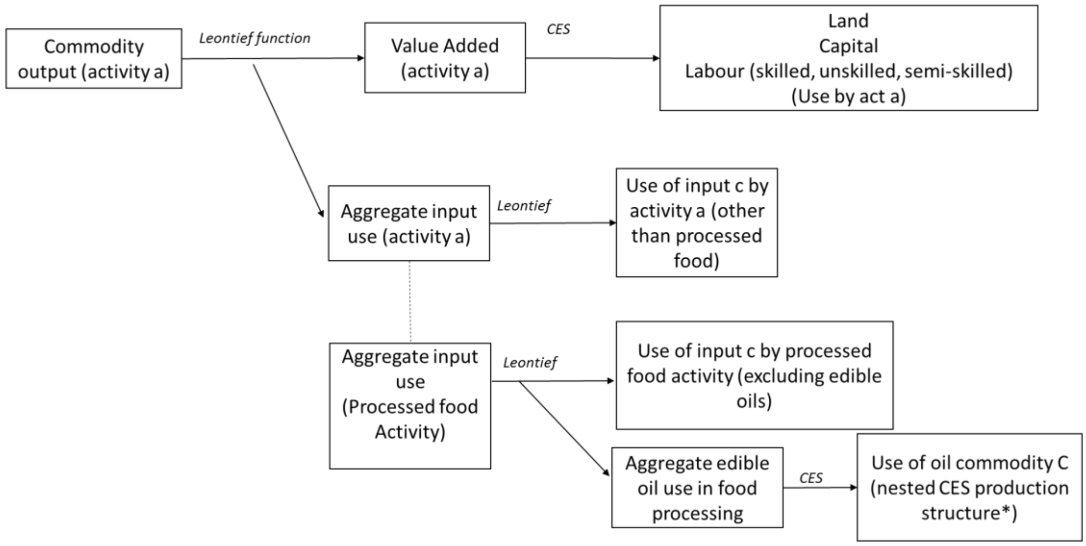
We have implemented a structure for input substitution technology in the processed food sector where palm oil and PHVO/vanaspati are aggregated into one bundle and other oils into a second bundle. These two intermediate bundles are aggregated into a composite edible oil input, which is then combined with all other inputs in the processed food sector following a Leontief function[41].

We only have only implemented a bottom-level CES technology for edible oil inputs (and PHVO). This structure could be extended to reflect substitution between other closely substitutable products such as different cereals or animal-origin products. The

[41] This nested function has implemented in order to reflect the different roles of vegetable oils in food processing, based on previous literature (Downs et al., 2013) and on our qualitative analysis, both of which suggest that PHVO and palm oil play a similar role in food processing. However, for simplicity, we have opted for a conservative approach and use a common rate of substitution for across CES bundles in our simulations.

technology structure can also be modified to include additional nested levels in order to reflect more detailed relationships between inputs.

Figure 9-2. Nested Production technology



Source: Own elaboration, adapted from (Lofgren et al., 2002).

9.3.2 Household income, expenditure and saving behaviour

We include five rural and four urban household categories, classified according to occupation. Households receive their income from hiring out labour, capital and land. Households also receive transfers from the government and remittances from the rest of the world. Income, therefore, is determined by factor endowments, factor remuneration across sectors, government transfers and remittances from abroad. This is represented by equation (8).

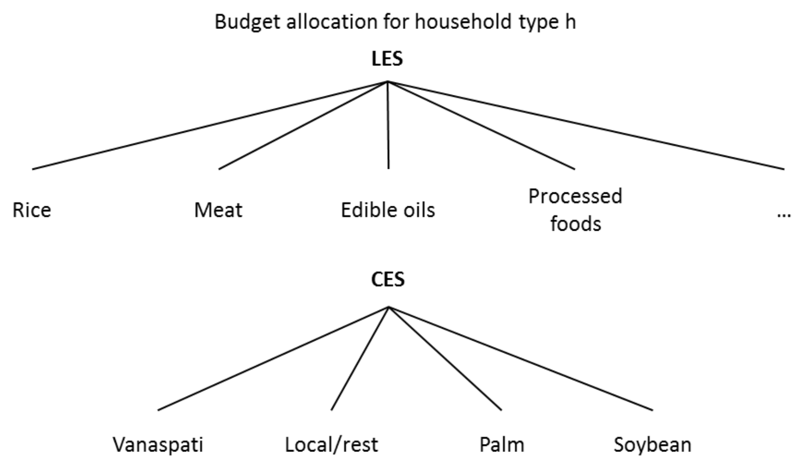
$$YH_h = \sum_a \sum_l YL_{h\,a\,l} + \sum_a (1 - tk) YK_{h\,a} + \sum_a YLAND_{h\,a} + TrGov_h + Rem\,XR \qquad (8)$$

Where $YL_{h\,a}$is the income from labour of skill level l, employed in sector a, by household type h. $YK_{h\,a}$ is the income from capital invested in activity a by household type h. Capital is taxed at a rate of tk. $YLAND_{h\,a}$ is the income from land employed in sector a by household type h. $TrGov_h$ are direct transfers from the government and Rem are remittances from the rest of the world. XR is the exchange rate.

Households use their income to consume, save or pay direct taxes. Household consumption is allocated across marketed commodities using a two-stage budgeting model, based the utility tree depicted in Figure 9-3.

Utility trees impose a group structure on commodities, so that goods that are closely related in consumption are in the same category (Deaton and Muellbauer, 1980a). In our case, edible oils are defined as a separate group, and this implies that the consumer can rank her preferences across different edible oils independently of her consumption of rice, milk, clothing and other goods. Utility trees are based on the concepts of two-stage budgeting and weak separability of preferences. Weak separability implies that the preferences over goods in one group are independent of the quantities in other groups (Gorman, 1959). Two-stage budgeting involves the assumption that consumers allocate their budget in two (or potentially more) independent stages. In a first stage they would allocate their budget across broad groups of commodities (in our case, they would decide how much they are going to spend on edible oils as a whole) and, in a second stage, they decide on the allocation of budget within each group (Deaton and Muellbauer, 1980a).

Figure 9-3. Household nested demand structure



Source: Own elaboration

In our model, the first stage allocation is defined as a Linear Expenditure System of Demand (LES), based on Stone-Geary utility functions (Stone, 1954), shown in Equation (10). Taxes are specified as a constant proportion of income, as are saving rates. Since our model does not include home consumption (consumption of home-produced commodities), all consumption expenditure is dedicated to marketed commodities. Equations (9) and (10) show, respectively, the allocation of income across consumption, savings and taxes, and the distribution of consumption expenditure across commodity groups.

$$\mathrm{EH_h} = (1 - s_h)(1 - DTax_h)\mathrm{YH_h} \tag{9}$$

Where EH_h is the total expenditure on consumption, s is the savings rate for household type h and $DTax_h$is the direct tax rate for household h.

$$PQ_{gh}\,\mathrm{QH}_{\mathrm{g\,h}} = PQ_g\gamma_{g\,h} + \beta_{g\,h}\left(EH_h - \sum_{g'} PQ_{gh}\gamma_{g'\,h}\right) \quad (10)$$

In this particular case, since we have only defined a second stage for edible oils, as relevant for our analysis, set of groups denoted by G in this first stage equation (10) map to a single commodity c, except for the edible oils category. $\mathrm{QH}_{\mathrm{g\,h}}$ is the quantity of group g consumed by household category h and. $\mathrm{PQ}_{\mathrm{gh}}$ corresponds to the commodity prices $\mathrm{PQ}_{\mathrm{c\,h}}$ for all single-commodity groups. In multiple-commodity groups, $\mathrm{PQ}_{\mathrm{gh}}$ is a price index (defined in appendix A-6). $\beta_{g\,h}$ is the marginal share of consumption expenditure dedicated by household h to commodity group g. $\gamma_{g\,h}$ reflects a minimum consumption level for commodity c and household h, which is commonly understood as a minimum subsistence level of consumption. In the case of food commodities, however, this should not be understood as being associated to minimum calorie intake or other measure of minimum dietary requirements. Rather, it can be understood as a level of consumption that the individual or household is "committed to" (Stone, 1954).

The second-stage demand for edible oils is represented by a constant elasticity of substitution (CES) function. Aasness and Holtsmark (1993) provide a detailed description of a two-stage budgeting demand system using nested LES and CES utility functions applied to household consumption in a CGE model[42].

In the second stage, consumers allocate the group budget across individual commodities, solving the following maximization problem:

[42] Subsequent versions of this specification have been used in the CGE model employed by the Central Bureau of Statistics in Norway. See Dixon and Jorgenson (2013) Chapter 3.

$Max_{QH_{ch}}$

$$u_{gh} = \alpha_{gh}\left(\sum_{c\epsilon C|g}\delta_{ch}QH_{ch}^{-\rho_G}\right)^{\frac{1}{-\rho_G}} \quad (11)$$

Subject to:

$$E_{gh} = \sum_{c\epsilon C|g} PQ_c QH_{ch} \quad (12)$$

Where u_{gh} is a CES sub-utility function for commodity group g, ρ_g is the CES exponent[43] and $\sum_{c\in C|g}\delta_{c\,h} = 1$ are distribution parameters and E_{gh} is the expenditure on group g. E_{gh} can be written as the product of a group commodity aggregate and a group price index, both of which are homothetic, given homothetic sub-utility functions in the second stage.

The resulting CES demand equations are given by:

$$QH_{c\,h} = \delta_{c\,h}\left(\frac{P_g}{PQ_c}\right)^{\sigma_G}\left(\frac{E_{gh}}{P_{gh}}\right) \quad (13)$$

Where P_g is a price index for commodity group g. A more detailed description of the two-stage demand equations and parameter calibration, using the indirect utility function, is given in appendix A6.

The choice of demand system involves trade-offs between several considerations of context-relevance, data availability, empirical appropriateness, ease of interpretation and simplicity. Some of the main advantages of the LES system of demand are its simplicity, intuitive interpretation and widespread use. This simplicity is particularly important in the context of CGE modelling, where the integration of AIDS (Almost Ideal Demand System) (Deaton and Muellbauer, 1980b) or other demand systems constitutes an additional source of complexity. This simplified approach, however, involves a series of limitations. In particular, Stone-Geary functions impose a constant income-elasticity parameter. The demand system, therefore, does not reflect

[43] The exponent parameter is $\rho_g = (1 - \sigma_g)/\sigma_g$ where σ_g is the elasticity of substitution across commodities in the group.

empirically estimated relationships between income and expenditure on commodities. In particular, empirical studies generally find a decreasing relationship between household income and the budget share of food, known as Engel's Law (Engel, 1895), (Lewbel, 2008). This is considered a strong assumption for agrarian policy analysis, where long-term income growth is an important driver of changes in food demand (Meyer et al., 2011). However, the assumption of constant income elasticities is not as problematic in the context of our study, where we focus on the short to medium-term impacts of tariff and tax policies. In addition, cross-price elasticities are proportional to own-price elasticities in LES demand specifications and the model does not allow for Hicksian complements or inferior goods. On the other hand, LES has been shown to perform well for estimation of own price elasticities, outperforming other more complex demand systems in cases with a high number of commodities (Meyer et al., 2011). We have combined the LES in the top level with a second-stage CES in order to model the substitution behaviour across closely related commodities, such as edible oils. This structure has the advantage of allowing for an appropriate representation of consumer behaviour based on relatively few parameters, which is useful in the simulation of policy shocks and alternative scenarios (Deaton and Muellbauer, 1980a). Although the homotheticity[44] of CES sub-utility functions has been criticized as un-realistic in some contexts, we maintain this assumption for the sake of simplicity and ease of interpretation Aasness and Holtsmark (1993).

9.3.3 Enterprises

Our model differentiates between public and private enterprises. Enterprises receive a simplified treatment in the model, merely acting as an intermediary between factor accounts and investment. Enterprises receive their income from capital, while wages and returns to land are paid directly to the recipient institutions from the corresponding factor accounts. Equation (14) represents the Enterprise income from capital, which is subsequently invested.

$$YENT_{ent} = shk_e(1 - tk) * YK - transf_k XR \qquad (14)$$

Where $YENT_{ent}$ is the income of enterprise ent (either public or private enterprise) and YK is the total income from capital. shk_e is the share of capital returns that is paid to enterprises, rather than being paid to households, or to the government as taxes, or

[44] We say a utility function is homothetic if it is homogeneous of degree 1, that is: $f(sx_r, a) = sf(x_r, a), r \in R$ Where s is any scalar. See Aasness and Holtsmark (1993) for a formal discussion of the implications of homotheticity in the second stage

transferred to the rest of the world. tk is the rate of taxes of capital, $transf_k$ represents the transfers to the rest of the world and XR is the exchange rate.

9.3.4 Government revenue, expenditure and investment behaviour

In our model of India, the government obtains all of its revenue from tax collection. The largest source of government revenue are direct taxes, paid by households. The second largest source of tax payments are tariffs. These, as well as the comparatively small export duties, are paid directly by the commodity accounts. Returns from capital are also taxed at a fixed rate, and productive activities pay a production tax. Taxes are reflected as positive amounts in the SAM and in the model, while subsidies are represented as negative amounts. Equation (15) shows government revenue from taxes.

$$\begin{aligned} YG = \sum_c Tariff_c\, pm_c QM_c\, XR \\ + \sum_c ExpT_c pe_c QX_c XR \\ + \sum_h Dtax_h YH_h + tk\, YK + \sum_a ta_a PA_a QA_a \end{aligned} \tag{15}$$

The government can redistribute its revenues to households or producers in the form of taxes, dedicate them to direct consumption. The remaining will dedicated to savings, which can be negative.

The majority of government expenditure in our model are dedicated to household transfers. These are associated to redistributive and social programs. The remaining expenditure, which accounts for around 47% of the government expenditure, is dedicated to government consumption. Almost 80% of government direct consumption is in the form of public service provision, including health care, education and administrative services. This is a common pattern across most countries, both in high income and low-middle income settings. In addition, food purchases account for almost 3% of total direct purchases by the government and 11% of non-service direct purchases. This reflects expenditure on food as part of India's public distribution system[45] and other programs under the food security act (Saini and Ahlawat, 2016). Savings are left to adjust as a residual in response to changes in

[45]Public Distribution System e-Portal, Ministry of Consumer Affairs, Food and Public Distribution, Government of India. http://pdsportal.nic.in/

revenues. This adjustment mechanism reflects the choice of model closure and is discussed in Section9.3.8. Equation (16) reflects government expenditure behaviour.

$$EG = \sum_{c} PQ_{C}\overline{QG_{c}} + \sum_{h} TrGov_{h}\overline{CPI} \tag{16}$$

Where EG stands for government expenditure, $\overline{QG_c}$ is government direct purchase of commodities (including both services and physical commodities). This quantity is fixed, as is the transfer rate. $\overline{CPI}$ is the consumer price index, which is fixed in the model and serves as a numeraire. Variations in government expenditure, therefore, depend on changes in the relative prices of the goods and services that the government purchases in order to function, deliver public services and carry out policy interventions.

In our case, changes in food prices can have a small but potentially relevant impact on government expenditure. Changes in tariffs, however, being one of the main contributors to public revenues, are likely to have a larger effect on the overall budget.

9.3.5 Factor Markets

Producers demand capital, labour and land in order to produce output which is sold in the market. Producers decide the amount of factor inputs they demand, given the existing technology and the relevant market prices. Formally, factor demand can be derived as a first order condition of producers' profit maximization (See Section9.3.1), and can be represented as follows:

$$WF_{f}\ wfdist_{f\ a} = \frac{VA_{a}QVA_{a}}{\delta_{f\ a}^{va}QF_{f\ a}^{(\rho_{a}^{va}-1)}\left(\sum_{f}\delta_{f\ a}^{va}QF_{f\ a}^{(\rho_{a}^{va})}\right)} \tag{17}$$

9.3.6 Commodity Markets

We describe in Section 9.3.1 how output levels are determined by producers' profit maximization behaviour. The present section describes how domestic production is exported or combined with imports and distributed across domestic uses. The demand for commodities by households, government and as intermediate input in production has already been described in the preceding section. The focus here, therefore, is primarily on the aggregation of commodities produced by different activities and the treatment of international trade. When modelling imports and exports, we adopt a “small country” assumption, which implies that changes in Indian import and export levels will not alter world market prices. This is a simplifying assumption and should be taken into account when interpreting the results, in particular in the case of palm oil, where India is a large importer of the commodity.

The model assumes that foreign commodities are imperfect substitutes for domestic products. We also assume that there is imperfect transformability for producers between exports and sales in the domestic market. This set of assumptions allows for two-way flows, providing results closer to empirical observations of international trade patterns.

Our model assumes that each productive sector produces a range of commodities in fixed proportions according to fixed yield coefficients. This reflects the fact that some commodities are produced as a by-product of other commodities. In our model this applies mainly to the production of oil meal as a by-product of edible oil processing. The treatment of the edible oil sector in the model is discussed in section 9.3.10. It is also the case that several productive sectors or activities could produce the same commodity. We aggregate the commodities produced by different sectors using a CES function, which reflects the fact that the output of one sector is usually not a perfect substitute for the commodities produced by a different sector. Equations (18) and (19) describe the production of different commodities by each activity according to fixed yield coefficients and the subsequent aggregation of commodities from different producers into an aggregate commodity output. Again, see section 9.3.10 for a description of how these model assumptions apply to the edible oil sector.

$$QAC_{a\,c} = \theta_{a\,c} QA_a \tag{18}$$

$$QC_c = \alpha_c^{ag} \left(\sum_a \delta_{a\,c}^{ag} \, QAC_{a\,c}^{-\rho_c^{ag}} \right)^{\frac{-1}{\rho_c^{ag}}} \tag{19}$$

Where $QAC_{a\,c}$ is the quantity of commodity c produced by activity a, and QC_c is the total marketed amount of commodity c, produced by all sectors. $\theta_{a\,c}$ is the yield coefficient of commodity c from activity a, α_c^{ag} is a shift parameter for the aggregation function, $\delta_{a\,c}^{ag}$ is a share parameter for the aggregation of domestic commodities and ρ_c^{ag} is the CES exponent for the domestic commodity aggregation function, which is a transformation of the elasticity of substitution (See footnote 190, page 190).

Once the commodities from different producers have been aggregated at the market level, the model determines the allocation of production to either the domestic market or the export market. This decision is based on the maximization of profits at the commodity market level, obtained by selling QC_c at market prices, subject to the following constraints:

$$PQ_cQC_c = PD_cQD_c + PE_cQE_c \tag{20}$$

$$QC_c = \alpha_c^{cet}\left(\delta_c^{cet}\, QE_c^{\rho_c^{cet}} + (1-\delta_c^{cet})\, QD_c^{\rho_c^{cet}}\right)^{\frac{-1}{\rho_c^{cet}}} \tag{21}$$

Equation (20) defines the total sales value from commodity sales at the market level as the sum of domestic sales and exports, valued at their respective prices. QD_c are the domestic sales of commodity c and QE_c are the exports of this commodity, while PD_c and PE_c are the corresponding prices.

Equation (21) is a constant elasticity of transformation (CET) function, which represents the imperfect transformability of commodity c between domestic and export uses. α_c^{cet} is the shift parameter, δ_c^{cet} is the share parameter and ρ_c^{cet} is the CET exponent. The CET exponent is equivalent to a CES exponent, but of opposite sign. The relationship between ρ_c^{cet} and the elasticity of transformation is given by the expression $\rho = \frac{\omega-1}{\omega}$ where ω is the elasticity of transformation.

Equations (22) and (20) result as first order conditions from profit maximization at the market level. Equation (22) establishes the optimal allocation across exports and domestic sales as a function of the ratio between the corresponding prices.

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PD_c}\frac{(1-\delta_c^{cet})}{\delta_c^{cet}}\right)^{\frac{1}{\rho_c^{cet}-1}} \tag{22}$$

Equation (23) shows that the contribution of activity a to the total amount of commodity c sold in the market is inversely proportional to the activity-specific price of such commodity.

$$PQAC_{a\,c} = \frac{PQ_cQQ_c}{\delta_{a\,c}^{ag}\, QAC_{a\,c}^{-(\rho_c^{ag}+1)}\left(\sum_{a'}\delta_{a\,c}^{ag}\, QAC_{a\,c}^{-\rho_c^{ag}}\right)} \tag{23}$$

Where $PQAC_{a\,c}$ is the price of commodity c produced by activity a.

Finally, imports are considered to be imperfect substitutes of domestic production. They are combined with domestic production into aggregate commodities using a CES function.

Producers minimize the cost of producing a fixed amount of aggregate commodity (Equation (24), combining domestic production and imported commodities at their market prices subject to certain constraints.

$$Cost = PM_c QM_c + PD_c QD_c \tag{24}$$

Where $QM_c$is the quantity of imported commodity c and PM_c is the corresponding price.

Equations (26), (27) and (27) represent the constraints faced by producers when making this cost minimization.

$$\overline{QQ_c} = QM_c + QD_c \tag{25}$$

$$PQ_c(1 - ts_c)QQ_c = PM_c QM_c + PD_c QD_c \tag{26}$$

Where QQ_c is the aggregate commodity, and ts_c is the sales tax rate.

$$QQ_c = \alpha_c^{arm} \left(\delta_c^{arm} \, QM_c^{-\rho_c^{arm}} + (1 - \delta_c^{arm}) \, QD_c^{-\rho_c^{arm}} \right)^{\frac{-1}{\rho_c^{arm}}} \tag{27}$$

Equation (27) is a CES function, which is also known as an Armington function when applied to the demand for imperfectly substitutable import commodities. α_c^{arm} is the Armington efficiency or shift parameter, δ_c^{arm} is the share parameter and ρ_c^{arm} is the exponent, which is a transformation of the elasticity of substitution between imports and domestic production.

Equation (28) is obtained as a first order condition of the above problem of constrained cost-minimization.

$$\frac{QM_c}{QD_c} = \left(\frac{PDS_c}{PM_c} \frac{(1 - \delta_c^{arm})}{\delta_c^{arm}} \right)^{\frac{1}{\rho_c^{arm}+1}} \tag{28}$$

9.3.7 Prices

In general, prices have been defined and the relations between price variables have been described when explaining their role in production, behaviour of households, government and enterprises and commodity and factor markets in sections 9.3.1 and 9.3.6. For the sake of simplicity, however, prices are sometimes defined at the activity level. The relationships between prices at the activity level and commodity prices are formalized in Equation (29).

$$PA_a = \theta_{a\,c} \sum_c PQAC_{a\,c} \tag{29}$$

Equation (29) is straightforward and defines the aggregate price at the activity level as the average of the prices of commodities produced, weighted by their respective activity and commodity specific yields.

9.3.8 Model Closure and system-level constraints

The model includes a number of constraints that operate at the system level. Two constraints ensure that, in the solution, all markets for commodities and factors of production are in equilibrium. This standard neoclassical assumption is equivalent to assuming full employment of resources, implicitly assuming that there is no involuntary unemployment. Although our focus is not on labour outcomes of policy interventions, this assumption should be taken into account when discussing and interpreting the impacts of various policy interventions.

In addition, three conditions ensure that macroeconomic accounts balance in the equilibrium. These include constraints on the material balances and the government budget, and the current and capital accounts of the balance of payments with the rest of the world.

Alternative assumptions can be made for these balances, but we implement a basic investment-driven closure:

Government savings are a flexible residual, and all tax rates are exogenous. We assume that the real exchange rate is flexible and foreign savings are fixed. Finally, saving rates are fixed and investment is determined by the sum of private, foreign and government savings.

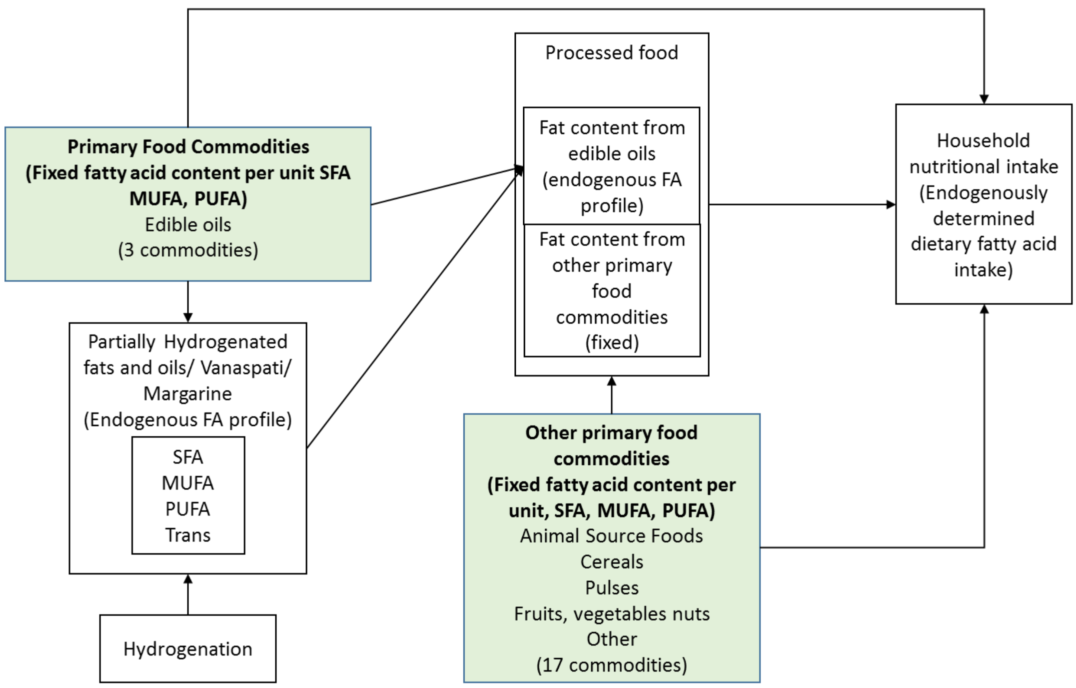
This combination is known as the standard neoclassical closure and is frequently used in empirical analysis (Lofgren et al., 2002). This closure offers both advantages and limitations. In the first place, we can adjust government tariffs and tax rates exogenously, in order to simulate relevant food policy scenarios. Secondly, we avoid increases in household welfare that are purely driven by decreases in in foreign savings, which could be misleading in the context of a comparative static analysis, where we cannot model the dynamics foreign debt. On the other hand, careful interpretation of is needed when discussing welfare changes, to account for potential changes in investment in the context of a static model, where we are not modelling capital accumulation.

9.3.9 Nutritional content and nutritional intake

We calculate nutrient intakes from un-processed or primary processed food commodities (we will refer to these as un-processed or primary food commodities) in the SAM, based on exogenous nutritional coefficients. The nutritional weights and the procedure to obtain them have been discussed in the SAM and nutritional data chapter.

The saturated, unsaturated and trans fatty acid content of an aggregate processed food category and of PHVO is approximated within the model, reflecting oil input substitution as a response to policy interventions (See Figure 9-5). Our methodology reflects nutrient consumption from primary food commodities, through food processing and to households, focussing in particular on the use of domestically produced and imported edible oils. This process is described in the rest of this section and is depicted in Figure 9-5. Equations are described in-text, as has been done throughout the chapter. Those values of variables that are calibrated and fixed, are referred to using an overbar.

Figure 9-5. Flow of nutrients within the model. Fatty acids content and intake



Source: Own elaboration based on (Rutten et al., 2013).

Each type of primary food commodity, including edible oils, has a fixed fatty acid content, given by exogenously calibrated nutritional coefficients (See appendix Table

A3-7, Table A3-9). These reflect the content of Saturated Fatty Acids (SFA) and unsaturated fatty acids (UFA) per unit[46].

A large proportion of primary food commodities is consumed directly by households. Primary food commodities are also used as inputs into the aggregate food processing activity. Edible oils, additionally, are used as an input for the production of PHVO/vanaspati, which is then also used in food processing. In order to capture this structure, the nutritional equations have a recursive structure (See Equations(30) to (38)).

In our equations (Equations (30)to (32)), the content of SFA in PHVO is approximated based on edible oil inputs. Trans fat (TFA) content of PHVO is fixed in the model using an exogenous parameter. (We carry out sensitivity analysis, varying the TFA parameter between 10%,reflecting regulatory limits after 2013 (FSSAI, ND) (FSSAI, 2013a) and 40%, reflecting pre-regulation levels estimated in the literature (Ghafoorunissa, 2008), (L'Abbe et al., 2009). See Chapter 11) . Equations (39) and (45) (31) and (32) define the weights for saturated and unsaturated -cis fatty acids[47].

In addition, the model includes an aggregate category for processed food commodities including items such as bakery products, snacks, sauces and spreads and a range of prepared and packaged foods. We use exogenous estimates of the contribution of macronutrients (fat, protein and carbohydrates) to energy per unit of processed foods, based on NSSO, (Government of India 2012)[48] and fix the total energy per unit of processed foods for each household type making the simplifying assumption households pay a price per Kcal for processed food that is twice the average price per Kcal of food prepared at home. This assumption is based on previous literature (Subramanian and Deaton, 1996), (Tandon and Landes, 2012) and allows us to obtain more realistic weights for processed food for different household categories (See SAM and nutritional data Chapter). Processed food contains fat from a variety of sources. These include edible oils but also meat, dairy products, eggs, cereals, pulses and other

---

[46] As explained in the SAM and nutritional data chapter, nutritional coefficients are converted to artificial "model units" for use in the model (nutrients per rupee in the counterfactual).

[47] This reflects the trend towards increased use of palm oil as an input, in response to reduced prices of palm oil (Downs et al., 2013). However, this is necessarily a simplification. In practice, producers can reformulate in complex ways, reducing trans fat content as they shift towards more saturated products or changing their process in other ways cannot be reflected in our model.

[48] Exogenous estimates of macronutrient content of processed foods are provided by the government of India, based on NSS data (NSSO, Government of India 2012) and nutritional composition tables (C. Gopalan, B. v. Rama Sastri & S.C. Balasubramanian, 1989) . The same databases are used in the construction of the SAM of India and the nutritional weights, which constitutes an advantage. However, it is worth noting that these values are only approximations.

commodities. Based on model data, edible oils (including PHVO) contribute around half of the overall fat content to processed food. This proportion is calibrated based on the SAM and the nutritional weights of food commodities used as inputs into food processing[49].

The saturated and unsaturated fatty acid contribution from non-edible oil sources into processed food (cereals, animal source foods and others) is calibrated and fixed, based on the fatty acid content of input commodities in the SAM (expressions (34), (35) and (37)). The proportion of different types of fatty acids coming from edible oil inputs, however, is calculated within the model, based on the different edible oils used as inputs (is not fixed and will change in response to prices). It will also depend on the use of PHVO as an input and, therefore, on the fatty acid content of PHVO, which, as described above, is also endogenous (See Figure 9-5).

Equations (30)to (32), define the nutritional weights for saturated and unsaturated fatty acids in PHVO depending on nutritional weights for edible oil inputs, edible oil input quantities in the model and exogenously fixed trans fatty acid content. Equations (33) to (37) define intermediate variables and parameters in order to calculate the nutritional weights that determine fatty acid content per unit of processed food, based on inputs of edible oils, PHVO and other primary food commodities, and their corresponding nutritional weights, and expression (38) provides the nutritional weight based on these intermediate variables and parameters.

$$\overline{NUTW}_{n=tr,'v'} = \overline{NUTW}_{n=fat,'v'}\overline{trlim} \tag{30}$$

$$\left(NUTW_{fa=sfa,'v'}\right) = \overline{NUTW}_{n=fa\_T,'v'}\left(\frac{\sum_{c\in oils}\overline{NUTW}_{n=sfa,oils}\ QINT_{oils,'v'}}{\sum_{fa}\sum_{c\in oils}\overline{NUTW}_{fa,oils}\ QINT_{oils,'v'}}\right) \tag{31}$$

$$\begin{aligned}\left(NUTW_{fa=ufa,'v'}\right) &= \left(\overline{NUTW}_{n=fa\_T,'v'}\overline{-NUTW}_{n=tr,'v'}\right.\\ &\quad \left.- NUTW_{sfa,\ 'v'}\right)\left(\frac{\sum_{c\in oils}\overline{NUTW}_{ufa,oils}\ QINT_{oils,'v'}}{\sum_{c\in oils}\overline{NUTW}_{fa,oils}\ QINT_{oils,'v'}}\right)\end{aligned} \tag{32}$$

[49] This is necessarily an approximation which cannot account for waste in processing or other sources of distortion and is not meant to calculate the nutritional component of any specific processed food item. It is also worth remembering that the focus of the study is on estimating policy impacts and, therefore, on changes rather than absolute values.

$$FASH_{fa\_tr,'procf',source=oilsv} = \frac{\sum_{c\in(oils)} \overline{NUTW}_{fatr,\ c} QINT_{c,\ 'procf'} + NUTW_{fa\_tr,v} QINT_{'v','procf'}}{\sum_{fa\_tr} \sum_{c\in(oils)} \overline{NUTW}_{fatr,\ c} QINT_{c,\ 'procf'} + \sum_{fatr} NUTW_{fa\_tr,v} QINT_{'v','procf'}} \quad (33)$$

$$\overline{FASH}_{fa\_tr,'procf',source=other} = \frac{\sum_{c\notin(oilsv)} \overline{NUTW}_{fa\_tr,\ c} QINT_{c,\ 'procf'}}{\sum_{fatr} \sum_{c\notin(oilsv)} \overline{NUTW}_{fa\_tr,\ c} QINT_{c,\ 'procf'}} \quad (34)$$

$$\overline{NUTWS}_{fa\_T,'procf',source} = \left(\frac{\sum_{c\in source} \overline{NUTW}_{fa\_T,c} * \overline{QINT0}_{c,'procf'}}{\sum_{c\in FOODC} \overline{NUTW}_{fa\_T,c} * \overline{QINT0}_{c,'procf'}} \right) \overline{NUTW}_{fa\_T,'procf'} \quad (35)$$

$$NUTW1_{fa\_tr,'procf',source=oilsv} = \overline{NUTWS}_{'fa\_T','procf',source=oilsv} * FASH_{(fa\_tr,'procf',source=oilsv)} \quad (36)$$

$$\overline{NUTW1}_{fa\_tr,'procf',source=other} = \overline{NUTWS}_{'fa\_T','procf',source=other} * \overline{FASH}_{(fa\_tr,'procf',source=other)} \quad (37)$$

$$NUTW_{fa\_tr,\ 'procf'} = \sum_{source} NUTW1_{fa\_tr,'procf',source} \quad (38)$$

Where $NUTW_{n,c}$is the nutritional weight for nutrient n and commodity c (nutritional content per unit), $\overline{trlim}$ is the trans fatty acid content in PHVO/vanaspati, defined as a percentage, $QINT_{c,a}$ is the intermediate input of commodity c used by activity a. fa is a subset of n that includes fatty acid types (SFA, UFA). $fatr$ includes also trans fatty acids. $NUTW_{n,\ c}$ represents the content of nutrient n per unit of commodity c. A specific element of a set is either indicated explicitly or using quotes. $'v'$ for example, refers to "vanaspati/PHVO" which is an element, not a set. $FASH_{(fa\_tr,'procf',\ source)}$ are shares for different types of fatty acids in processed food. $NUTW_{fa\_T}$ is nutrient content from fatty acids (total). This is defined separately for fatty acids coming from oils and PHVO *(source=oilsv)* and for fatty acids coming from other sources (cereals, meat, etc.) *(source=others)*. While the former shares are endogenously calculated in the model, the latter are calibrated based on initial inputs in the SAM and fixed. $\overline{QINT0}_{c,a}$is the initial quantity of input c used by activity a in the SAM.

$\overline{NUTWS}_{'fa-T,'procf',source}$ and $NUTW1_{(fa\_tr,'procf',source)}$ are intermediate weights. $\overline{NUTWS}_{'fa-T,'procf',source}$can be defined as the total fatty acid content per unit of processed food coming from different inputs (sources), where again we distinguish only between fats from edible oils and PHVO and fats from other inputs *(source=others)*. $NUTW1_{(fa\_tr,'procf',source)}$ can be interpreted as the fatty acid content per unit in processed food commodities, where we also differentiate between nutrients from edible oils and from other sources. $NUTW_{nfatr,'procf'}$ are the nutritional weights for processed food, which are the sum of fatty acids from edible oils and from other sources.

Finally, processed foods are consumed by households. We obtain the dietary intake of fatty acids for households based on their intake of fats both in the form of directly purchased of edible oils and other food commodities, as well as through their consumption of processed foods.

$$INTAKEPC_{n\,c\,h} = scale * NUTW_{n\,c}QH_{c\,h}/Population_h \quad (39)$$

Where $INTAKE_{n\,c\,h}$ is the intake of nutrient n from food commodity c for household category h, $NUTW_{n\,c}$ is the content of nutrient n per unit of food commodity c and $QH_{c\,h}$ is the consumption of nutrient commodity c by household category h, over population in household category h. $scale$ is a scaling parameter that is adjusted to replicate average per capita Kcal intake estimates from FAO[50]. This equation is defined over the set FOODC of commodities that are consumed by households as food ($C \in (FOODC)$).

9.3.10 Structure of the edible oil sector in the model

The information provided in this section has already been discussed throughout this chapter and the previous. This is a summary of the CGE equations as applied to the edible oils sector. To a large extent, this reflects only standard assumptions in CGE modelling, as applied in our context. Figure 9-6 shows a simplified diagram of the flow of marketed commodities for the edible oil sector in our model.

Each oil-producing activity produces their own corresponding edible oil commodity, using oilseed as an input. All activities in the sector produce oil meal as a by-product of edible oil processing.

Oil meal production from different edible oil activities is combined into an aggregate commodity using a CES function, treating oil meal from different edible oil types as imperfect substitutes (see equation (19)). This aggregate oil meal commodity is sold to the animal husbandry sector as feed or exported. Individual edible oil commodities are considered to be imperfectly transformed between exports and domestic sales. Allocation to the domestic sector and exports is modelled through a CET function

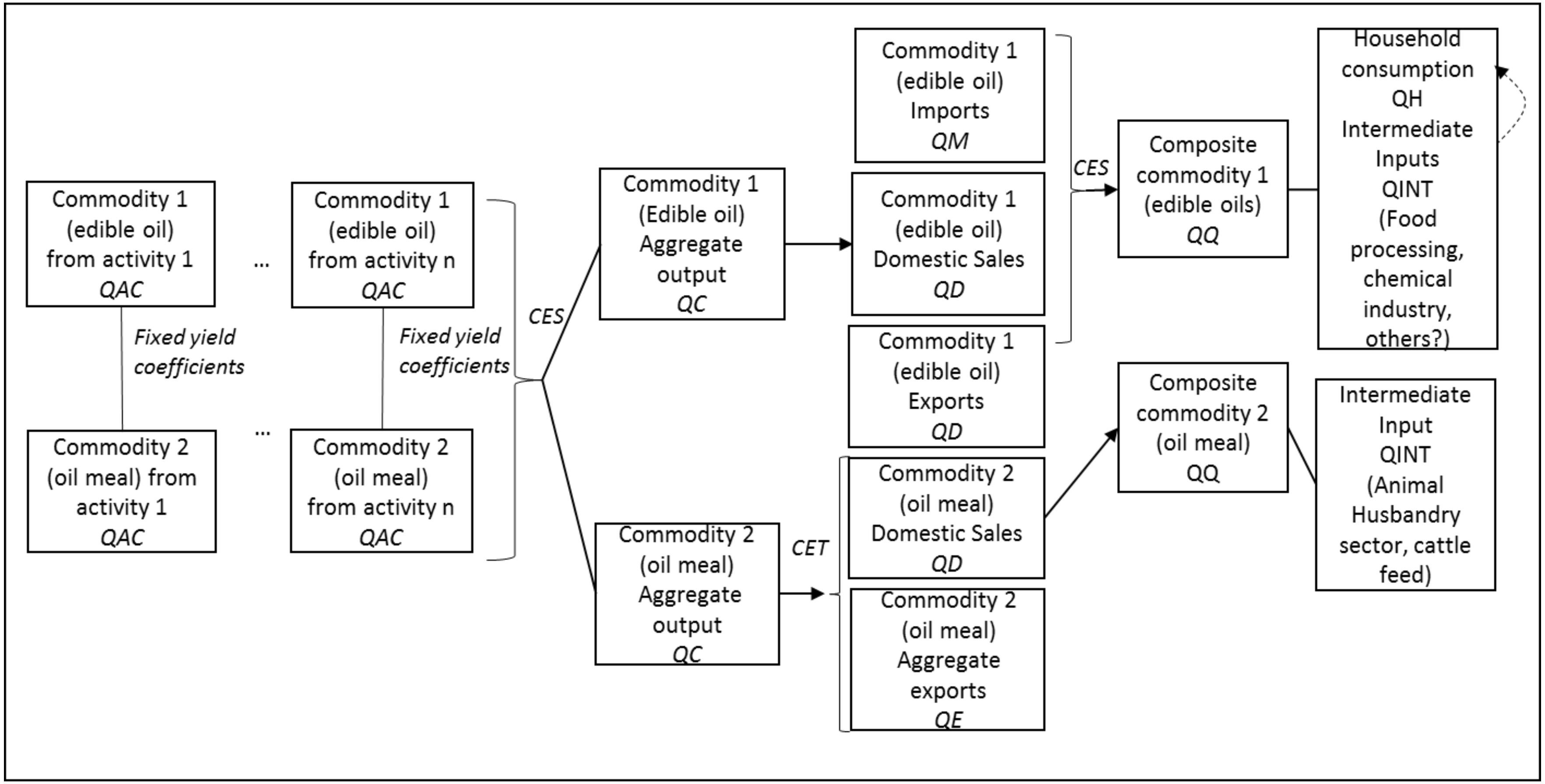
[50] Based on parameter models we underestimate Kcal intake by 5% with respect to NSS estimates (NSSO, Government of India, 2012a) and by 18% with respect to FAO estimates (FAOSTAT, nd).

(equation (21)). A CES equation is also used to combine the output of edible oils from its main producing activity and with the residual output produced by the PHVO activity and with imports, to produce aggregate commodities for each edible oil, which are then sold to other sectors as intermediate inputs, including food processing, as well as to households for food consumption. The assumption of imperfect substitutability of commodities from different origins is standard in trade modelling and allows for the existence of two-way foreign trade.

Edible oils are sold to households, to the processed food sector, to the PHVO industry and to other productive activities as well as, in a small proportion, exported.

The use of edible oils as inputs in PHVO and food processing industries is modelled using nested CES functions, described in equations (6) and (7), allowing for input substitution in response to price changes. Intermediate commodity bundles are aggregated into a composite edible oil input, which is then combined with all other inputs in the processed food sector following a Leontief function.

Figure 9-6. Flow of marketed commodities in the edible oil sector commodities in the model. Simplified representation



Source: Own elaboration based on (Lofgren et al., 2002)

9.3.11 Calibration and parameters

The model is calibrated to the data in the SAM to ensure that the baseline simulation reproduces the benchmark data. External sources are used to calibrate behavioural specifications which include additional parameters that cannot be calibrated based on the initial year dataset. Model parameters are not statistically estimated. Sensitivity analysis is used as the main tool to estimate the sensitivity of simulation results to key calibrated parameters.

Our model is calibrated based on the adapted India SAM 2007/08, which has been described in detail in the previous chapter. Additional parameters for behavioural equations, such as production and demand elasticities, are taken from previous literature when available. In some cases, the relevant parameters have been empirically estimated for India. In other cases, we extrapolate from other settings or use the available information to make an "educated guess" (Sadoulet and De Janvry, 1995). The main data sources and assumptions are discussed below. Sensitivity analysis is used to assess the impact of changes in key parameter values. This not only serves as a tool for model validation but is a valuable step in the policy analysis process. Thorough sensitivity analysis can highlight the relative importance of specific transmission mechanisms and assumptions about behaviour or economic structure and can also serve to identify priorities for future data collection and statistical analysis. Table 9-2 shows the values for the elasticity parameters for model calibration.

We obtain estimates of income elasticities of household demand for different food groups from (Kumar et al., 2011). This study provides estimates of elasticity of demand for commodities with respect to total expenditure at the household data. The authors use several rounds of data on consumption expenditure and quantities purchased from the National Sample Survey Organization (NSSO) household consumption expenditure survey. Due to the lack of empirical data for elasticity of substitution across edible oil, we choose a reference value consistent with estimates from the literature and carry out extensive sensitivity analysis[51] (Miao et al., 2013).

Trade elasticities for India are based on (Imbs and Méjean, 2016), using the cross-country trade database BACI. The values of import and export elasticities have been

51 (Miao et al., 2013) estimate CES elasticities of substitution of 0.77 for fats and 1.04 for oils in the US. We choose a conservative reference value of 0.7 for edible oils as a plausible assumption and carry out extensive sensitivity analysis.

found to be larger for low and middle-income countries, including India, compared to high income countries. Trade elasticities also tend to be higher in the longer term. Production elasticities are based on study assumptions and will be subject to sensitivity analysis and discussed in the following sections. Elasticity of substitution between factors of production and between intermediate aggregate input and value added are in line with assumptions used in other partial and general equilibrium models applied to food policy (Al-Riffai et al., 2010).

Table 9-2. Elasticity parameters for model calibration

Elasticity parameters	
Income or expenditure elasticities of demand	
Cereals	0.187
Pulses	0.716
Vegetables & fruit	0.817
Milk	1.64
Edible oils	0.772
Sugar	0.942
Other food commodities	0.887
Non-Food Commodities	1
Elasticity of substitution in the edible oils lower nest	0.7
Trade elasticities	0.7
Armington	4.9
Transformation	2.8
Production Elasticities	
Elasticity of substitution between value added and aggregate intermediate input	0.6
Elasticity of substitution between factors of production	1.4
Elasticity of substitution between intermediate edible oil inputs in food processing	0.7
Output aggregation elasticity	**4**

Source: (Kumar et al., 2011). (Imbs and Méjean, 2016). (Miao et al., 2013)

The implied own and cross-price elasticities from the CES equations and from the two-stage budgeting are provided in tables 9.2 to 9.5. A more detailed discussion of the values is provided below, but we briefly summarise the main features of the consumer demand system as characterized by the implicit elasticities:

- Own-price elasticities are around -0.7 for all edible oils in the reference case. This is similar to the values reported in the literature for the own-price elasticity of palm oil (-0.71 (Basu et al., 2013) and -0.65 (Pan et al., 2008)). The comparison for other oils is less straightforward given that previous studies have used different data and different commodity aggregations.

- Cross-price elasticities in the reference case are low (between -0.02 and 0.02). These values are lower than the ones reported by Basu et al (2013) (between 0.09 and 0.88) but similar to the values reported by Pan et al. (2008).
- Variations across household categories are small for all elasticity parameters.
- The sensitivity analysis is meant to reflect extreme cases. While own-price elasticities vary between 0.1 and -2.2, cross-price elasticities vary between -0.09 (slight complementarity) and 1.2 (strong substitutability).
- Elasticities for input demand from the food processing industry are similar to consumer demand elasticities (see Table 9.2).

Although discussed earlier in this chapter, it is important to remember that we have adopted a simplified approach to demand modelling. While this offers important advantages in the context of CGE analysis, particularly given the existing data limitations, it also involves important assumptions. Although the resulting model can reflect reasonable responses to policy shocks, further research would be required to model more realistic consumer behaviour.

It is also important to bear in mind that overall nutritional impacts depend not only on consumer demand elasticities, but also of rates of substitution across edible oil inputs into food processing, which are based on set of nested CES equations.

Note that, due to the use of a CES function in the second stage of our two-level demand model $\varepsilon_{ij} = \varepsilon_{kj} \; \forall \; i,j,k \in r$ where ε_{ij} is the cross-price elasticity between commodities i and j; i, j and k represent individual commodities and r represents any group of commodities. This is a restrictive assumption which should be taken into account when interpreting the results of this study. Further research could involve the inclusion of a more realistic and sophisticated demand model.

The implied own and cross-price elasticities for the second-stage CES are derived using the following equations:

$$\varepsilon_{(r)ij} = \omega_{(r)j}(\sigma_r - 1) \tag{40}$$

$$\varepsilon_{(r)jj} = -\sigma_r + (\sigma_r - 1)\omega_{(r)j} \tag{41}$$

Where $\varepsilon_{(r)ij}$ is the cross-price elasticity of commodity i with respect to the price of commodity j, σ is the CES constant elasticity of substitution parameter, and s_i is the within-group budget share of commodity i. These equations can be obtained as the derivatives of the CES equations (Varian, 1992).

The group own price elasticity derived from the Linear expenditure demand functions in the first stage are given by:

$$\varepsilon_{rr} = \frac{\gamma_r(1-\beta_r)}{QH_r} \quad (42)$$

Where γ_r is the minimum expenditure on r, β_r is the marginal propensity to spend and QH_r is the initial consumption. In the case of the first stage CES nest for input demand, the equations are analogous to expressions *(40)* and *(41)* reflecting the second-stage CES elasticities.

The total elasticities implied by two-stage budgeting are obtained using the following equations, based on (Edgerton, 1997):

$$\varepsilon_{ij} = \delta_{rs}\varepsilon_{(r)ij} + \omega_{s(j)}\mu_{(r)i}[\delta_{rs} + \varepsilon_{rs}] \quad (43)$$

Where $\omega_{s(j)}$ is the within-group budget share, ε_{rs} is the group price elasticity with respect to an aggregate price index for the group $\mu_{(r)i}$ is the second-stage income elasticity which is 1 in this case, and δ_{rs} is the Kronecker delta which is 1 for s=r.

The compensated price elasticities are given by the following expressions:

$$\varepsilon_{ij}^{c} = \varepsilon_{ij} + \omega_j\mu_i \quad (44)$$

$$\varepsilon_{(r)ij}^{c} = \varepsilon_{(r)ij} + \omega_{(r)j}\mu_{(r)i} \quad (45)$$

Where μ_i is the total income elasticity, which is the product of the second-stage income elasticity and the group income elasticity, which is 0.77 in this case (Kumar et al., 2011).

Table 9-3. elasticity parameters for input demand from food processing industry

Reference case. CES elasticity of substitution 0.7 (all nested functions)	Unompensated elasticities	Compensated elasticities
Total own-price elasticities for input substitution		
Commodity c		
Vanaspati	-0.73	-0.63
Local edible oils/others	-0.85	-0.36
Palm oil	-0.79	-0.50
Soybean oil	-0.74	-0.62
Total cross-price elasticities for input substitution		
Price c		
Vanaspati	-0.03	0.07
Local edible oils/others	-0.15	0.34
Palm oil	-0.09	0.20
Soybean oil	-0.04	0.08
Sensitivity analysis. CES elasticity of substitution 0.1 (all nested functions)	**Unompensated elasticities**	**Compensated elasticities**
Total own-price elasticities for input substitution		
Commodity c		
Vanaspati	-0.19	-0.63
Local edible oils/others	-0.54	-0.05
Palm oil	-0.36	-0.07
Soybean oil	-0.21	-0.09
Total cross-price elasticities for input substitution		
Price c		
Vanaspati	-0.09	0.01
Local edible oils/others	-0.44	0.05
Palm oil	-0.26	0.03
Soybean oil	-0.11	0.01
Sensitivity analysis. CES elasticity of substitution 2.4 (all nested functions)	**Unompensated elasticities**	**Compensated elasticities**
Total own-price elasticities for input substitution		
Commodity c		
Vanaspati	-2.25	-0.63
Local edible oils/others	-1.71	-1.22
Palm oil	-2.00	-1.71
Soybean oil	-2.23	-2.12
Total cross-price elasticities for input substitution		
Price c		
Vanaspati	0.15	0.25
Local edible oils/others	0.69	1.18
Palm oil	0.40	0.69
Soybean oil	0.17	0.28

Table 9-4 Elasticity parameters for consumer demand. Reference case

CES elasticity of substitution 0.7	**Household categories**								
	RH1	**RH2**	**RH3**	**RH4**	**RH5**	**UH1**	**UH2**	**UH3**	**UH4**
Commodity C									
Uncompensated Own-price elasticities in the second stage									
Vanaspati	-0.73	-0.72	-0.73	-0.73	-0.73	-0.72	-0.72	-0.72	-0.72
Local edible oils/others	-0.91	-0.88	-0.89	-0.89	-0.90	-0.88	-0.87	-0.87	-0.88
Palm oil	-0.72	-0.73	-0.72	-0.72	-0.72	-0.73	-0.73	-0.73	-0.73
Soybean oil	-0.75	-0.77	-0.76	-0.75	-0.75	-0.77	-0.78	-0.78	-0.77
Compensated Own-price elasticities in the second stage									
Vanaspati	-0.63	-0.66	-0.63	-0.63	-0.64	-0.64	-0.66	-0.66	-0.65
Local edible oils/others	-0.22	-0.66	-0.63	-0.63	-0.64	-0.64	-0.66	-0.66	-0.65
Palm oil	-0.65	-0.66	-0.63	-0.63	-0.64	-0.64	-0.66	-0.66	-0.65
Soybean oil	-0.59	-0.66	-0.63	-0.63	-0.64	-0.64	-0.66	-0.66	-0.65
Price of C									
Uncompensated cross-price elasticities in the second stage									
Vanaspati	-0.03	-0.02	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02
Local edible oils/others	-0.21	-0.18	-0.19	-0.19	-0.20	-0.18	-0.17	-0.17	-0.18
Palm oil	-0.02	-0.03	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03
Soybean oil	-0.05	-0.07	-0.06	-0.05	-0.05	-0.07	-0.08	-0.08	-0.07
Compensated cross-price elasticities in the second stage									
Vanaspati	0.07	0.04	0.07	0.07	0.06	0.06	0.04	0.04	0.05
Local edible oils/others	0.48	0.42	0.44	0.45	0.47	0.41	0.40	0.39	0.43
Palm oil	0.05	0.07	0.06	0.05	0.05	0.07	0.08	0.08	0.07
Soybean oil	0.11	0.17	0.13	0.13	0.12	0.16	0.18	0.19	0.15
Commodity C									
Total uncompensated own-price elasticities from two-stage budgeting									
Vanaspati	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
Local edible oils/others	-0.69	-0.72	-0.71	-0.70	-0.69	-0.72	-0.72	-0.72	-0.71
Palm oil	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
Soybean oil	-0.70	-0.71	-0.70	-0.70	-0.70	-0.71	-0.71	-0.71	-0.70
Total compensated own-price elasticities from two-stage budgeting									
Vanaspati	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
Local edible oils/others	-0.68	-0.70	-0.70	-0.69	-0.69	-0.71	-0.71	-0.71	-0.70
Palm oil	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
Soybean oil	-0.69	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.71	-0.70
Price of C									
Total uncompensated cross-price elasticities from two-stage budgeting									
Vanaspati	0.002	-0.002	-0.002	-0.001	0.001	-0.002	-0.002	-0.002	-0.001
Local edible oils/others	0.011	-0.020	-0.011	-0.005	0.007	-0.016	-0.016	-0.023	-0.006
Palm oil	0.001	-0.003	-0.001	-0.001	0.001	-0.003	-0.003	-0.005	-0.001
Soybean oil	0.003	-0.008	-0.003	-0.001	0.002	-0.006	-0.007	-0.011	-0.002
Total compensated cross-price elasticities from two-stage budgeting									
Vanaspati	0.003	0.000	0.000	0.001	0.002	-0.001	-0.001	-0.001	0.000
Local edible oils/others	0.024	-0.002	0.003	0.010	0.015	-0.009	-0.011	-0.012	-0.002
Palm oil	0.002	0.000	0.000	0.001	0.002	-0.002	-0.002	-0.002	0.000
Soybean oil	0.005	-0.001	0.001	0.003	0.004	-0.004	-0.005	-0.006	-0.001

Table 9-5. Elasticity parameters for consumer demand. Sensitivity analysis

CES elasticity of substitution 0.1	**Household categories**								
	RH1	**RH2**	**RH3**	**RH4**	**RH5**	**UH1**	**UH2**	**UH3**	**UH4**
Commodity C									
Uncompensated Own-price elasticities in the second stage									
Vanaspati	-0.18	-0.15	-0.19	-0.19	-0.18	-0.17	-0.16	-0.15	-0.16
Local edible oils/others	-0.72	-0.64	-0.67	-0.68	-0.70	-0.63	-0.62	-0.60	-0.65
Palm oil	-0.16	-0.19	-0.17	-0.17	-0.17	-0.19	-0.20	-0.20	-0.19
Soybean oil	-0.24	-0.32	-0.27	-0.26	-0.25	-0.31	-0.33	-0.34	-0.30
Compensated Own-price elasticities in the second stage									
Vanaspati	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
Local edible oils/others	-0.03	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
Palm oil	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
Soybean oil	-0.08	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
Price of C									
Uncompensated cross-price elasticities in the second stage									
Vanaspati	-0.08	-0.05	-0.09	-0.09	-0.08	-0.07	-0.06	-0.05	-0.06
Local edible oils/others	-0.62	-0.54	-0.57	-0.58	-0.60	-0.53	-0.52	-0.50	-0.55
Palm oil	-0.06	-0.09	-0.07	-0.07	-0.07	-0.09	-0.10	-0.10	-0.09
Soybean oil	-0.14	-0.22	-0.17	-0.16	-0.15	-0.21	-0.23	-0.24	-0.20
Compensated cross-price elasticities in the second stage									
Vanaspati	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Local edible oils/others	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06
Palm oil	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Soybean oil	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02
Commodity C									
Total uncompensated own-price elasticities from two-stage budgeting									
Vanaspati	-0.15	-0.14	-0.16	-0.16	-0.15	-0.15	-0.14	-0.14	-0.14
Local edible oils/others	-0.50	-0.48	-0.49	-0.49	-0.49	-0.47	-0.46	-0.46	-0.47
Palm oil	-0.14	-0.17	-0.15	-0.15	-0.14	-0.16	-0.17	-0.17	-0.16
Soybean oil	-0.19	-0.25	-0.22	-0.21	-0.20	-0.25	-0.26	-0.27	-0.23
Total compensated own-price elasticities from two-stage budgeting									
Vanaspati	-0.15	-0.14	-0.16	-0.16	-0.15	-0.15	-0.14	-0.14	-0.14
Local edible oils/others	-0.49	-0.46	-0.48	-0.48	-0.48	-0.46	-0.45	-0.45	-0.47
Palm oil	-0.14	-0.16	-0.15	-0.15	-0.14	-0.16	-0.17	-0.17	-0.16
Soybean oil	-0.19	-0.25	-0.21	-0.21	-0.20	-0.24	-0.26	-0.27	-0.23
Price of C									
Total uncompensated cross-price elasticities from two-stage budgeting									
Vanaspati	-0.054	-0.037	-0.060	-0.058	-0.053	-0.049	-0.040	-0.038	-0.042
Local edible oils/others	-0.400	-0.379	-0.391	-0.393	-0.392	-0.367	-0.360	-0.356	-0.375
Palm oil	-0.039	-0.066	-0.050	-0.047	-0.044	-0.063	-0.069	-0.074	-0.058
Soybean oil	-0.091	-0.152	-0.116	-0.109	-0.101	-0.147	-0.160	-0.172	-0.135
Total compensated cross-price elasticities from two-stage budgeting									
Vanaspati	-0.052	-0.035	-0.058	-0.056	-0.052	-0.049	-0.040	-0.037	-0.041
Local edible oils/others	-0.387	-0.361	-0.377	-0.379	-0.384	-0.361	-0.354	-0.345	-0.371
Palm oil	-0.038	-0.063	-0.048	-0.045	-0.043	-0.062	-0.068	-0.072	-0.058
Soybean oil	-0.088	-0.145	-0.112	-0.105	-0.099	-0.144	-0.157	-0.167	-0.134

Table 9-6. Elasticity parameters for consumer demand. Sensitivity analysis

CES elasticity of substitution 2.4	Household categories							
	RH1	**RH2**	**RH3**	**RH4**	**RH5**	**UH1**	**UH2**	**UH3**	**UH4**
Commodity C									
Uncompensated Own-price elasticities in the second stage									
Vanaspati	-2.27	-2.32	-2.26	-2.27	-2.27	-2.29	-2.31	-2.32	-2.30
Local edible oils/others	-1.44	-1.56	-1.51	-1.49	-1.47	-1.58	-1.60	-1.62	-1.54
Palm oil	-2.31	-2.25	-2.29	-2.29	-2.30	-2.26	-2.25	-2.24	-2.27
Soybean oil	-2.18	-2.06	-2.14	-2.15	-2.16	-2.07	-2.04	-2.02	-2.09
Compensated Own-price elasticities in the second stage									
Vanaspati	-2.18	-2.26	-2.17	-2.17	-2.19	-2.21	-2.25	-2.26	-2.24
Local edible oils/others	-0.76	-2.26	-2.17	-2.17	-2.19	-2.21	-2.25	-2.26	-2.24
Palm oil	-2.24	-2.26	-2.17	-2.17	-2.19	-2.21	-2.25	-2.26	-2.24
Soybean oil	-2.03	-2.26	-2.17	-2.17	-2.19	-2.21	-2.25	-2.26	-2.24
Price of C									
Uncompensated cross-price elasticities in the second stage									
Vanaspati	0.13	0.08	0.14	0.13	0.13	0.11	0.09	0.08	0.10
Local edible oils/others	0.96	0.84	0.89	0.91	0.93	0.82	0.80	0.78	0.86
Palm oil	0.09	0.15	0.11	0.11	0.10	0.14	0.15	0.16	0.13
Soybean oil	0.22	0.34	0.26	0.25	0.24	0.33	0.36	0.38	0.31
Compensated cross-price elasticities in the second stage									
Vanaspati	0.22	0.14	0.23	0.23	0.21	0.19	0.15	0.14	0.16
Local edible oils/others	1.64	1.43	1.52	1.55	1.60	1.41	1.37	1.33	1.48
Palm oil	0.16	0.25	0.20	0.19	0.18	0.24	0.26	0.28	0.23
Soybean oil	0.37	0.58	0.45	0.43	0.41	0.56	0.61	0.64	0.53
Commodity C									
Total uncompensated own-price elasticities from two-stage budgeting									
Vanaspati	-2.24	-2.30	-2.24	-2.24	-2.25	-2.27	-2.29	-2.30	-2.28
Local edible oils/others	-1.23	-1.40	-1.33	-1.30	-1.26	-1.42	-1.44	-1.48	-1.36
Palm oil	-2.28	-2.23	-2.26	-2.27	-2.27	-2.23	-2.22	-2.21	-2.24
Soybean oil	-2.13	-2.00	-2.08	-2.10	-2.11	-2.01	-1.98	-1.95	-2.03
Total compensated own-price elasticities from two-stage budgeting									
Vanaspati	-2.24	-2.30	-2.24	-2.24	-2.25	-2.27	-2.29	-2.30	-2.28
Local edible oils/others	-1.21	-1.39	-1.32	-1.29	-1.26	-1.41	-1.44	-1.47	-1.36
Palm oil	-2.28	-2.22	-2.26	-2.27	-2.27	-2.23	-2.22	-2.21	-2.24
Soybean oil	-2.13	-1.99	-2.08	-2.09	-2.10	-2.01	-1.97	-1.95	-2.02
Price of C									
Total uncompensated cross-price elasticities from two-stage budgeting									
Vanaspati	0.159	0.097	0.163	0.161	0.153	0.132	0.107	0.099	0.116
Local edible oils/others	1.175	0.996	1.065	1.096	1.137	0.980	0.957	0.923	1.039
Palm oil	0.115	0.173	0.137	0.131	0.127	0.169	0.183	0.192	0.161
Soybean oil	0.267	0.400	0.317	0.305	0.294	0.392	0.424	0.446	0.374
Total compensated cross-price elasticities from two-stage budgeting									
Vanaspati	0.161	0.099	0.165	0.163	0.154	0.133	0.108	0.100	0.116
Local edible oils/others	1.188	1.014	1.080	1.110	1.145	0.986	0.962	0.934	1.043
Palm oil	0.116	0.176	0.139	0.133	0.128	0.170	0.184	0.195	0.162
Soybean oil	0.270	0.407	0.321	0.309	0.296	0.395	0.427	0.451	0.375

Total own-price elasticities in the reference case are around -0.7 for all oils and across households. These values are consistent with those reported in previous literature, particularly for palm oil. Basu et al. (2013) estimate an own-price elasticity of -0.71 for palm oil, while (Pan et al., 2008) obtain a value of -0.65.

The comparison of own-price elasticities across studies is less straightforward for other oil categories, given that others have used different aggregations and classifications. Own-price elasticities for the “local edible oils/other” category in our model are between -0.69 and -0.72 for different household categories. This category includes the major domestic oils (mustard/rapeseed, groundnut and coconut, as well as other minor edible oils such as sunflower).

Basu et al. (2013) report own-price elasticities for the main local edible oils (mustard, groundnut and coconut oil), ranging from -0.31 for coconut oil to -0.09 for groundnut oil, which are smaller than the values in our model for the local edible oils category. Both Pan et al. (2008) and Basu et al. (2013) report similar values for palm oil (around -0.7) and mustard oil (around -0.2). The estimates for groundnut oil own-price elasticity differ greatly across both studies, with Pan et al. (2008) finding very high elasticities for this product, of around -1.27, contrasting with the very low value reported by Basu et al. (2013). This is potentially due to differences in the regional coverage of the sample. Groundnut oil is most consumed in Gujarat, where it is used to prepare traditional dishes. Pan et al. (2008) include only households in Andhra Pradesh and Uttar Pradesh. It is plausible that, while groundnut oil might be a staple in Gujarat, it might be consumed as a luxury product in other States, explaining the wide difference in estimates across studies.

The cross-price elasticities in the reference case are low. Compensated cross-price elasticities in the second stage range from 0.04 (between other oils and vanaspati) to 0.48 (for all oils with respect to changes in the local oil prices category). The implied total uncompensated cross-price elasticities are very low for the reference case (close to zero in most cases).

These values are relatively conservative with respect to those reported in Basu et al. (2013), who report cross-elasticities between 0.02 (between mustard/rapeseed and groundnut) and 0.88 (0.2)(between mustard/rapeseed and coconut). Pan et al. (2008) find non-significant cross-price elasticities across edible oil categories with the exception of groundnut oil and butter, which are found to be complementary. This is attributed by the authors to income effects, as well as to specific consumption patterns of liquid butter, which is often not used as a cooking oil, but rather consumed in other ways.

The sensitivity analysis is meant to reflect extreme cases. Own price elasticities range from -0.1 at one end (very inelastic) to -2.2 at the other (extremely elastic). Cross-price elasticities in the second stage vary between -0.09 at one end (reflecting slight complementarity) and 1.2 at the other (high substitutability). While the lower end for cross-price elasticity is within the range found in the literature (Pan et al., 2008), the higher end reflects more substitutability than the values reported in previous studies, where the highest cross-price elasticity reported is 0.88 (0.2) (between mustard/rapeseed and coconut oil) (Basu et al., 2013).

Although this has been discussed in previous chapters (Chapter 3 and Chapter 8), It is worth reminding here that animal fats are excluded from our model. This is related to the structure of our underlying SAM, where animal fats are included within the animal husbandry sector. This limitation should be taken into account when interpreting the results, given that animal fats such as ghee and butter are important products, particularly in northern regions of India, where animal fats are frequently used for cooking many traditional dishes (Kumbla et al., 2016). It is difficult to comment on the potential impact of this omission, and pre-existing literature offers limited insight. To our knowledge, the only study analysing potential substitution behaviour between vegetable oils and animal fats in India is (Pan et al., 2008), which found complementarity between animal fats and groundnut oil, and non-significant cross-price elasticities with other oils, suggesting that the omission of animal fats might not greatly affect the analysis. However, more research would be needed into this subject in order to better understand consumption behaviours of animal fats and vegetable oils in different States and different socioeconomic groups.

9.4 Conclusion

This chapter describes the comparative static CGE model for India, to evaluate nutritional and economic impacts from policies in the edible oils sector. Particular attention is paid to the characteristics of food sectors in the Indian economy, and in particular of the edible oil sector. 21 out of the 70 productive activities in the model produce food commodities.

Household consumption is allocated across marketed commodities using a two-stage budgeting model, with a LES demand function at the top and a CES function in the bottom nest. Our approach to household demand involves some simplifying assumptions, which have been discussed in this chapter. However, it allows us to maintain a relatively simple structure, while reflecting substitution across similar commodities. Substitution across edible oil inputs in food processing is modelled using nested CES functions.

The model uses a standard neoclassical closure. Government savings are flexible and adjust to maintain budget balance in response to changes in tax revenue. The marginal propensity to save from domestic non-government institutions is fixed and exchange rates are flexible. The model includes nutritional weights for food commodities and a set of nutritional equations that trace changes in nutritional content of processed food as a response to policy shocks in the edible oils sector.

Policy scenarios and simulation results will be discussed in the following chapter.

Chapter 10. Scenarios and results: Nutritional and economic impacts of palm oil liberalisation in India

10.1 Introduction

In this chapter we present the results of a set of policy scenarios concerning the palm oil and edible oil sectors in India, focusing on nutrition and economic impacts.

We simulate different combinations of tariffs and subsidies and compare the impacts of tariffs and subsidies under a range of values for behavioural and technical parameters (substitution elasticities), for both food industry and consumers. In this sense, we understand trade liberalisation not only as the reduction of applied tariffs, but also as the process constraining the policy options available through the imposition of bound tariffs. In this sense, the adoption of a new trade agreement represents the foregone possibility of implementing certain policies which, in some cases, can restrict governments' capacities promote public health (see Chapter 2 for a theoretical discussion around the issue of trade liberalisation and nutrition, 0 for a brief overview of trade liberalisation in the Indian oils sector)

Each scenario is compared to the counterfactual, and interventions are implemented in an incremental way, so that the differences across them can be attributed to a single policy. Scenarios are summarized in Table 10-1, in Section 1.2.

We report aggregate results, as well as disaggregated impacts by sector and for each of the nine household categories in our model. The comparison across broad rural and urban household categories can provide an insight into the degree of variation in policy impacts across population groups, illustrating important driving factors. We discuss linkages with the food processing and PHVO sectors as they mediate nutritional and economic effects also analyse the potential macroeconomic impacts of tariff interventions[52]. The reader can refer to Chapter 5 for a more in-depth analysis of the role of food processing and PHVO in edible oils (palm oil) value chain.

[52] As explained in previous chapters, for the purpose of this study, "processed food" or "out of home" are used as synonyms, to refer to food use of oil other than that directly purchased by households for cooking. Partially hydrogenated fats (PHVO) and vanaspati are occasionally used interchangeably for simplicity. The partially PHVO sector, is the sector producing partially hydrogenated oils (mainly in the form of vanaspati) as its main output. This sector produces small amounts of other non-hydrogenated oils.

Throughout the analysis, as is frequent when interpreting CGE models, we focus primarily on the sign or direction of impacts and on the size of impacts relative to alternative policy scenarios. As discussed in Chapter 7, our main aim is not to predict or provide a prescriptive result. Rather, we use CGE modelling in its original interpretation as a policy "thinking tool" (Taylor, 2016), to inform decision making by illustrating different potential mechanisms and the impact of specific assumptions.

In the first section we justify and describe the policy scenarios. Section 10.3 presents the nutritional outcomes. Section 10.4 describes the economic impacts of different interventions. In Section 10.5 we discuss the results, as well as the limitations of our study and the scope for further research. Section 5 summarizes and concludes. Summary results tables are provided in Table 10-3 and in the appendix.

10.2 Design of scenarios for policy interventions in the edible oil sector in India

10.2.1 Motivation and strategy for the design of policy scenarios

10.2.1.1 Context-relevance

We have chosen context-relevant scenarios, based on insights from our qualitative analysis. This doesn't necessarily mean that all scenarios are realistic, but that they provide useful insights and illustrate relevant mechanisms for trade policy in the Indian oils sector. We focus on tariffs, which have been identified as a relevant policy instrument, and which are frequently adjusted to pursue food security and economic objectives (see Chapter 6).

We choose tariff levels reflecting historical bound and applied tariff rates as discussed in the background section and qualitative analysis. This choice illustrates the relevant range of variation in policy instruments, and the potential effects of trade agreements, in terms of the policy options available.

Tariff impacts, however, crucially depend on assumptions regarding substitution across edible oils, both for consumers and for the food processing industry. We compare changes in tariff levels and subsidies under different combinations of producer and consumer elasticity. This sensitivity analysis is, in part, a way of dealing with the uncertainty around elasticity of substitution parameters, given the lack of sufficient data to obtain estimates, in a context where adulteration is prevalent, and oils are frequently sold loose or in unlabelled blends. Moreover, as we will discuss in the final section of this chapter, the sensitivity analysis around key parameters serves to illustrate the role of assumptions around consumer and producer behaviour in mediating the nutritional and economic impacts of palm oil tariffs, in a context where elasticity parameters can experience relatively rapid changes in response to technological, regulatory and social factors.

Our qualitative analysis provides, in fact, several examples of factors which can affect the degree of substitution across oils in the short term, including rapid changes in marketing, branding and packaging of oils, or processing regulations, such as the ban on trans fats, which, for technical reasons, can affect the capacity of producers to substitute across oils in response to price changes (Downs et al., 2013).

Although we focus our discussion on the direction of impacts, their comparison across scenarios and the mechanisms driving changes, the reference case can be understood as providing a lower bound for the impacts of palm oil tariffs. In the first place, we should take into account that palm oil imports have considerably increased since 2007, meaning that if the analysis was carried out with later data impacts would be larger. Moreover, we adopt conservative assumptions with regards to substitution towards local edible oils. Alternative approaches using different demand models, more disaggregated commodity categories or less conservative assumptions are likely to find larger impacts.

10.2.1.2 Methodological motivation

From a methodological point of view, our choice of scenarios serves to illustrate an approach to nutrition-sensitive analysis of food policy in a multi-sectoral framework. The use of a multi-sectoral CGE model allows us to trace the flow of nutrients through the economy, into food processing and to the final consumers (Rutten et al., 2013), (Haddad 2000). In particular, the role of input substitution in food processing, and its potential role in mediating nutrition outcomes from food taxes, have been recognized as an important area for research in the context of health-related food taxes and food policy for NCD in general (Miao et al., 2012), (Jensen and Smed, 2013). Our specification of production technology in the food processing industry allows us to explore these issues in a multi-sectoral framework, contributing to the literature on health-oriented food taxation. In addition, both palm oil taxes (Basu et al., 2013) and trans fat regulation (Downs et al., 2013) have been proposed and analysed in the academic literature as strategies to address the growing burdens of NCD in India. These studies contribute to informing our scenario design and provide a reference for our discussion.

10.2.2 Design and implementation of policy shocks and sensitivity analysis

The main policy scenarios are summarized in Table 10-1, at the end of this section, where each simulation scenario is identified with a label. Parameter values for sensitivity analysis are summarized and labelled in Table 10-2 at the end of this section.

10.2.2.1 Counterfactual

The counterfactual scenario corresponds to the baseline SAM dataset, and serves as a benchmark against which the different policy shocks are compared. In the SAM, tariffs on palm oil and soybean oil are 20%, and sales taxes or subsidies are 0%

10.2.2.2 Import tariffs on palm oil

In our scenarios we compare the baseline tariff levels (20%) (Scenario CF), to a removal of tariffs (0%) (Scenario A), and to the ASEAN bound rates 45% (Scenario B), the maximum tariff levels imposed in the last decade (80%) (Scenario C) and the maximum tariff levels according to WTO agreements (300%) (Scenario D). We do not distinguish between refined and crude oil in our model, and consider a single tariff rate for each oil commodity.

Tariffs are specified as an additive exogenous shock in the model. This is added to the baseline tax levels (See expressions 10.1, 10.2). Therefore, when the shock on palm oil tariffs equals 0.2, the effective tariff rate is of 40%, because the baseline scenario included tariff levels of 20%.

$$TM'(C) = TM(C) + shockTariff \qquad (10.1)$$

Where TM'(C) is the tariff rate on commodity C, TM(C) is the initial tariff rate and $shockTariff$ is an exogenous parameter that takes on positive values for tariff increases.

For graphical representation, we have chosen the tariff scenarios which best illustrate impact patterns in each case. In some cases, adding the most extreme tariff increases, up to the WTO bound rate, can help visualize relevant patterns of impact. In other cases, the results from subsequent tariff rises do not provide any qualitatively relevant information nor substantially add to the interpretation of results, or obscure visual representation. In these cases, we represent only the results from smaller tariff increases.

10.2.2.3 Palm oil tariffs combined with revenue-neutral subsidies

Although this is not their main policy objective, food import tariffs can raise substantial revenues. In order to account for the revenue effect, we define a scenario where palm oil tariffs are kept high, and revenues are used to subsidize the sales of either soybean or local edible oils. Revenue-neutral subsidy levels have been calculated within the model, based un simulations using reference elasticity values. Domestic sales taxes are also implemented as an additive shock.

$$TQ'(C) = TQ(C) + shockTax \qquad (10.2)$$

Where TQ'(C) is the sales tax rate on commodity C, TQ(C) is the initial tax rate and $shockTariff$ is an exogenous parameter that takes negative values for subsidies.

10.2.2.4 Trans Fatty Acid levels

We carry out a sensitivity analysis on the trans fatty acids content of PHVO, varying its value between 10% (regulatory limit) and 40% (pre-regulation level). This represents a change in a technical parameter, not a behavioural change. 10% represents full implementation of the 2014 regulatory limits (FSSAI, 2013) although, recent studies suggest that implementation is so far incomplete (Dorni et al., 2017). 40% is based on measures of TFA content in vanaspati prior to regulation (Ghafoorunissa, 2008), (L'Abbe et al., 2009).

This allows us to analyse the potential effects of palm oil tariff changes on trans fat consumption in the absence of effectively implemented regulation in the hydrogenated fats and oils sector.

The limit on trans fat content is defined as a proportion of total fat in PHVO, reflecting the regulation, and implemented as an exogenous parameter (see expression 10.3). $(NUTW_{'tr','v'})$ is the trans fat content of PHVO, $\overline{NUTW_{'fat',' v'}}$ is the "total fat nutritional" weight for PHVO and *translim* is the parameter for trans fatty acid limits.

$$(NUTW_{'tr','v'}) = \overline{NUTW_{'fat',' v'}}(tramslim) \qquad (10.3)$$

10.2.2.5 Behavioural and technological parameters for sensitivity analysis

As described in the introduction, we compare the impact of different policy interventions over a range of values for key behavioural and technological parameters. In particular, we compare policy impacts under a rage of values for elasticity of substitution across edible oils in household demand and food production technology. High and low values of the interval represent extreme cases, within the range of CES elasticity of substitution across similar goods in the literature (Miao et al., 2013), (Aasness and Holtsmark, 1993), (Paltsev et al., 2004). At the lower end of the interval, substitution across oils is very small, and almost comparable to a Leontief function.

We systematically subject scenario C to sensitivity analysis. We also carry out sensitivity analysis on other scenarios in order to aid the graphical representation of policy impacts under a range of assumptions. We do not carry out sensitivity analysis on scenarios with revenue-neutral subsidies, given that any changes in parameters would change the revenue-neutral subsidy level, meaning that scenarios would not be directly comparable.

Table 10-1. Summary of policy scenarios

Description	Palm oil tariff rate	Palm oil tariff change	Soybean sales tax (subsidy)	Local oils sales (subsidy)	Scenario label
Counterfactual	20%	0%	0%	0%	CF
Tariff removal	0%	-20%	0%	0%	A
ASEAN bound tariff	45%	+25%	0%	0%	B
Historical maximum level within the last decade	80%	+60%	0%	0%	C
WTO bound tariff	300%	+280%	0%	0%	D
High tariffs and revenue neutral subsidy on soybean	80%	+60%	-23%	0%	C+S1
High tariffs and revenue neutral subsidy on local oils	80%	+60%	0%	-0.8%	C+S2
WTO bound tariff and revenue neutral subsidy on soybean	300%	+280%	-70%	0%	D+S3
WTO bound tariff and revenue neutral subsidy on local oils	300%	+280%	0%	-22%	D+S4

Revenue neutral subsidy levels correspond to own calculations based on scenario simulations.

Table 10-2. Parameters for sensitivity analysis

Description	Label	Low (L)	Reference (R)	High (H)
Elasticity parameter Household Demand	EHD	0.1	0.7	2.4
Elasticity parameter food processing	EFP	0.1	0.7	2.4
Elasticity parameter vanaspati/ partially hydrogenated vegetable oil production	EVP	0.1	0.7	2.4
Limit for trans fatty acid content in vanaspati/PHVO	Translim	10%	--	40%

EFP and EVP and EHD refer to the elasticity of substitution in nested CES functions specific to the edible oils sector. Consumer demand is modelled using LES equations for the top demand level, and CES for the second, more disaggregated level, in this case for edible oils. When labelling graphs or tables for sensitivity analysis, for example, a simulation where (R), EFP = 0.7 EVP = 0.7 and EHD = 0.1 can be summarized with the label RRL (reference, reference, low).

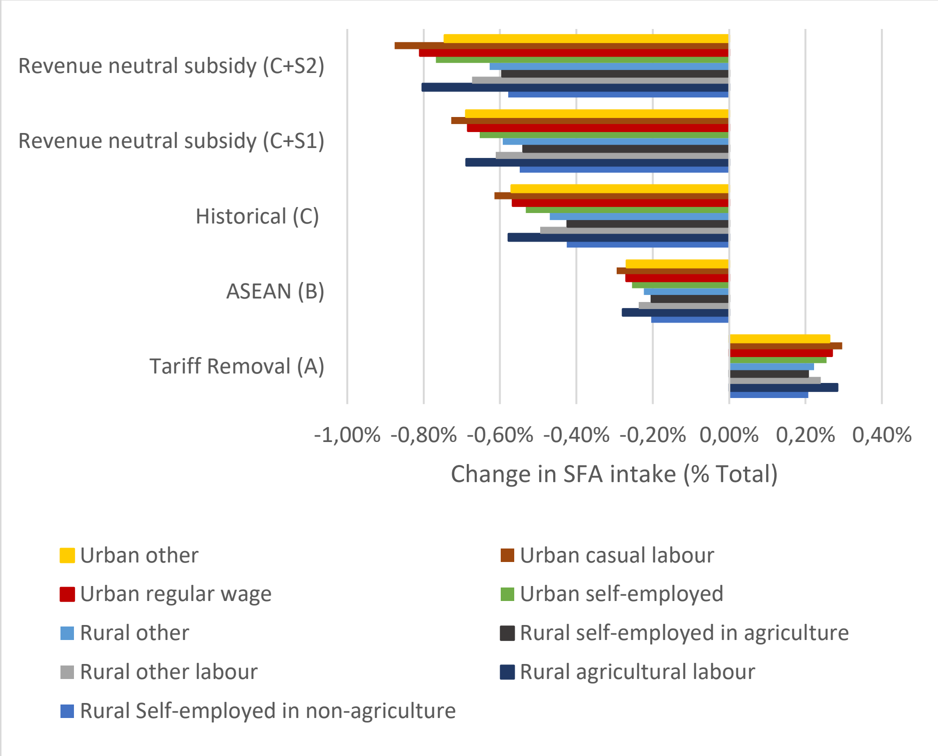
10.3 Nutritional outcomes

In this section we analyse the impact of policy shocks on fatty acid intakes, Kcal from processed food and consumption of edible oils. The reported nutritional impacts result from changes in the overall dietary patterns, and not just changes in demand for edible oils, as well as changes in the composition of food processing. We report saturated fat intake as a proportion of total fatty acid, in line with the recent evidence pointing to substitution as a more relevant factor in determining health effects, rather than absolute values of fat intake (Mozaffarian et al., 2010), (de Souza et al., 2015).

10.3.1 Saturated fatty acids

Figure 10-1 to Figure 10-3 show the changes in SFA as a proportion of total fatty acids. Figure 10-1 shows changes in SFA under different policy scenarios, using reference elasticity values.

Figure 10-1. SFA consumption as a response to policy interventions. CF, A, B, C, C+S1, C+S2



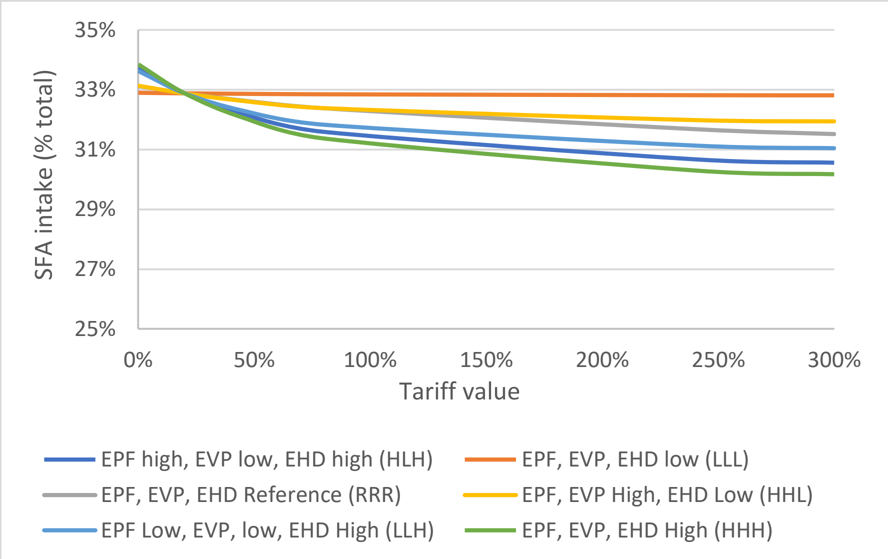
The first three scenarios in Figure 10-1 represent changes in tariff levels, and in the last two we assume that tariffs are set at the maximum applied rate for the last decade and revenues used to subsidize other edible oils (See Table 10-1).

We observe that an increase in tariff levels leads to small reductions in SFA consumption for all household categories (and substitution towards unsaturated fats). A 20% reduction in tariffs, or tariff removal (Scenario A), leads to the highest levels of SFA consumption, and the effect is proportionally slightly larger for tariff reduction than for increases. If we assume that tariff revenues are used to subsidize other edible oils (Scenarios C+S1, C+S2), the switch away from saturated fats is slightly reinforced, particularly in the case of a soybean subsidy. The effect of revenue-neutral subsidies is, nevertheless, small compared to the effects of tariff changes.

Although impacts on SFA are relatively small overall, some household categories are more affected than others. We can observe that reductions in SFA consumption are larger in general for urban households. In general, this is because urban households have a relatively higher consumption of vegetable oils. An exception to this is rural agricultural labour (RH2). This is the lowest-income household type in our model. Households in this category have a lower consumption of animal source foods, implying that vegetable oils represent a larger proportion of their total fat (and SFA) intake, compared to other household categories, resulting in larger proportional impacts. In the case of UH4 (Urban other), which includes higher-income households, the larger impacts can be explained because of their high indirect consumption of edible oils through processed foods.

The size depends to an extent on substitution behaviour on the part of consumers and food processing industry. Figure 10-2 shows the sensitivity analysis over a range of values for elasticity of substitution, both for food processing technology (EFP), (EVP) and household demand (EHD).

Figure 10-2. SFA intake in response to palm oil tariffs. Sensitivity analysis on key elasticity parameters

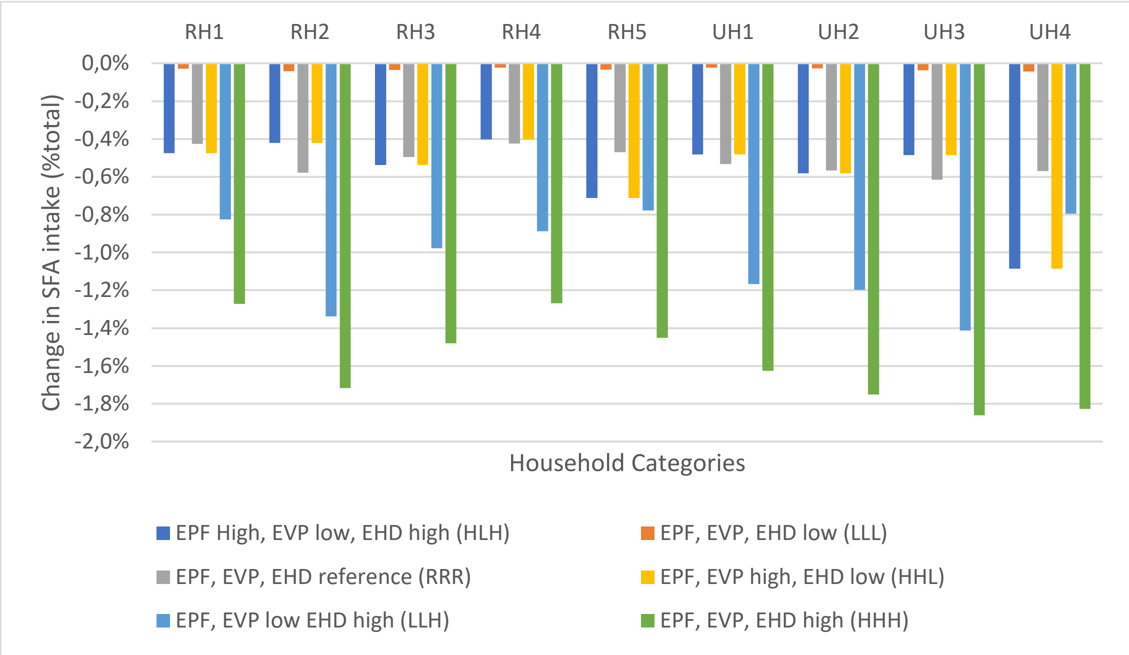


This graph shows tariff impacts on saturated fat intakes under a rage of values for behavioural parameters. Only some combinations are shown, to visually illustrate the impact.

Figure 10-2 shows impacts on SFA intakes under a range of assumptions. In the most extreme scenarios, with large tariff increases, reaching the WTO bound rate, and assuming that edible oils were highly substitutable both in production and consumption (HHH), the contribution of SFA to total fatty acid intake would go down by around 3 percent points (from 32.9% to around 30.2%). We also see that accounting for input substitution in food processing tends to slightly reinforce the effects of the tariff on SFA intakes (increase from LLL to HHL).

Moreover, as shown in Figure 10-3, the sensitivity to elasticity parameters varies across households. The nutritional impact of palm oil tariffs on most household categories depends mainly on consumer substitution behaviour. For example, the nutritional impacts of urban households classified as “casual labour” (UH3) depend to a large extent on their substitution behaviour, since they mainly consume edible oils directly. In the case of urban household category UH4 (receiving "income from capital"), however, the nutritional impacts depend mainly on whether the food industry switches to alternative oils as a response to the policy (compare yellow line HHL to dark blue LLH, and both to reference case) Therefore, ignoring input substitution could result in an underestimate of the overall nutritional impacts of tariff changes, while also affecting the distributional effects of the policy, potentially leading to an underestimate of the impacts on some urban household groups.

Figure 10-3. Changes in SFA intake in response to a 60% tariff increase. Scenario C. Sensitivity analysis on key elasticity parameters, by household category



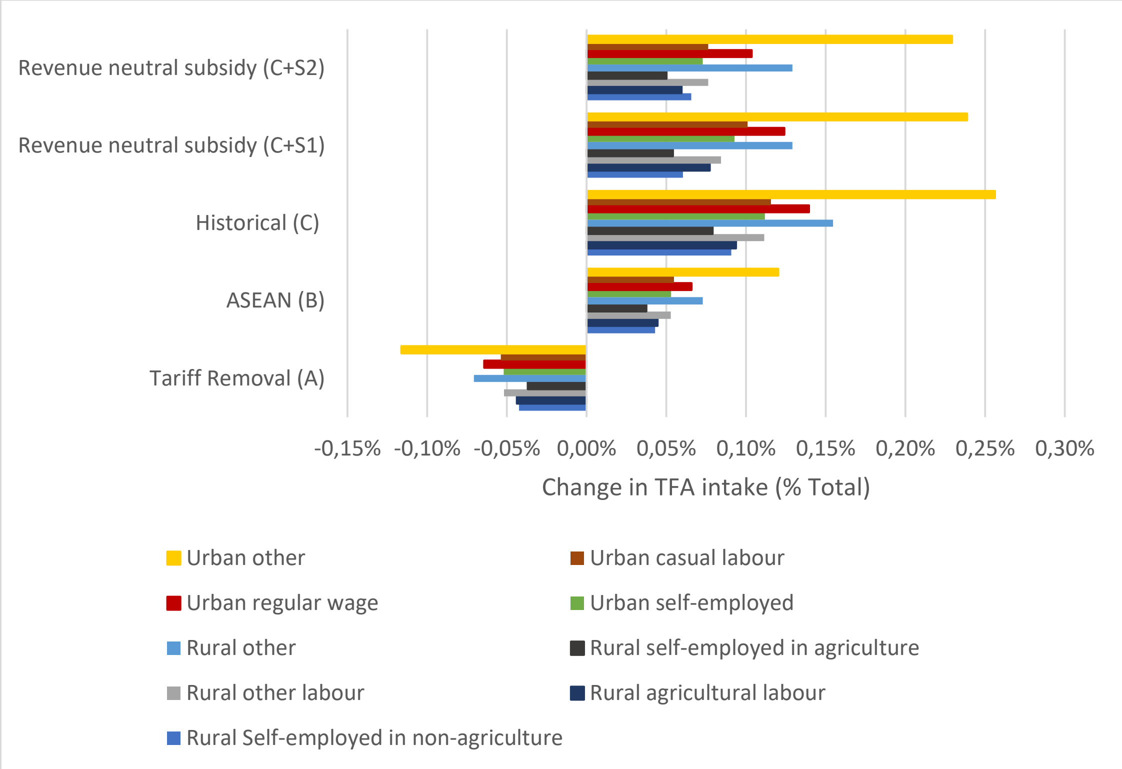
10.3.2 Trans fats

As discussed in Section 5.2.3 there are important links between palm oil and vanaspati or similar products containing partially hydrogenated (trans) fatty acids. In the first place, PHVO/vanaspati and other vegetable oils are close substitutes in consumption as well as in food processing. Moreover, palm oil is an important input into the production of PHVO. Therefore, changes in palm oil tariffs can be expected to affect not only saturated fat intakes but also trans fat consumption.

Our results show that, in the absence of effective trans fat regulation, an increase in tariff levels could, in addition to beneficial reductions in SFA intakes, lead to small increases in trans fat consumption for all household categories (See Figure 10-4). Although the overall size of the effect is small, variations across household categories are large. Overall, urban households are more affected than rural households.

Particularly, impacts are much larger for UH4 (Urban other), due to indirect consumption through processed foods.

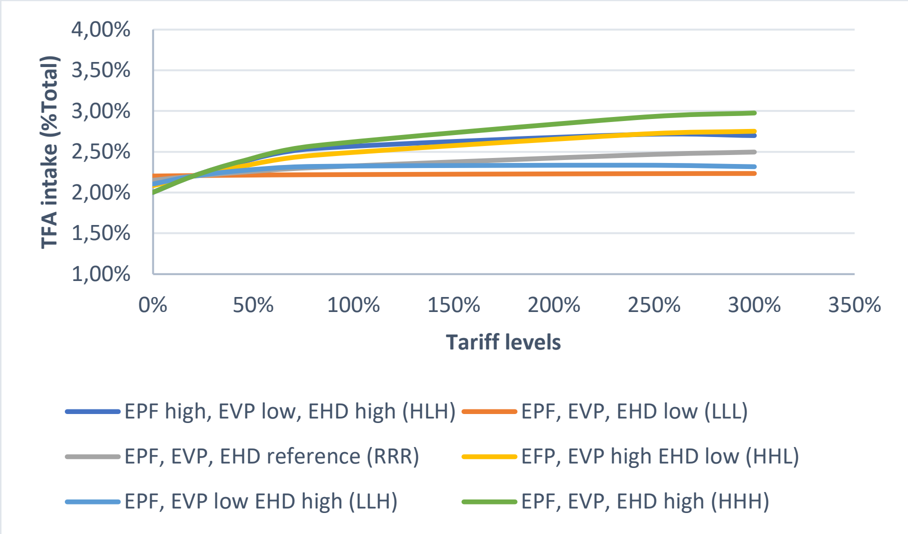
Figure 10-4. Trans fat intake levels under the main tariff and subsidy scenarios. Scenarios CF, A, B, C, C+S1, C+S2.



Sensitivity analysis also show that, only for very low levels of substitution (almost no substitution), there is a slight decrease in trans fat consumption for some households (See Figure 10-5). While increased palm oil import tariffs are likely to be complemented by increased trans fat intakes and thereby work counter to the beneficial reduction in SFA intakes, the size of this side-effect depends (critically) on the potential for substitution towards other edible oils in production and demand.

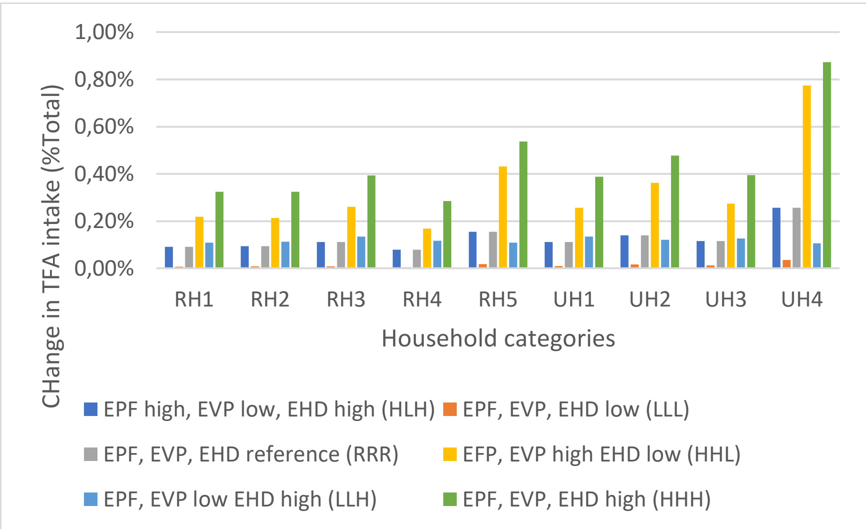
Figure 10-5 also shows that, on average, trans fatty acid consumption increases the most when edible oils are highly substitutable as production inputs (yellow and green line; HHH, HHL), regardless of consumers' behaviour (blue and orange; LLH, LLL). This is because, under these circumstances, vanaspati producers can easily switch across oil inputs, without increasing the price of their products in response to a tariff. In turn, both the food processing industry and consumers increase their use of PHVO. The same pattern can be observed in Figure 10-6.

Figure 10-5. Changes in trans fat consumption as a response to palm oil tariffs in the absence of effective regulation. Sccenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters



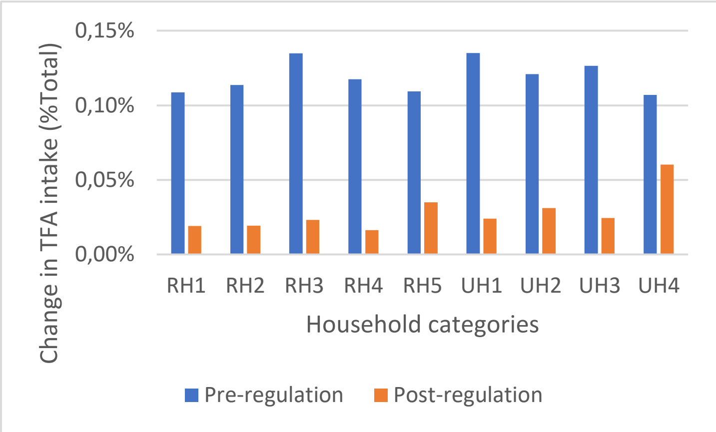
As in the case of saturated fats, however, a more disaggregated analysis, as shown in Figure 10-6, shows that the role of specific assumptions around substitution differs across households. The impact of a 60% additional tariff on trans fat intakes doubles or even triples for some household categories if we assume that vegetable oils are easily substitutable as inputs in the food processing industry.

Figure 10-6. Changes in trans fat consumption as a response to a 60% increase in palm oil tariffs in the absence of effective regulation.Scenario C. Sensitivity analysis on key behavioural parameters



Impacts are also crucially dependent on the implementation of regulation limiting the content of trans fat in PHVO (FSSAI, 2013a), (Figure 10-7) shows the sensitivity analysis on the parameter reflecting TFA limit in PHVO. The effective implementation of a 10% limit (post-regulation) greatly reduces the impacts of palm oil tariff changes on TFA.

Figure 10-7. Changes in trans fat intake in response to a 60% increase in tariffs. Scenario C. Sensitivity analysis pre-and post- trans fat regulation. Reference elasticity values



10.3.3 Energy from fats and processed foods

Apart from changes in fatty acid profiles, fiscal policy interventions on edible oils can also have other relevant nutritional impacts, leading to small reductions in overall fat consumption or energy intake from processed foods.

Figure 10-8 shows changes in daily fat intake of up to 1% in response to a 20% tariff reduction. Tariff increases, on the other hand, tend to slightly reduce fat consumption, with the effects flattening out for larger tariff changes. Impacts are dependent on behavioural parameters and, in particular, substitution across oils in household demand. These are average effects, however, and do not have a straightforward interpretation in terms of food security. Even though we capture changes in the whole diet, our model presents important limitations when it comes to the analysis of food security outcomes, given that we do not analyse impacts on or below the poverty line[53].

[53] Food security-related measures in our model, which can provide some indication of the magnitude of the effects, include daily calorie intake, contribution of cereals to calorie intake and proportion of household expenditure dedicated to food. Rural households engaged in non-agricultural labour (RH3), are the most food-insecure household in our sample, obtaining over 60% of their calories from cereals, and dedicating around 45% of their income to food. For households in this category, the most extreme scenario, with the highest tariff level allowed within WTO agreements, and assuming low elasticities of substitution across edible oils, calorie intakes would fall by 0.9%, and the contribution of cereals to the diet would increase by 0.8%. These findings are roughly consistent with previous studies, which report small food security impacts of palm oil taxes in India (Basu et al., 2013). However, it is worth repeating that appropriate analysis of food security impacts would require further research, using more sensitive demand models, and estimating the effects on the poverty line (See Basu et al. 2013).

Palm oil tariffs also increase the cost of processed food and can decrease its consumption. Figure 10-9 shows reductions of around 0.9% in the contribution of processed foods to calorie intake as a result of increases in palm oil tariffs up to the WTO bound rate. Changes are of around 0.23% for a 60% increase in the reference case. Although this is a small change, the averages hide important differences across population sub-groups, with some groups of urban households (UH4, in our model), consuming around seven times more processed foods than the average household engaged in agricultural labour (RH3).

Figure 10-8. Changes in daily fat intake in response to tariffs. Scenarios A, B, C. Sensitivity analysis

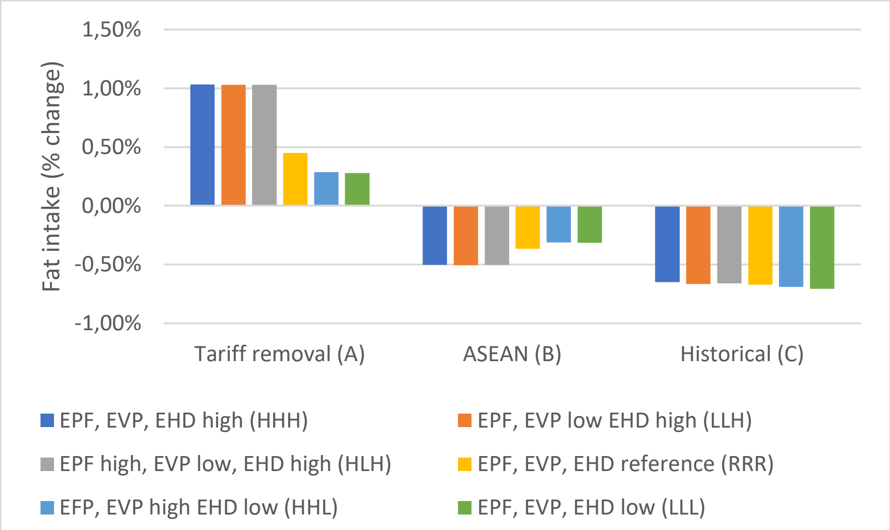
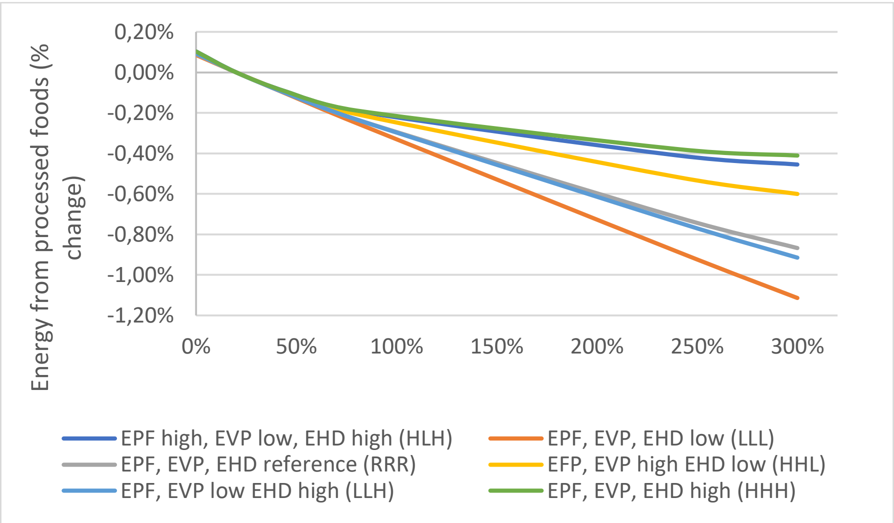


Figure 10-9. Changes in energy intake from processed foods as a result of palm oil tariffs. Scenarios CF, A, B, C, D.



10.4 Economic impacts

In addition to nutritional impacts, the policies we are analysing also have economic impacts for consumers, producers and government.

Tariffs and subsidies affect consumer expenditure, value added in the sectors affected and government revenues, and can also have aggregate economic impacts, involving efficiency losses. As in the case of nutritional outcomes, we analyse the impact of palm oil tariffs and their combination with revenue-neutral subsidies. We also examine the role of behavioural parameters for both producers and consumers through sensitivity analysis.

10.4.1 Household expenditure

We find that the imposition of a tariff on palm oil can lead to small but non-negligible increases in household expenditure on edible oils, equivalent to around 1% of overall food expenditure, and representing between 5 and 15% of total expenditure on edible oils (See Figure 10-10). The combination of tariffs with a revenue-neutral subsidy on local edible oils or, to a lesser extent, soybean, mitigates the impact on household expenditure (See

Figure 10-11). The size of these effects can be driven to a certain extent by our use of an LES demand system at the top level of commodity aggregation, which allows for low substitution across vegetable oils and other food groups such as cereals or vegetables. However, a recent review with meta-analysis found that cross-price elasticities of fats and oils with other broad food categories are non-significant (Cornelsen et al., 2015), providing some support for our simplifying assumption.

Figure 10-10. Change in expenditure on edible oils in response to palm oil tariffs. Scenarios CF, A, B, C, D

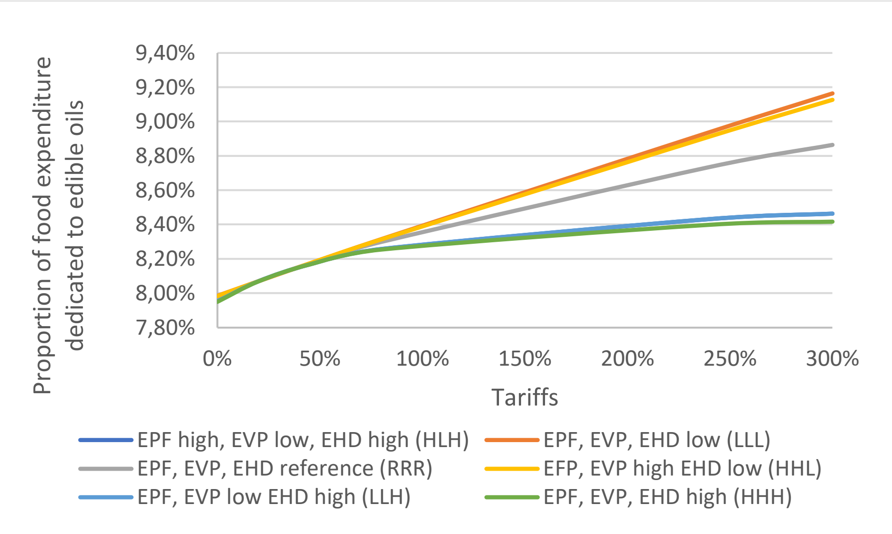
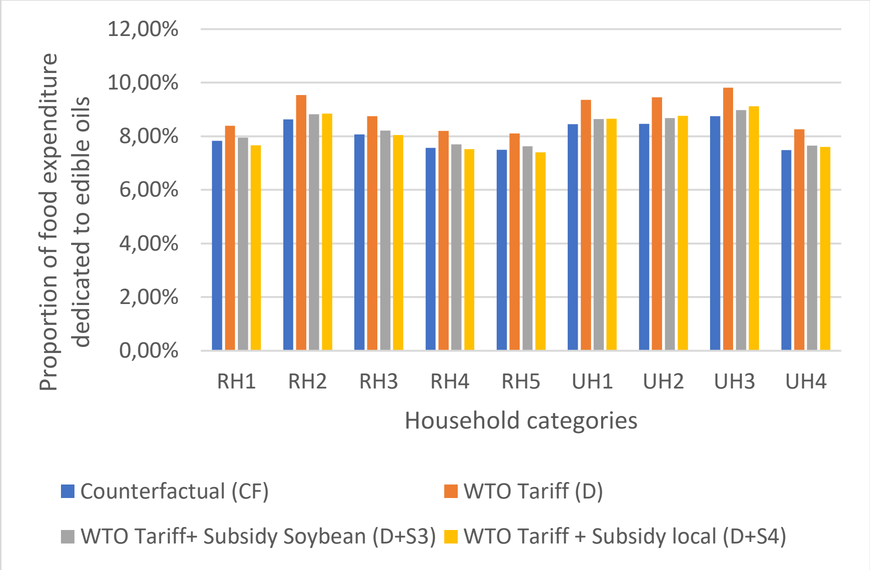


Figure 10-11. Expenditure on edible oils as a proportion of total food expenditure in response to a 60% tariff increase (Scenario C)



10.4.2 Government revenues

Although revenue raising is not their main purpose, food import tariffs represent an important source of income for the Indian government[54] .

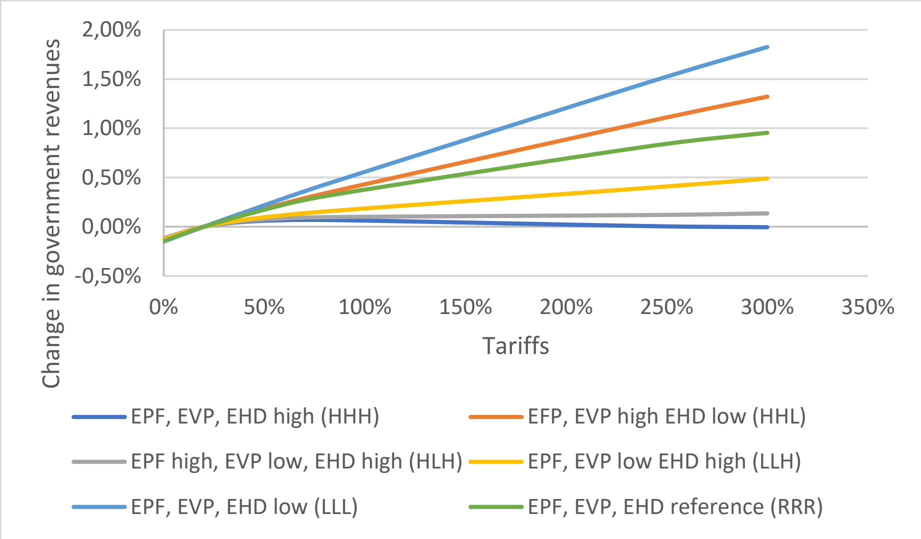
Figure 10-12 shows changes in government revenue under a range of assumptions on parameter values.

Again, consumer and producer behaviour play a role in determining the overall budget effects. Only at the upper end of the elasticity value range we find a "Laffer curve"[55] (Buchanan and Lee, 1982) peaking at a tariff level higher than maximum historical levels (80%). For our reference elasticity values, tariff increases result in plausible and significant, although progressively slowing, revenue increases. A 60% tariff increase results, in a revenue increase of 0.31%. for the reference case.

[54] In our model, food import tariffs represent around 1% of government revenues. Over one third of this amount corresponds to edible oils.

[55] A Laffer curve shows an increase in government revenues as taxes increase up to a certain tax rate, beyond which, further tax increases lead to revenue loss as the impacts of the tax, discouraging consumption and reducing efficiency, reduces the tax base.

Figure 10-12. Changes in government revenues in response to palm oil tariffs. Scenarios CF, A, B, C, D



10.4.3 Sectoral value added

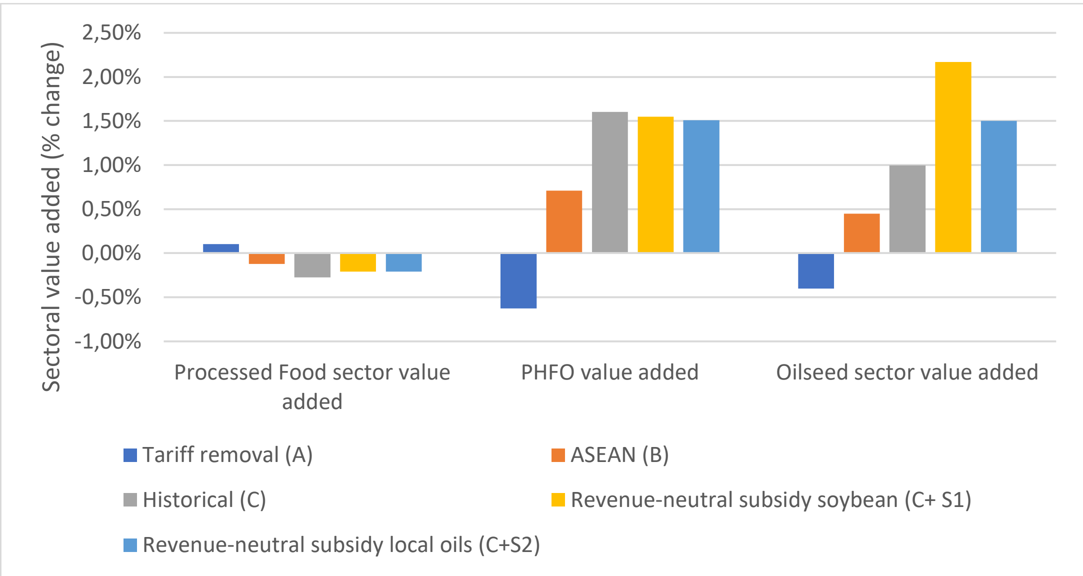
In this section, we discuss the distribution of impacts sector by sector, focussing on those activities which experience the largest impacts, due to their linkages with the edible oils industry. In particular, our analysis is focussed on downstream linkages with the processed food and PHVO sectors. Although we report and briefly comment on the effects on oilseed production, a detailed analysis of agricultural labour impacts and upstream linkages is beyond the scope of this study. For a more detailed analysis of the economic impacts of liberalisation on the oilseed sector see (Chaudhary, 1997) (Persaud et al., 2006), (Srinivasan, 2012), (Jha et al., 2012). Figure 10-13 shows sectoral economic impacts of changes in tariff levels. The largest losses from tariff increases, as a percentage of value added, correspond to the processed foods industries and the chemicals industry, which is also an important user of edible oils, although not the main focus of our study.

In the case of the PHVO industry, however, accounting for substitution across edible oils and PHVO/vanaspati, we find that increases in palm oil tariffs can lead to considerable economic growth in this sector, with gains of around 1.5% of value added in the reference scenario (see scenario (C) in Figure 10-13).

The largest value-added gains, nevertheless, concentrate in the oilseeds sectors, which are the main input providers for edible oil manufacturers and which represent a larger proportion of the value added than oil manufacturing. As previously mentioned, however, a detailed analysis of impacts on agricultural production, labour and resource use is beyond the scope of this study, and so the results concerning the oilseed sector are presented in an aggregate way and should be interpreted with caution[56]. As for the combination of palm oil tariffs with revenue-neutral subsidies on soybean or local edible oils, this would slightly mitigate the impacts on the processed food industry (particularly in the case of soybean subsidies) while reinforcing the gains from the oilseeds sector (particularly for subsidies on local oils).

Tariff removal, on the other hand, results in losses for the oilseed and PHVO sectors, as consumers substitute from imported oils towards locally produced oils and PHVO. The processed food and chemical sectors, on the other hand, gain from liberalisation, as they can access cheaper imported inputs (See scenario (A) in Figure 10-13).

Figure 10-13. Changes in sectoral value added as a result of changes in palm oil tariffs. Scenarios A, B, C, C+S1, C+S2



Figures 10-14 to 10-16 show the sensitivity analysis for value added gains for the processed food, PHVO and oilseeds sectors. For the most extreme scenarios, with tariffs at the WTO bound, value added results are highly sensitive to substitution assumptions, and much more stable for less extreme scenarios.

We observe in general that accounting for input substitution in the processed food sector mitigates the economic costs of tariff increases, since producers can react to changes in prices by reformulating their products (In Figure 10-14, blue and yellow

[56] We will refer in the discussion to the oilseed sectors or oilseed sector in general. This includes groundnut, coconut and "other oilseeds".

lines LLL, LLH, showing higher losses than the reference case, versus orange grey and blue lines, HHH, HHL, HLH, showing mitigated losses,).

In the case of the PHVO industry, the sensitivity analysis shows that economic impacts would be negative at the lower end of the substitution range, as input prices go up and this additional cost is not compensated by increased demand, given the low rates of substitution (case LLL in Figure 10-18). With higher rates of substitution, the PHVO industry would benefit from tariff increases. These also increase if we assume that PHVO producers can also switch across edible oil inputs, reducing the impacts of palm oil tariffs on their production costs, at the same time as consumers and food industry increase their demand of PHVO/vanaspati as a close substitute for palm oil. Other oil producing sectors experience similar growth, as palm oil imports are taxed, and are negatively affected by tariff reductions.

Gains from increased protection in the oilseed sector are also larger for higher levels of substitution (See Figure 10-19), as consumers and the food industry react to tariffs by increasing their demand of domestic oilseeds. For very low levels of substitution (case LLL), tariffs lead to small losses in this sector. In this case, this is the result of the efficiency losses associated to fiscal intervention, discussed in the above section, which are not sufficiently compensated by increased demand for domestic oils.

Figure 10-14. Changes in value added in the processed food sector in response to palm oil tariffs. Scenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters.

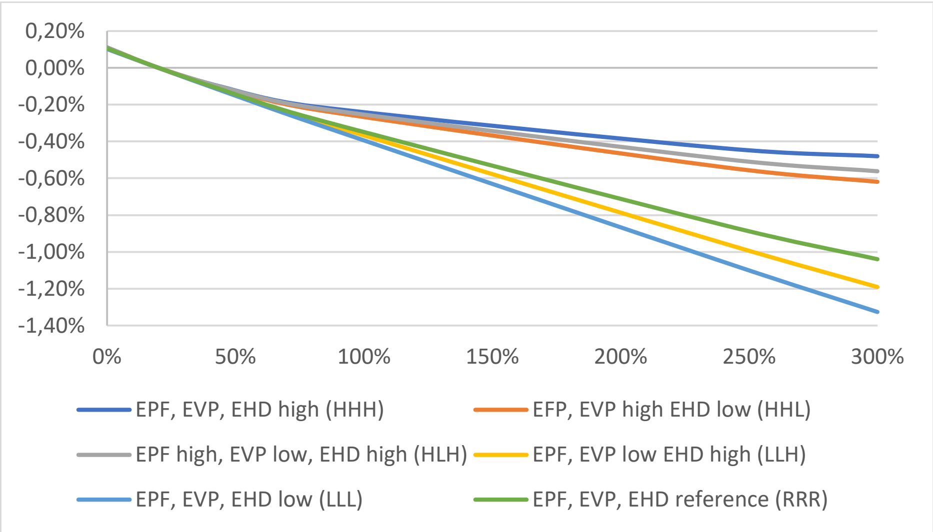


Figure 10-15. Changes in value added in the PHVO industry as a result of palm oil tariffs. Scenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters

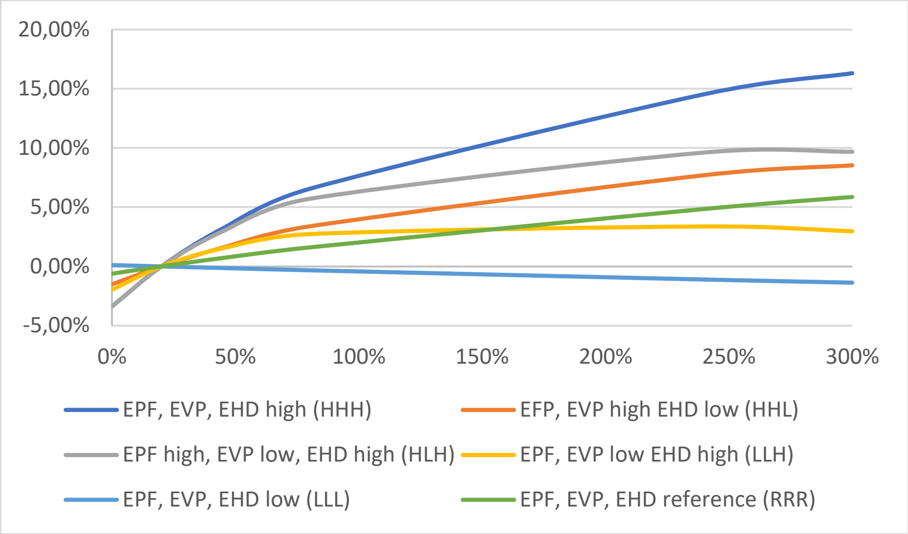
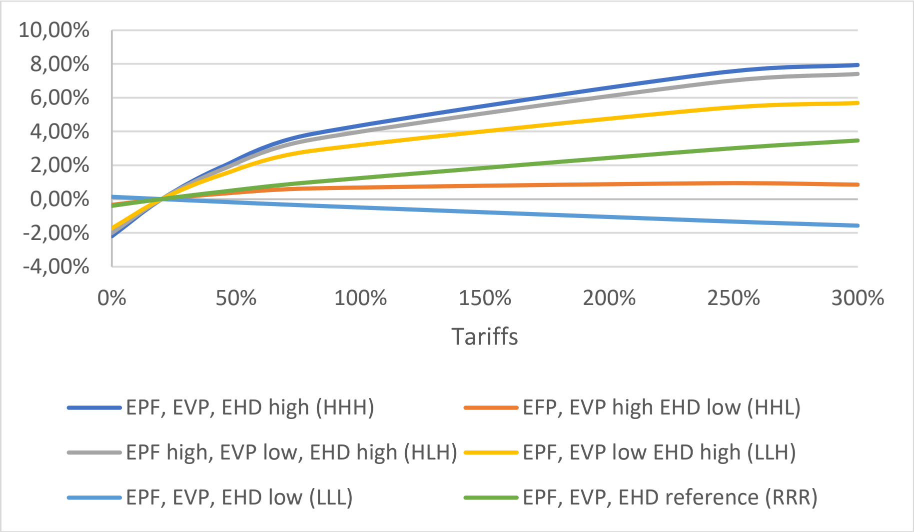


Figure 10-16. Changes in value added in the oilseed sector in response to palm oil tariffs. Scenarios CF, A, B, C, D. Sensitivity analysis on key behavioural parameters



10.4.4 Domestic absorption

Figure 10-17. Changes in domestic absorption and components as a result of palm oil tariffs and revenue-neutral subsidies. Scenarios A, B, C, C+S1, C+S2

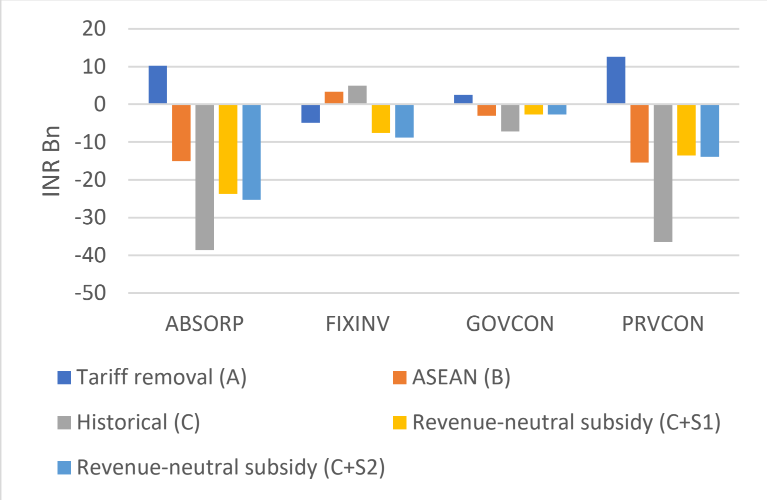
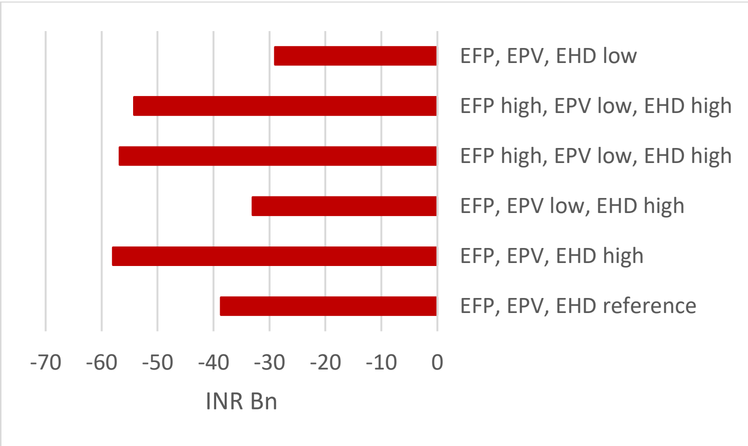


Figure 10-18. Sensitivity analysis, changes in domestic absorption as a result of palm oil tariffs. Scenario C



Figures 10-17 and 10-18 show the impacts of trade policy shocks on domestic absorption. Domestic absorption is the sum of domestic private consumption, fixed investment and government consumption. This variable is used as an indicator for aggregate welfare analysis and is equal to GDP at market prices plus foreign trade deficit[57]. We can see that, overall, tariff increases slightly reduce domestic absorption while the removal of palm oil tariffs would lead to a small increase in the same variable. In order to understand this effect and the transmission mechanism within the model, we start with import prices as an entry point.

[57] In this case, GDP at market prices and domestic absorption follow the same pattern of impacts with respect to trade policy.

As the cost of imports increases, as a result of higher tariffs, the cost of intermediate goods increases with respect to the price of domestic factors of production, which is reflected in a reduction in real wages and returns to capital which, in turn, is translated into a loss of income for households. As a result, private consumption and private savings fall slightly. At the same time, the government uses tariff revenues to increase public savings. In our model, total investment is determined by the amount of public and private savings. In this case, net investment grows as a result of tariff increases. Therefore, the net fall in absorption as a result of higher tariffs is driven by reductions in private consumption, which are only partly compensated by small net increases in investment. The quantity of government consumption is fixed in the model, and small changes in the value reflect price changes. The combination of tariffs with revenue-neutral subsidies mitigates the impact on domestic absorption by reducing the private consumption losses. In this case, investment falls with respect to the counterfactual, driven by reductions in private savings.

Overall, the aggregate reduction in domestic absorption associated to tariff increases reflect cumulative efficiency losses throughout the economy, as a result of taxation and is a standard result in tax theory. Domestic absorption losses are larger towards the higher end of the elasticity of substitution range (Figure 10-18), reflecting cumulative efficiency losses throughout the economy as agents react to distorted prices.

10.5 Summary and interpretation of results

We have analysed the nutritional and economic impacts of changes in palm oil import tariffs, and the combination of tariffs with revenue neutral subsidies on local edible oils and palm oil. The insights from our model can help us understand how the liberalisation of the edible oils sector in India has driven nutritional and economic outcomes over the past decades, and also gain a better insight into the potential use of palm oil taxation as a policy instrument to promote healthier oil consumption. Here we briefly summarize and interpret the results presented in the above sections.

The main results from this chapter are again summarized and discussed in Chapter 11, along with the findings of other chapters We do this in order to better integrate the findings from our different chapters. Nevertheless, Section 11.2 involves some repetition with this section and can be referred to for a summary of results.

Box 10-1. Key findings

Nutritional impacts: Increases in palm oil tariffs lead to modest reductions in saturated fat consumption, small reductions in energy from fat and processed foods and small increases in trans fat intakes.

Economic impacts:

Increased trade barriers on palm oil lead to positive impacts on the oilseed sector, smaller gains for the PHVO sector and losses for the food processing sector.

Tariff increases, moreover, lead to overall efficiency losses, reflected in reductions in domestic absorption, real wages, returns to capital, private consumption and savings. Aggregate welfare reductions are larger high end of the elasticity of substitution range.

Revenue-neutral subsidies:

Revenue-neutral subsidies on healthier oils mitigate the economic costs of palm oil tariffs on the food processing sector, while increasing the economic benefits to the oilseed and PHVO sectors and mitigating aggregate reductions in value added.

They also slightly reinforce the nutritional benefits in terms of saturated fat intakes, without increasing trans fat consumption, even in the absence of trans fat regulation

The impacts of tariff reductions are opposite in sign to those of tariff increases for all relevant variables in our model. However, the results show some asymmetry, with proportionally larger impacts from tariff removal.

Like Basu et al. (2013),we find that higher tariffs on palm oil lead to a substitution away from saturated fats and towards healthier unsaturated fats for all household categories[58]. We find also small reductions in energy from fats and processed foods, and small increases in trans fat consumption. In addition, we find that tariff changes of the magnitude analysed have economic impacts both at an aggregate level and on specific economic sectors.

Nutritional impacts, although small on average, seem to be unequally distributed. In our model, impact distribution is mainly driven by broad differences in initial consumption patterns. Overall, urban households experience larger changes in saturated and trans fat intakes, given higher initial levels of oil consumption. There are also important differences within rural and urban households, however, with specific categories experiencing larger impacts. In the case of urban households, the relatively high-income group of capital income earners UH4, experience the largest variations in saturated and particularly trans fat consumption which are mediated to a large extent through processed food consumption and input substitution in the processed food industry. The "agricultural labour" household category, RH2, which, given a very low intake of animal source foods, relies on edible oils as a source of fat, experiences the largest increases in relative saturated fat intakes, but these are not compensated by similarly large changes in trans fat consumption.

Nutritional effects are sensitive, in terms of size if not sign, to behavioural and technological assumptions about substitution across edible oils. The sensitivity to specific parameters, however, varies considerably across household categories. For specific household categories (UH4), which obtain a large proportion of their calories from processed foods, tariff impacts depend to a large extent on the substitution behaviour of the food industry. This suggests that ignoring product reformulation could lead to biased estimates of the distribution of impacts across population groups, underestimating impacts on households that rely more on meals purchased out of the house and highly processed foods. Product reformulation has been identified as a

[58] Given the differences in approaches and underlying data, it is not possible to make a direct comparison between our results and Basu et al., (2013). In general, we find smaller nutritional impacts, although of a comparable magnitude. Basu et al., (2013) find that a 20% tax on palm oil would lead to a decrease of around 1 g /day in per capita consumption of SFA, (95% confidence interval 0.4 to 1.6). We find that a 20% tariff change results in reduction of SFA (0.05 to 0.42 g/day), with reference value 0.25 g/day. The difference can be attributed to differences in the baseline data and modelling approach. Basu et al. use later USDA data reflecting larger palm oil imports, as well as modelling household demand for edible oils using an AIDS model and excluding PHVO/vanaspati. As mentioned in Section 10.2, our results for the reference case can be interpreted as providing a lower bound for the nutritional impacts of palm oil tariffs.

relevant and frequently neglected mechanism in relation to health-oriented food taxes (Miao et al., 2012).

Given that palm oil is an input into PHVO, increased tariffs could have, theoretically, led to higher costs for PHVO and reduced consumption. However, once taken into account the possibility of substitution across vanaspati/PHVO and other oils, the impacts are positive for all households and robust in sign to sensitivity analysis. The resulting impacts, although small, call for caution in their interpretation. This result is consistent with findings from our own qualitative research and from previous qualitative studies (Downs et al., 2013), suggesting that palm oil liberalisation was one of the factors potentially facilitating a move away from partially hydrogenated oils which were unregulated throughout most of the period following liberalisation (L'Abbe et al., 2009). Given that impacts are dependent on the adoption of trans fat regulation it is also worth reminding that recent studies show that regulation implementation is still incomplete, with several samples of vanaspati containing trans fats above the policy limits (Dorni et al., 2017) [59]. Impacts across households are also highly unequal, suggesting that specific population groups could experience significant effects.

The increases in overall fat consumption and the slight increases in energy from processed food associated to tariff removal, while not necessarily negative from a health perspective seem to indicate that palm oil liberalisation tends to reinforce existing dietary trends associated to the nutrition transition.

In addition to nutritional impacts, tariff changes in the edible oils sector also have economic impacts, both at an aggregate and sectoral level. In the first place, tariff increases lead to reductions in domestic absorption, reduced real wages and returns to capital. As a result, there is a small loss in household income and which is reflected in reduced private consumption and savings. This reflects an aggregate loss of efficiency, as agents react to distorted prices. Tariff removal, on the other hand, has the opposite effect, leading to cumulative aggregate gains. Although this finding is consistent with tax theory, it is not always true in a second-best context (Lipsey and

[59] In this study we compare the impact of tariff levels on fatty acid intakes, with and without effective trans fat regulation, as part of our sensitivity analysis. In doing so, we assume changes in the trans fat level in PHVO according to regulatory limits. However, producers can react to regulation by introducing technological changes and reformulating products (shifting towards interesterification, for example, in the medium term). These potential changes are not reflected in our model, and nor are potential costs or efficiency losses associated to compliance with regulation.

Lancaster, 1956) where there are numerous simultaneous market distortions (such as taxes on various sectors), an additional distortion does not always reduce efficiency. Even in a second-best world, the existence of potential efficiency losses associated to taxation policies would perhaps deserve more attention when it comes to comparing nutrition-oriented fiscal interventions with other policy alternatives, or with other fiscal interventions.

Additionally, changes in palm oil tariffs also have important "downstream" and "upstream" economic effects, mainly affecting the food processing and PHVO sectors, and the oilseed sector. Previous studies (Shivakumar et al., 2007) found that the liberalisation of the edible oils sector would have positive economic effects both on the processed food and on the PHVO sector and a negative impact on the oilseed sector, while increases in tariffs would have positive effects. Our findings coincide regarding the economic impacts of tariff changes on the processed food and oilseed sectors. In the case of the partially hydrogenated vegetable oils sector, however, we find that liberalisation (tariff increases) leads to a negative (positive) impact on the sector, as industry and consumers rely less on PHVO/vanaspati, having access to cheap imported palm oil.

We have also considered scenarios where high tariffs on palm oil are imposed, and the revenues are used to subsidise healthier edible oils. This policy reinforces the reductions in SFA and the shift towards unsaturated fatty acids, both compared to the baseline scenario with low tariff rates and to a scenario with high tariffs and no subsidy, although the effect of the subsidy is small compared to that of tariff changes. In terms of economic effects, the use of tariff revenues to fund a subsidy on local edible oils would slightly mitigate the losses experienced by the processed food sector, while enhancing the positive impacts on oilseed producers in the reference scenario, compared to the impact of a tariff alone.

Although palm oil tariffs lead to a shift away from saturated fats, towards healthier unsaturated fats, we find potential trade-offs in terms of economic impacts and possible nutritional side-effects, suggesting the need for caution. The use of revenue-neutral subsidies on healthier oils as a compensatory measure seem to slightly reinforce the nutritional benefits and mitigate potential economic losses.

Additionally, it is worth taking into account, as discussed in chapter 7, that palm oil tariffs can have potentially relevant distributional implications which are not fully captured by our model. This is because lower income households, which are more likely to consume palm oil due to its relative affordability, could be disproportionately affected by a tariff on this commodity. The introduction of a revenue-neutral subsidy on healthier oils, therefore, could mitigate economic and food security impacts on poorer households. Improved data collection on the consumption of imported oils across socioeconomic and regional groups and further analysis could provide additional insight on these distributional and food security issues which, as discussed in chapter 6 and chapter 11, are crucial policy concerns and defining elements of the policy space.

Finally, it is important to frame the policy shocks analysed in this chapter within the broader range of potential policy interventions which could be used to promote healthier oil consumption (see discussion on policies and goals at the end of chapter 6). These policies could include interventions along different segments of the value chain, or combinations of these which could specifically target nutrition goals. Some of these interventions (or certain aspects of them) could be analysed using CGE modelling. Examples of such potential policies include:

- Health-oriented sales tax on palm oil, potentially combined with subsidies on healthier oils.
- Public agricultural investment or subsidies to incentivise domestic oilseed producers.
- Targeted distribution of healthier domestic oils through the PDS.

The quantitative assessment of these policy interventions would require additional data and analysis that is beyond the scope of this work. However, further research could explore the economic and nutritional impacts of these interventions, either in isolation or combined, and compare them with the effects of the tariff and subsidy shocks analysed in this chapter, comparing efficiency as well as distributional aspects (across household groups as well as across s. A sales tax, for example, could have different impacts on domestic value added and producer incentives, compared to a tariff, while targeted distribution through PDS would have vastly different distributional implications when compared to a subsidy on the sales of healthier oil. A detailed discussion of potential policy instruments and matching goals is provided in chapter 6. Policy recommendations are discussed in the following chapter, drawing on the results of this and previous chapters.

Table 10-3. Results Summary table (C), (C+S1)

Results summary table 3. Scenarios (C), (C+S1). 60% increase increase in palm oil tariffs (Historical levels); 60% increase and revenue-neutral subsidy on soybean oil

	Nutritional Outcomes												Economic impacts			
	SFA [1]		UFA [1]		Trans [1]		Fat [2]		Processed food [2]		Edible oils [2]		Expenditure oils		Household income	
Tariff change	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**
Rural																
Self-employed in non-agriculture	-0.43%	-0.58%	0.33%	0.51%	0.09%	0.07%	-0.56%	0.24%	-0.22%	-0.16%	-1.32%	0.50%	0.12%	0.22%	-0.13%	-0.05%
agricultural labour	-0.58%	-0.80%	0.48%	0.74%	0.09%	0.06%	-0.90%	0.41%	-0.30%	-0.16%	-2.10%	0.77%	0.04%	0.22%	-0.13%	-0.05%
other labour	-0.49%	-0.67%	0.38%	0.60%	0.11%	0.08%	-0.68%	0.28%	-0.27%	-0.16%	-1.32%	0.61%	0.07%	0.21%	-0.14%	-0.06%
self-employed in agriculture	-0.42%	-0.59%	0.34%	0.54%	0.08%	0.05%	-0.59%	0.29%	-0.23%	-0.14%	-1.78%	0.60%	0.11%	0.24%	-0.12%	-0.04%
other	-0.47%	-0.63%	0.32%	0.50%	0.15%	0.13%	-0.53%	0.19%	-0.22%	-0.17%	-0.66%	0.54%	0.12%	0.21%	-0.14%	-0.05%
Urban																
self-employed	-0.53%	-0.77%	0.42%	0.69%	0.11%	0.07%	-0.70%	0.36%	-0.21%	-0.15%	-1.68%	0.76%	0.13%	0.23%	-0.13%	-0.05%
regular wage	-0.57%	-0.81%	0.43%	0.71%	0.14%	0.10%	-0.71%	0.35%	-0.21%	-0.15%	-1.23%	0.80%	0.13%	0.22%	-0.13%	-0.05%
casual labour	-0.61%	-0.88%	0.50%	0.80%	0.12%	0.08%	-0.88%	0.43%	-0.27%	-0.15%	-1.79%	0.85%	0.07%	0.22%	-0.14%	-0.06%
other	-0.57%	-0.74%	0.31%	0.52%	0.26%	0.23%	-0.52%	0.17%	-0.21%	-0.17%	-0.40%	0.69%	0.13%	0.21%	-0.13%	-0.05%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.00%	-0.07%	-0.05%	-0.27%	-0.21%	1.60%	1.51%	1.00%	1.50%	0.07%	0.04%	48.41%	48.52%	0.14%	-18.17%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Kcal. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Reference elasticity parameters: EFP, EVP, EHD= 0.7

Chapter 11. Summary, discussion of main findings and contributions and conclusion

11.1 Introduction

Throughout this thesis we have analysed the nutritional and economic impacts of trade liberalisation of palm oil in India and explored potential policy options for the promotion of sustainable healthy oil consumption in India.

The main findings have already been summarized and discussed in each relevant chapter. At the risk of repeating some of these conclusions, we use this chapter to bring together our quantitative and qualitative findings, focussing on the main emerging insights. Necessarily, we leave out some partial findings from specific parts of the research, which can be found in the corresponding chapters. We will then provide an overview of the limitations of our study and suggest some potential areas for further research. Finally, we will outline some cautious policy recommendations that stem from our results.

11.2 Main findings and contributions

Literature review: Economic globalisation, nutrition and related health outcomes

We have started this thesis with a review of the empirical associations between trade liberalisation, nutrition and related health outcomes, which we use to inform a theoretical discussion around the role of liberalisation and economic globalisation as a driver of the nutrition transition, situating our study within the broader debate on this topic. This review contributes to the literature by rigorously contrasting quantitative empirical evidence with different hypothesized impact pathways. From this review, we can highlight some conclusions that are of particular relevance in framing the rest of this study:

- The studies reviewed find mixed results concerning the links between trade openness and undernutrition, with some recent evidence pointing to reductions in undernutrition and underweight associated to trade openness. There is no clear evidence linking trade openness per se to overweight, obesity or diet-related NCD.
- Both FDI and increased international flows of information (Goryakin et al., 2015), (Costa-Font and Mas, 2016), have been found to be associated to increased consumption of sugary and highly processed foods and

increases in overweight and obesity in LMIC in particular (Schram et al., 2015) (Baker et al., 2016) Miljkovic et al. (2015).

- Despite some evidence of an association between FDI and some indicators of malnutrition, we have found no clear evidence linking it to underweight, with some recent studies pointing towards sectoral composition of impacts as an important mediator of effects (Mihalache-O'keef and Li, 2011) and (Djokoto, 2012).

The lack of association between trade openness and over-nutrition could also suggest that availability and affordability of food products, per se, are not enough to lead to the changes in lifestyle and consumption patterns associated to NCD prevalence. Direct investment, on the other hand, has the capacity to deeply transform the food sector and the wider economic system, altering consumer behaviour as part of this process (Hawkes 2006), (Baker et al., 2016). In this sense, FDI and trade openness operate as complementary phenomena for the transformation of food systems, facilitating market penetration of TFC through vertical and horizontal integration, transformation of the distribution and retail segments, effective advertisement and adaptation to local consumer tastes or 'glocalization' (Roudometof, 2005).

Additionally, the scarce evidence linking trade openness to reduced under-nutrition and under-weight could reflect the impact of trade policies explicitly aimed at improving food security and insulating domestic staple food prices from international price spikes. These measures include selective reductions in import protection of essential foods, sometimes coupled to public stockpiling and distribution programs (Gillson and Fouad, 2015), (Anderson et al., 2014), (Haggblade, 2008).

The findings throughout the rest of this thesis suggest that the case of palm oil and edible oil liberalisation in India is, in many ways, far from an exception to the global patterns described in our review. Although trade liberalisation and trade policy have undoubtedly played an important role in driving increased consumption of vegetable oils and palm oil, these changes cannot be fully understood in isolation from wider transformations in the food system as a whole, and in the oils sector in particular, which are in turn linked to different degrees to wider processes of globalisation and liberalisation (Reardon and Minten 2011b). While our quantitative analysis focusses exclusively on nutritional and economic impacts of trade policy, in our qualitative analysis, we also consider the promotion of healthy fat consumption in relation to sustainability challenges in the palm oil sector.

The value chain for edible oils: Characteristics, incentives and potential areas of intervention for sustainable nutrition

First, we have examined the structural characteristics and incentives in the edible oils sector that contribute to explaining the dependency on unsustainable palm oil imports and drive unhealthy consumption patterns. Many of these factors, by contributing to relatively lower cost of imported oils, reduced consumer awareness and the marketing of palm oil demand as a low-margins commodity, also discourage investment in sustainable sourcing or consumer-oriented labelling strategies which have supported sustainability commitments in higher-income countries. These dynamics undermine incentives for domestic producers and can contribute to a process of dietary "convergence-divergence", where oil and fat consumption increases at a population level while there is a divergence in quality, as some groups of population increasingly consume palm oil, while the middle classes shift towards healthier oil consumption. Key constraints affecting both nutrition and sustainability outcomes through the mechanisms described include:

First, constraints in the agricultural oilseed sector reduce availability of healthier domestic oils, while directly leading to negative impacts for domestic sustainability. Previous literature dealing with import dependence has often focussed on constraints in the agricultural sector (Downs et al., 2015), (Jha et al., 2012) and the consequent excess capacity for the domestic oil processing industry (Srinivasan, 2012), (Persaud et al., 2006) which contributes to overall low efficiency.

Second, the emergence of a highly efficient import-oriented processing infrastructure, situated directly at the ports, reinforces the price advantage of oil imports with respect to healthier domestic oils. The need to protect small domestic producers which coexist with this newer industry also creates challenges with respect to the implementation of strict regulation for oil labelling or packaging.

Third, price differences are also reinforced by a rapid process of market segmentation. This process to a large extent based on health-oriented advertising and driven by competition among the main brands in an increasingly concentrated oil processing segment. Healthier oils, therefore, are increasingly likely to be sold branded, for a premium. Palm oil, meanwhile, is often distributed in unlabelled blends, or used to adulterate healthier oils, and sold to low-income households or to food retailers and food processing industries.

Fourth, palm oil demand is fuelled by the rapid increase in out-of-home food consumption, including street food, eateries and highly processed products. Food processors often face barriers in obtaining domestic oils (Downs et al., 2014b). Demand in this sector is highly price-driven, oil sourcing is often not transparent, and adulteration with palm oil is frequent.

Fifth, public distribution of edible oils to low-income households relies on imported palm oil. Although distribution is now occasional, and the overall volumes reduced, this approach reinforces inequalities in the access to healthier oils. The impacts of this policy, however, might go beyond their direct consumption effects, discouraging domestic oilseed producers, and contributing to a negative perception of palm oil as a commodity and, therefore, to market segmentation.

As a positive aspect we find that the domestic oil processing industry faces growing incentives to engage with international sustainability standards. These are mainly driven by the increased influence of multinational food processing and retail companies in the value chain, which have acquired global sustainability commitments. An additional factor is the fact that leading processing companies have become involved in (still marginal) domestic oil palm plantations, and are keen to differentiate their product, targeting the export market. The lack of a domestic price premium for sustainable oil, and the sectoral characteristics identified above, however, constitute important challenges, implying that a shift towards sustainable palm oil is likely to require public intervention and support.

Based on our analysis of the value chain and focussing on areas of intervention identified as relevant by interviewees, we discuss some potentially synergistic approaches, which, tackling structural factors in the sector, could contribute to a shift towards healthier, sustainable oil:

- Interventions promoting climate adaptation, sustainable intensification and extension in the oilseed sector.
- Use of differential import tariffs for unsustainable palm oil, whose resources can potentially be used to subsidize sustainably produced, healthier oils.
- Supporting transparent sourcing of oils for food processors and food retailers, facilitating access to healthier, sustainable domestic oils (Downs et al., 2014b).
- A shift towards domestic oils in public distribution programmes. This would reduce inequalities in the access to healthy fats and also, potentially, reduce leakages and adulteration, incentivize domestic producers and facilitate sustainability-based product differentiation.

The policy space for promoting healthy, sustainable oil consumption in India

Following our value chain analysis, we have analysed the policy space for the promotion of healthy sustainable oil consumption in India, identifying opportunities and challenges given by the historical, international and political context, the agenda-setting circumstances or policy processes and the characteristics of existing interventions.

Opportunities for the promotion of healthy, sustainable oil consumption

- Contextual factors: Overall, the promotion of healthy, sustainable fat consumption is supported by the increased recognition of NCD prevention and climate adaptation and mitigation as national priorities. This has been articulated though multi-sectoral policy frameworks which explicitly include the oilseed sector, and the reduction of saturated and trans fat consumption among their key objectives (Ministry of Health and WHO, 2016), (Ministry of Agriculture, 2014b).
- Policy process and influence of non-state actors: The existence of structures for sectoral policy coordination, historically aimed at market monitoring and intervention, can facilitate the adoption of coherent strategies for sustainable nutrition.

  The increased role of health actors in the oils sector, and the existence of a supportive environment for the translation of nutrition evidence into practice are also facilitating factors. We also find an increased engagement of sustainability advocates, who exert their influence mainly through their alignment with corporate actors in the oil processing industry. Additionally, emergent rights-based civil society movements, although mainly focussed on food security and livelihoods (Pande and P Houtzager, 2016) could provide an important support for the inclusion of local edible oils into PDS, shifting away from reliance on palm oil for food security interventions.
- Characteristics of key existing interventions in the sector: Current state-led agricultural interventions in the oilseed sector, focussing on small-holders, provide opportunities for the adoption of nutrition-sensitive approaches in the promotion of inter-cropping, crop rotation or variety-improvement.

Challenges for the promotion of healthy, sustainable oil consumption

- Contextual barriers: The space for intervention is shaped by the increasing constraints to trade policy imposed by international trade agreements, as well as a by stark division of powers across state and central government which can complicate the implementation of key policies throughout the sector including agricultural intervention, regulations on processing and packaging or distribution policies.
- Policy process and influence of non-state actors: We find that policies for sustainable, healthy oil consumption can be constrained by a historical mandate to a promote food security in the oils sector (understood as price stability and calorie provision). This constraint is reinforced by important perceived trade-offs across the promotion of healthy fat consumption, food security and sustainability objectives with regards to oil imports.

  Furthermore, we find that advocates for sustainability and nutrition tend to focus on different segments of the value chain, with sustainability-oriented actors focussing on upstream segments while nutrition advocates tend to focus on downstream interventions.

- Characteristics of key existing interventions in the sector: The distribution of economic impacts of key policies in the sector such as agricultural promotion, tariff-setting or public distribution can constitute an important challenge, determining the acceptability and implementation of specific interventions. Regional distribution of impacts and effects on organised industry stakeholders are crucial elements.

Overall, our findings highlight the importance of identifying synergistic interventions, as part of a sector-wide agenda for sustainable nutrition. This approach, going beyond siloed advocacy and intervention, can leverage existing structures for policy coordination, incorporate sustainable nutrition goals within existing interventions and increase the influence of both nutrition and sustainability advocates. Finally, careful consideration of the interaction between proposed interventions and broader sectoral priorities regarding self-sufficiency, food security, regional development and the protection of domestic producers is likely to be crucial for the successful adoption and implementation of policies to promote healthier, sustainable oil consumption.

Quantitative policy analysis: The economic and nutritional impacts of tariff changes in the vegetable oils sector

In our quantitative analysis, we assess the economic and nutritional impacts of changes on palm oil tariffs. We interpret the results from the point of view of the effects of liberalisation, as well as from the perspective of tariffs as a potential intervention to promote healthy fat consumption. In this sense, our study connects to the literature on health-oriented food taxation (Basu et al., 2013). Although this literature generally refers to sales taxes, this is similar to our case, given that we are referring to a commodity where domestic production represents less than 2% of overall supply. As is frequent in CGE analysis, we mainly discuss the sign and relative magnitude of impacts and their sensitivity to key behavioural parameters, comparing across policy scenarios. The use of a multi-sectoral macroeconomic model captures some mechanisms driving economic and nutritional effects, related to inter-sectoral linkages and general equilibrium mechanisms, which are not apparent in partial equilibrium analysis:

Nutritional impacts

Our model corroborates the findings from previous research (Basu et al., 2013), finding that taxation of palm oil leads to modest reductions in saturated fat intakes, and substitution towards healthier, unsaturated fats . Additionally, there are small decreases in the energy from fats and the contribution of processed foods to total energy intake.

However, we also find that higher (lower) palm oil tariffs can lead to small increases (decreases) in trans fatty acid consumption. This finding is robust to sensitivity analysis, except for the most extreme scenario where we assume no substitution across oils and the magnitude of the effect depends crucially on the capacity of the food processing industry to substitute across oil inputs (the higher the degree of substitution, the larger the increases in TFA). Overall impacts are very small, although highly variable across households, suggesting they might be significant for segments of population highly exposed to vanaspati and processed food. Impacts are reduced by more than 50% if we assume that the regulatory limits on the TFA content of vanaspati are effectively implemented (FSSAI, 2013b).

Nutritional effects vary considerably across household categories in our model. In our model, this is driven not only by initial levels of oil consumption but also by other broad differences in dietary patterns, such as the contribution of processed foods to overall calories or the proportion of saturated fats obtained from vegetable oils. Nutritional impacts are larger for urban households overall, as well as for specific household categories, both rural and urban, which is consistent with the existence of occupation-related dietary patterns in relation to processed food, for example.

Sensitivity to elasticity of substitution parameters also varies across household categories. For example, input substitution slightly reinforces the nutritional impacts of palm oil tariffs. The sensitivity to this parameter is particularly large for specific household categories, for whom policy impacts can depend more on the behaviour of the food processing industry than on their own substitution behaviour. Overall, we find that ignoring input substitution could bias estimates of the distribution of tariff impacts.

Tariff reduction shows effects of the opposite sign to tariff increase for all relevant variables, but of impacts are steeper. There is a shift from unsaturated towards saturated fats, as well as a small decrease in trans fat consumption, as liberalisation of palm oil imports allows for a shift away from hydrogenated fats. Again, the latter impact is small, although highly variable across households and dependent on whether the regulatory limits on TFA in PHVO are implemented.

Economic Impacts

Increased tariff rates (reduction) lead to (relatively small) economic losses (gains) at an aggregate level, reflected in reduced domestic absorption, lower real wages and returns to capital and reduced household income, which in turn leads to slightly lower private consumption and saving. These impacts reflect an aggregate efficiency loss from increased taxation, as economic agents react to distorted prices.

We also find that increases (reductions) in palm oil tariffs tend to have a positive (negative) economic impact on oilseed producers and on the PHVO industry, while leading to losses for the food processing sector.

Sectoral economic impacts, although potentially important, depend on assumptions regarding input substitution. The possibility of product reformulation in food processing can mitigate the economic impacts of tariff and reinforces the positive impacts on the partially hydrogenated sector, which can benefit from high tariff barriers, suffering losses as a result of liberalisation.

As with all fiscal policy, another important economic impact of tariffs is related to revenue generation. As expected, these revenues are larger when consumers and food industry do not substitute across edible oils. We only find a "Laffer curve" (a net fall in government revenues beyond a certain tax increase) for the highest end of the substitution range.

The effects of tariff removal in our model are of opposite sign to those of tariff increases for all relevant economic variables, but proportionately larger, showing some degree of asymmetry.

Revenue-neutral subsidies on healthier oils

The combination of palm oil tariffs with revenue-neutral subsidies on other oils slightly reinforces reductions in saturated fat intake without increasing trans fat consumption, while mitigating aggregate and sectoral economic losses. From a nutritional point of view, at least, the introduction of compensatory subsidies could be advantageous, while having at least some positive economic impacts.

Our results show the potential for positive nutritional impacts from palm oil tariffs, but also the potential trade-offs involved, in terms of economic impacts, as well as nutrition side-effects whose impact might depend on regulation in other segments of the value chain. Regarding aggregate economic costs, it is important to bear in mind that dietary changes could potentially reduce the burden of NCD, creating a positive externality and leading to economic gains which are not incorporated in our model. Nevertheless, and although policy decisions are made in a second-best context where the introduction of additional distortions does not always decrease efficiency (Lipsey and Lancaster, 1956) the potential efficiency losses associated to fiscal food policy, although frequently neglected in the literature on health-oriented food taxes, could deserve more attention.

Finally, although our discussion focusses on the direction of effects, and the comparison across policy scenarios and assumptions, it is worth remembering that our results are conservative and most likely provide a lower bound for effects, as discussed in Section 10.2.

11.2.1 Methodological contributions

Table 11-1. Methodological contributions

We combine qualitative and quantitative methods which are usually employed separately (value chain analysis, analysis of the policy space and CGE modelling) and show that they can be highly complementary.
We apply qualitative value chain analysis for sustainable nutrition, showing potential to identify common structural causes for sustainability and nutrition issues, pointing towards potential synergies
We illustrate the potential of multi-sectoral CGE modelling as a tool for nutrition-sensitive analysis of trade policy analysis applied to NCD-related health outcomes, reflecting sectoral and aggregate economic impacts, as well as nutrient intake both through unprocessed (or primary processed) food commodities and through processed food.

In our qualitative analysis we have followed a pragmatic approach (Johnson and Onwuegbuzie, 2004). We have chosen the methods that could best contribute to our understanding of the topic and to answering the research questions in a way that was complementary to our quantitative approach. We have relied on methods that have been applied to similar settings or topics (Hawkes, 2009), (Downs et al., 2014a), (Downs et al., 2015), (Thow et al., 2016). We briefly comment here on the way in which these methods have been adapted and combined to our research topic and point out some insights gained in this process.

First, our value chain analysis is based on the framework developed by Hawkes (2009) for nutrition-oriented value chain analysis. This is a consumption-oriented framework, and therefore we have had to adapt it slightly to incorporate environmental sustainability dimensions. Hawkes (2009) analyses how sectoral characteristics and incentives affect marketing, pricing and availability as mediators of nutrition outcomes. In addition, we incorporate sourcing and agricultural practices as mediators of key sustainability issues. In order to contextualize our analysis, we have first identified key dimensions of sustainable nutrition security in the Indian edible oils sector based on the literature, following the structured multi-dimensional definition of sustainable nutrition security (SNS) provided by (Gustafson et al., 2016).

We then analyse how value chain characteristics and incentives can create synergies and trade-offs across nutrition and sustainability outcomes of interest. Environmental impacts in other steps of the value chain, such as milling, processing, packaging or distribution are not analysed, or systematically compared with alternative crops. By identifying common structural characteristics related to both nutrition and sustainability challenges, this framework allowed us to identify potential synergies and areas of intervention. Although we find that it would not be sufficient on its own to generate policy recommendations, this type of approach can be useful in combination with other methodologies and can contribute to an understanding of sectoral challenges from the perspective of sustainable nutrition and highlight areas of intervention where there are apparent synergies, particularly in cases where there are pre-identified sustainable nutrition outcomes of interest.

In our case, VCA has been combined with a framework for policy space analysis, as well as with our quantitative methodology, and has helped us focus our analysis and interpret our findings within a coherent understanding of sectoral structure.

The methodology for policy space analysis applied in this thesis was designed to inform policy analysis in developing countries (Grindle and Thomas, 1991), without a specific focus on health, nutrition or sustainability. Its application to the area of nutrition is relatively recent (Thow et al., 2016). Like Thow et al. (2016) we find that the use of this framework is helpful in exploring barriers and opportunities for policy intervention, allowing us to analyse and explain “good policy making”. In particular, the application to sectoral policy analysis in combination with a value chains framework can provide an understanding of the interaction between technological, financial and organizational factors and policy priorities, and processes.

The main aim of our quantitative simulations is to act as a policy "thinking tool", providing useful insights into the potential impacts of alternative policy interventions from a multi-sectoral, general equilibrium point of view (Taylor, 2016), (GTAP, 2011). However, the contributions of our quantitative analysis are, to a certain extent, methodological. We address issues which have been recognized as increasingly relevant but often neglected. This includes the role of food processing as a mediator of food policy impacts (Rutten et al. 2014), as well as the potential sectoral and macroeconomic impacts of health-oriented taxation and the role of product reformulation and substitution within groups in response to food taxes (Miao et al., 2012), which are often neglected in econometric analyses of food taxation.

Like Rutten et al. (2014), we capture nutrient intake from unprocessed (or primary processed) agricultural commodities, as well as through processed food and to households. While Rutten et al. (2014) develop a multi-purpose tool, we have developed a more specific application, focusing on saturated and trans fats and on a specific sector and policy intervention. From a methodological point of view, our approach constitutes a step in the direction of nutrition-sensitive analysis of food and food trade policy (Haddad, 2000). In that sense, our study serves as an illustration of the possibilities and limitations for the application of nutrition-sensitive multi-sectoral models to the assessment of NCD-related impacts of trade policy.

Finally, the combination of CGE modelling, value chains and policy analysis illustrates the potential of a mixed-methods approach using methodologies which are highly complementary, but seldom combined, and which contributes to a fuller and more nuanced interpretation of results.

Our study, nevertheless, has numerous limitations and involves some important assumptions, which have been identified throughout the analysis, and will be discussed in a separate section.

11.3 Limitations and further research

Most of the limitations mentioned in this section have already been discussed throughout the previous chapters and during the analysis of results. In this section we summarize the main limitations and their implications and suggest some areas for further research.

11.3.1 Qualitative analysis

One important limitation of the qualitative part of this study is its national scope, which excludes a detailed analysis of links with foreign markets and producers, which would require a global value chains or global production networks approach. Due to this limitation, we incorporate global sustainability only in terms of the incentives to reduce imports of unsustainable palm oil, either by shifting towards sustainable certified imports, or by reducing imports altogether, replacing them with potentially more sustainable domestic alternatives. We also comment on the existence of a margin for sustainable intensification and extension for oilseeds, as well as for replacement of other commercial crops, as it creates opportunities for synergistic intervention. However, given our qualitative, single country approach, we cannot comment on the degree of import substitution that could be achieved in a sustainable manner, leading to net environmental gains. This could be the subject of further research.

Furthermore, our methods and data allow us to analyse broad sectoral characteristics, incentives and policy processes in relation to nutrition and sustainability outcomes. However, many of the phenomena analysed, from oilseed cultivation to public distribution present important regional variations. We do not include sub-national actors, local dynamics or regional patterns in our study.

Finally, our focus on policy characteristics and policy space at a sectoral level limits the amount of detail that can be devoted to each policy area. Each of the areas and interventions discussed could be the object of a detailed analysis in itself. Our data, however, do not allow for detailed analysis of specific policy processes.

Further research could analyse this topic from a global or regional value chains perspective, or at a sub-national level, or could also include cost-benefit or qualitative analysis of specific interventions in the sector, from the perspective of sustainable nutrition.

11.3.2 Quantitative analysis

In the first place, we have discussed how the use of a CGE model involves limitations and assumptions regarding the productive structure and the behaviour of economic agents. Particularly, CGE models in principle assume fixed production structures, and competitive markets, where all agents are price-takers.

In addition, the baseline SAM dataset which reflects the approximate structure of the Indian economy and the edible oils sector is based on data from the years 2007/08 and 2009/10. The SAM, therefore, provides a snapshot of the Indian economy, based on the triangulation of several data sources, and does not reflect the most recent changes in production and consumption. This is another important limitation in the context of CGE models, where the Input-Output tables and other data necessary to construct a SAM are generally available with a considerable delay, particularly in the case of developing countries (Buetre et al., 2003). These limitations have been discussed in the "Methodology in Context" chapter and taken into account when interpreting results. In that sense, the results of CGE simulations cannot be understood as *"unconditional predictions but rather thought experiments about what the world would be like if the policy change had been operative in the assumed circumstances and year"* (GTAP, 2011). In our case, there have been substantial increases in palm oil consumption since 2007, as well as changes in sector structure, as discussed in the value chain analysis.

In addition to limitations related to the choice of a CGE modelling framework, we make a number of simplifying assumptions, which also need to be taken into account when interpreting our results. One important limitation concerns the potential food security impacts of changes in palm oil tariffs. We comment on the effects on food security-related variables including energy intake for the poorest household category in our database, including changes in food expenditure as a proportion of total household expenditure, or the contribution of cereals to overall food consumption. However, given that we do not carry out an analysis of consumption behaviour and impacts on the poverty line, these results do not adequately reflect potential food security impacts of these policies. An adequate assessment of food security would add considerable methodological complexity and is beyond the scope of our study. It is worth noting that Basu et al. (2013) find that a 20% tax on palm oil could have negative but small effects on food security for households on the poverty line.

The occupational household classification in our SAM, which we have chosen to maintain as provided in the original database (Pradhan et al., 2013), reflects important differences in the consumption of edible oils and, particularly, processed foods. However, it does not adequately capture the socioeconomic gradient in palm oil consumption which was identified by interviewees in our qualitative research as an important pattern of consumption. Although alternative household classifications based on region or income levels might have provided interesting information, their additional value would have been hampered by the lack of detailed data on consumption of imported oils at a household level.

Furthermore, we do not include a detailed analysis of the agricultural oilseeds sector, including differences in labour use and skill mix and land productivity, which are to a large extent related to regional variations. We also do not incorporate constraints such as water use, which are determinant in explaining the evolution of the domestic oilseeds sector. For a more detailed analysis of these policies, the reader can refer to (Jha et al., 2012).

Moreover, we use a simplified approach to demand modelling, defining a two-stage budgeting model, with an LES at the top level and a CES at the bottom level. This approach has been used previously in CGE models (Aasness and Holtsmark, 1993), due to its relative simplicity and its capacity to reflect consumer behaviour at different levels of disaggregation. In this case, this decision is driven both by data limitations and by practical considerations, keeping in mind the purpose of our analysis as well as model complexity. This functional form allows us to reflect consumer behaviour regarding close substitute food products (different edible oils). Additionally, the second-level CES structure facilitates the sensitivity analysis over key elasticity of substitution parameters. Nevertheless, this demand model involves some strong assumptions (See SAM and nutritional data chapter). The top level LES imposes constant income elasticity of demand and assumes limited substitution across large food groups. Meanwhile, the CES specification assumes homotheticity in the second stage, and a constant rate of substitution across edible oils. Although these assumptions are not realistic, they produce reasonable results, which are comparable in size to those of previous studies which use more sophisticated demand models (Basu et al., 2013). Further research could incorporate more realistic demand models involving, for example, the specification of a two-level AIDS or QUAIDS demand system (Deaton and Muellbauer, 1980b). However, it is worth noting that the incorporation of an AIDS system of demand in the CGE framework comes at the expense of adding a considerable degree of complexity to an already complex model. This complexity needs to be traded off against gains in accuracy or explanatory capacity, in light of the important data limitations that result from current oil consumption patterns discussed elsewhere (consumption of most of palm oil in blends and for food processing out of the house, and high degrees of adulteration).

Our design of policy instruments has also been simplified, in line with our analysis and aims. For example, the Indian government has recently maintained a gap between tariff rates for crude and raw oil. We do not disaggregate between crude and raw oil in our model and consider a single tariff rate for each oil commodity.

Another important limitation concerns our assumption that India is a "small country", or a "price taker" when it comes to palm oil imports. In practice, world prices of palm oil are affected by many factors which can include demand fluctuations in the large importing countries, along with many other factors such as energy and biofuel prices, global soybean markets and movements in financial markets commodity derivatives (Basiron, 2002) (Mekhilef et al., 2011).

Finally, in order to simplify our approach, we have adopted a static model. Our analysis, therefore, compares two snapshots; before and after the intervention, assuming that all changes occur immediately, or at once. The use of a static model, in principle, precludes the estimation of health impacts, such as cardiovascular disease, stroke or diabetes, which occur over time. Moreover, a static model cannot reflect processes of capital accumulation. This can be of importance for the expansion of home production and needs to be considered when comparing the short term and medium to long-term effects of liberalisation. In this sense, our analysis can perhaps better reflect medium term impacts of liberalisation, or the effects of tariff fluctuations when domestic capacity has already expanded and does not impose a constraint on expansion as a response to protection.

Further research is needed in order to analyse regional trade dynamics in a multi-country modelling framework and incorporate more detailed demand modelling. Further extensions to this model are also needed to estimate health and environmental effects as well as their potential feedbacks into the economy. Some of these issues are being addressed by researchers involved in this study, in the context of the Palm Oil Sustainability, Health and Economic aspects (POSHE) project (POSHE, n.d.).

11.4 Policy recommendations

Box 11-1. Policy recommendations

Our results suggest that, although palm oil tariffs could be used as a tool to promote healthier oil consumption, there are potential trade-offs involved. A cautious approach would be recommended, therefore in the use of tariffs for as a nutrition-oriented intervention. We can make the following recommendations:

- We would recommend routine assessment of the nutritional impacts of edible oil trade policy, considering the double-burden of malnutrition perspective, and incorporated into the decision-making process.
- We would recommend that interactions between trade policy and regulation in other segments of the value chain (oil processing, hydrogenation, labelling etc.) are analysed in order to support policy coherence and avoid unexpected nutritional side-effects of trade policy.
- We would recommend that compensatory measures are implemented when palm oil tariffs are increased, in order to mitigate negative economic impacts, while reinforcing the nutritional benefits. Revenue-neutral subsidies, using tariff revenues, are a possibility, but interventions targeted towards highly exposed groups could also be considered.
- Differential tariffs to promote healthier, sustainable oil could be considered as part of a sectoral agenda for sustainable nutrition including interventions targeting the agricultural segment, out-of-home food environments and food-security oriented distribution policies.

As our study, and others before, have highlighted (Dohlman et al., 2003),(Downs et al., 2015) liberalisation has been only one of the elements driving a shift towards imported oils and the associated nutritional patterns and economic effects. Trade policy itself, in turn, has been conditioned by various sectoral constraints. Our recommendations in this section can be interpreted in the context of such constraints, and of previous proposals regarding health-oriented palm oil taxation (Basu et al., 2013), (Shankar and Hawkes, 2013). Given the frequent tariff adjustments in the sector, and the potential for associated nutrition impacts, the inclusion of routine analysis of nutrition impacts with a double-burden of NCD focus could perhaps be a first step in the direction of more nutrition-sensitive trade policy. This approach could highlight the role of regulations in other segments of the value chain which mediate nutritional impacts of tariffs (such as the trans fat ban, or other regulation concerning cultivation, processing or packaging), supporting policy coherence.

Based on our results, we can also point towards the introduction of compensatory policies to mitigate potential trade-offs, in terms of economic impacts or nutritional side-effects. We have explored the use of tariff revenues to subsidise healthier oils, but other options might present advantages. Given the uneven policy impacts across household categories, targeted compensatory interventions might be appropriate, including targeted distribution, but also interventions on specific food environments which could be associated to high exposure (schools, street food etc.) Moreover, targeted interventions could also mitigate potential impacts on food security (Basu et al., 2013), which we do not capture in our quantitative model, where we do not analyse effects on the poverty line.

From the perspective of sustainability, our qualitative analysis suggests that tariffs are a potentially relevant instrument to increase incentives for sustainable oil imports, which could also be acceptable to stakeholders. This suggests the existence of an opportunity to use tariffs and their combination with compensatory interventions as an instrument to address two of the most pressing challenges in the sector, potentially improving both nutrition and sustainability outcomes

As our qualitative research has highlighted, however, a restrictive import policy by itself, besides its potential trade-offs, would fail to address existing constraints in other areas of the value chain. Differential tariffs on oil imports could perhaps be combined with interventions in other segments of the value chain, as part of a sectoral agenda for sustainable nutrition. Other interventions could include climate-sensitive and nutrition-sensitive agricultural policies in the oilseed sector, which are already receiving increased funding and attention, interventions aimed at improving transparent oil sourcing for food processors and the use of tariff revenues to fund targeted distribution of healthier domestic oils to low-income households through PDS.

This approach would not necessarily involve a large number of new interventions or additional funds, but could leverage structures for sectoral policy coordination, adapting existing interventions to incorporate an explicit sustainable nutrition approach throughout the value chain.

11.5 Conclusion

Throughout this thesis we have analysed trade policy in the Indian edible oils sector, from the point of view of nutritional and economic impacts and as a potential tool for the promotion of healthier, sustainable oil consumption.

This study has combined methodologies such as qualitative value chain analysis and analysis of the policy space with multi-sectoral macroeconomic modelling. These approaches, although generally used separately, have proven highly complementary, providing relevant insights and allowing us to make some cautious recommendations for policy and further research. This research can also be seen as demonstrating an approach for nutrition-sensitive analysis of trade policy and for sectoral analysis of food policy where the interactions between economic and sustainable nutrition goals need to be considered.

In the context of a liberalised sector, dominated by price-driven imports, differential palm oil tariffs could perhaps be used as an intervention to promote healthier, sustainable oil consumption. In order to improve effectiveness and mitigate side-effects, this type of intervention could be used in combination with adequate context-sensitive compensatory measures, and as part of a wider agenda for sustainable nutrition, addressing structural constraints in different segments of the value chain.

This study involves several limitations in terms of data availability, as well as simplifying assumptions involved in modelling. Additionally, the findings in this thesis are limited by an exclusively national scope. Further research is needed in order to analyse the links with trade policy in supplying countries and the potential economic feedback effects from nutrition-related health outcomes, as well as to explore and compare various compensatory measures such as agricultural interventions or targeted oil distribution from the point of view of sustainable nutrition.

References

Aasness, J., Holtsmark, B., 1993. Consumer demand in a general equilibrium model for environmental analysis. Central Bureau of Statistics.

Adhana, D.K., 2016. Foreign Direct Investment in Indian Agricultural Sector: Opportunities and Challenges. KAAV Int. J. Econ. Bus. Manag.

Agus, F., Gunarso, P., Sahardjo, B.H., Harris, N., van Noordwijk, M., Killeen, T.J., 2013. Historical CO2 emissions from land use and land use change from the oil palm industry in Indonesia, Malaysia and Papua New Guinea. Roundtable Sustain. Palm Oil Kuala Lumpur.

Aide, T.M., Grau, H.R., 2004. Globalisation, migration, and Latin American ecosystems. Science 305, 1915–1916.

Allison, G.T., Graham, A., 1999. Essence of decision.

Alarcon, P., Fèvre, E.M., Murungi, M.K., Muinde, P., Akoko, J., Dominguez-Salas, P., Kiambi, S., Ahmed, S., Häsler, B., Rushton, J., 2017. Mapping of beef, sheep and goat food systems in Nairobi—A framework for policy making and the identification of structural vulnerabilities and deficiencies. Agricultural systems 152, 1–17.

Alonso-Fradejas, A., Liu, J., Salerno, T., Xu, Y., 2016. Inquiring into the political economy of oil palm as a global flex crop. J. Peasant Stud. 43, 141–165.

Al-Riffai, P., Dimaranan, B., Laborde, D., others, 2010. Global trade and environmental impact study of the EU biofuels mandate. IFPRI Washington, DC.

Amīn, S., 1977. Imperialism and unequal development. New York: Monthly Review Press.

Anania, G., 2013. Agricultural Export Restrictions and the WTO. Int. Cent. Trade Sustain. Dev. Issue Pap.

Anderson, K., Ivanic, M., Martin, W.J., 2014. Food price spikes, price insulation, and poverty, in: The Economics of Food Price Volatility. University of Chicago Press, pp. 311–339.

Anderson, K., Jackson, L.A., 2005. Some implications of GM food technology policies for Sub-Saharan africa. J. Afr. Econ. 14, 385–410. https://doi.org/10.1093/jae/eji013

Anderson, K.J., 2005. Genetically Modified Rice Adoption: Implications for Welfare and Poverty Alleviation. J. Econ. Integr.

Aneja, R., Krishna, K., Phansalkar, S., Gulati, V., 1992. Oilseed and vegetable oil economy of India: Sectoral policy issues, INSTITUTE OF RURAL MANAGEMENT ANAND. ed.

Aradhey, 2016. Oilseeds and Products Update (No. IN6144). GAIN.

Arndt, C., Robinson, S., Tarp, F., 2002. Parameter estimation for a computable general equilibrium model: a maximum entropy approach. Econ. Model. 19, 375–398.

ASA, 2017. ASA Welcomes Approval of Soybean Oil Heart Health Claim [WWW Document]. URL https://soygrowers.com/asa-welcomes-approval-soybean-oil-heart-health-claim/ (accessed 10.30.17).

ASEAN, 2016. ASEAN Investment Report 2016 Foreign Direct Investment and MSME Linkages.

Australian Government, 2009. ASEAN- Australia New Zealand Free Trade Agreement. Fact Sheet-Dairy Products.

Bachani, D., 2017. National Multi-sectoral Action Plan for Prevention & Control of NCDs in India.

Baker, P., Friel, S., 2014. Processed foods and the nutrition transition: evidence from Asia. Obes. Rev. 15, 564–577.

Baker, P., Friel, S., Schram, A., Labonte, R., 2016. Trade and investment liberalisation, food systems change and highly processed food consumption: a natural experiment contrasting the soft-drink markets of Peru and Bolivia. Glob. Health 12. https://doi.org/10.1186/s12992-016-0161-0

Baker, Phillip, Kay, A., Walls, H., 2014. Trade and investment liberalisation and Asia's noncommunicable disease epidemic: a synthesis of data and existing literature. Glob. Health 10. https://doi.org/10.1186/s12992-014-0066-8

Baker, P., Kay, A., Walls, H., 2014. Trade and investment liberalisation and Asia's noncommunicable disease epidemic: a synthesis of data and existing literature. Glob. Health 10.

Baldwin, R.E., 2011. 21st Century Regionalism: Filling the gap between 21st century trade and 20th century trade rules.

Balma, L.C., 2010. Simulation of the Effects of the Economic Crisis and Response Policies on Children in West and Central Africa: the Case of Burkina Faso. PEP-MPIA Work. Pap. MPIA.

Banerjee, O.M., 2015. An Economy-Wide Analysis of Climate Change Impacts on Agriculture and Food Security in Bangladesh. Clim. Change Econ.

Banks, J., Blundell, R., Lewbel, A., 1997. Quadratic Engel curves and consumer demand. Rev. Econ. Stat. 79, 527–539.

Barlow, P., Labonte, R., McKee, M., Stuckler, D., 2018. Trade challenges at the World Trade Organization to national noncommunicable disease prevention policies: A thematic document analysis of trade and health policy space. PLoS medicine 15, e1002590.

Basiron, Y., 2002. Palm oil and its global supply and demand prospects. Oil Palm Ind. Econ. J. 2, 1–10.

Basu, S., Babiarz, K.S., Ebrahim, S., Vellakkal, S., Stuckler, D., Goldhaber-Fiebert, J.D., 2013. Palm oil taxes and cardiovascular disease mortality in India: economic-epidemiologic model. BMJ 347.

Becker, G.S., 2010. Sanitary and phytosanitary (SPS) concerns in agricultural trade.

Berg, A., Krueger, A.O., 2003. Trade, growth, and poverty: A selective survey. Presented at the Annual World Bank Conference on Development Economics, pp. 47–89.

Bezuneh, M., Yiheyis, Z., 2014. Has trade liberalisation improved food availability in developing countries? An empirical analysis. J. Econ. Dev. 39, 63.

Bhowmik, S.K., 2005. Street vendors in Asia: a review. Econ. Polit. Wkly. 2256–2264.

Blouin, C., Chopra, M., van der Hoeven, R., 2009. Trade and social determinants of health. The lancet 373, 502–507.

Borras Jr, S.M., Franco, J.C., Isakson, S.R., Levidow, L., Vervest, P., 2016. The rise of flex crops and commodities: implications for research. J. Peasant Stud. 43, 93–115.

Bouët, A., Decreux, Y., Fontagné, L., Jean, S., Laborde, D., 2008. Assessing applied protection across the world. Rev. Int. Econ. 16, 850–863.

Bowen, G.A., 2009. Document analysis as a qualitative research method. Qual. Res. J. 9, 27–40.

Breisinger, C., Ecker, O., 2014. Simulating economic growth effects on food and nutrition security in Yemen: A new macro-micro modeling approach. Econ. Model. 43, 100–113. https://doi.org/10.1016/j.econmod.2014.07.029

Brink, L., 2015. Policy space in agriculture under the WTO rules on domestic support.

Brownell, K.D., Warner, K.E., 2009. The perils of ignoring history: Big Tobacco played dirty and millions died. How similar is Big Food? Milbank Q. 87, 259–294.

Buchanan, J.M., Lee, D.R., 1982. Politics, time, and the Laffer curve. J. Polit. Econ. 90, 816–819.

Buchanan, J.M., Tollison, R.D., 1984. The Theory of public choice--II. University of Michigan Press.

Buetre, B.L., Rodriguez, G., Pant, H.M., 2003. Data issues in general equilibrium modelling. ABARE.
BV Mehta, 2014. Present and Prospect of Rice Bran Oil Development in India. Solvent Extractors Association of India, 2014. 1st IARBO symposium on safety, nutrition and health. Wuhan, China. https://storage.unitedwebnetwork.com/files
Byerlee, D., Falcon, W.P., Naylor, R.L., 2017. The Tropical Oil Crop Revolution. Oxford University Press.
C. Gopalan, B. v. Rama Sastri & S.C. Balasubramanian, 1989. Nutritive value of Indian foods.
National Institute of Nutrition, Indian Council of Medical Research
Carlson, K.M., Curran, L.M., Asner, G.P., Pittman, A.M., Trigg, S.N., Adeney, J.M., 2013. Carbon emissions from forest conversion by Kalimantan oil palm plantations. Nat. Clim. Change 3, 283–287.
Caswell, J.A., Ning, Y., Liu, F., Mojduszka, E.M., 2003. The impact of new labeling regulations on the use of voluntary nutrient-content and health claims by food manufacturers. J. Public Policy Mark. 22, 147–158.
CCEA, 2016. Minimum support prices for Kharif Crops 2016-2017. Press Information Bureau Government of India Cabinet Committee on Economic Affairs.
Central Statistical Organisation, n.d. Input-Output Transactions tables of India, National Account Statistics. Ministry of Statistics and Programme Implementation, Government of India.
Centre for Responsible Business, 2014. Responsible practices in the Indian Palm Oil Sector.
Cerra, V., Saxena, S.C., 2002. What caused the 1991 currency crisis in India? IMF Staff Pap. 395–425.
Chand, 2007. Agro-industries characterization and appraisal: Soybeans in India (No. Marketing and Finance working document 20:), Rome, Ital. Food and Agriculture Organization of the United Nations.
Chand, R., 2007. International trade, food security and the response to the WTO in South Asian countries. Food Secur. Indic. Meas. Impact Trade Openness 262–283.
Chang, H.-J., 2009. Rethinking public policy in agriculture: lessons from history, distant and recent. J. Peasant Stud. 36, 477–515.
Chaudhary, S., 1997. Government intervention and trends in the Indian oilseeds sector: An analysis of alternative policy scenarios.
Cockburn, J., Emini, A.C., Tiberti, L., 2014. Impacts of the global economic crisis and national policy responses on children in Cameroon. Can. J. Dev. Stud. 35, 396–418. https://doi.org/10.1080/02255189.2014.934212
Commission for Agricultural Costs and Prices, 2012. Price Policy for Copra. The 2013 season. Department for Cooperation and Agriculture, Ministry of Agriculture, Government of India, New Delhi.
Commissioner of Horticulture, Andhra Pradesh, 2014. OIL PALM DEVELOPMENT IN ANDHRA PRADESH. (Mini Mission –II (OIL PALM) Under National Mission on Oilseeds and Oil palm (NMOOP).
Coriakula, J., Moodie, M., Waqa, G., Latu, C., Snowdon, W., Bell, C., 2018. The development and implementation of a new import duty on palm oil to reduce non-communicable disease in Fiji. Globalization and health 14, 91.
Cornelsen, L., Green, R., Turner, R., Dangour, A.D., Shankar, B., Mazzocchi, M., Smith, R.D., 2015. What Happens to Patterns of Food Consumption when Food Prices Change? Evidence from A Systematic Review and Meta-Analysis of Food Price Elasticities Globally. Health Econ. 24, 1548–1559.
Costa-Font, J., Mas, N., 2016. 'Globesity'? The effects of globalisation on obesity and caloric intake. Food Policy 64, 121–132.
Cramb, R., McCarthy, J.F., 2016. The oil palm complex: Smallholders, agribusiness and the state in Indonesia and Malaysia. NUS Press.

CSO, Government of India, n.d. Annual Survey of Industries, Microdata Archive [WWW Document]. URL http://mail.mospi.gov.in/index.php/catalog/ASI#_r=&collection=&country=&dtype=&from=1975&page=1&ps=&sk=&sort_by=nation&sort_order=&to=2015&topic=&view=s&vk=

Cybex, n.d. HS codes for Indian trade data [WWW Document]. URL HS commodity codes http://www.cybex.in/imports-data-india/hs-code-1511.aspx

Danielson, Mike, 2015. Nutritious palm oil is non-GMO; great for families trying to eat clean [WWW Document]. Palm Oil Health Your Health Nutr. Resour. URL http://www.palmoilhealth.org/nutrition/nutritious-palm-oil-is-non-gmo-great-for-families-trying-to-eat-clean/ (accessed 6.2.18).

Del Rio, P., Howlett, M.P., 2013. Beyond the'Tinbergen Rule'in Policy Design: Matching Tools and Goals in Policy Portfolios.

de Souza, R.J., Mente, A., Maroleanu, A., Cozma, A.I., Ha, V., Kishibe, T., Uleryk, E., Budylowski, P., Schünemann, H., Beyene, J., 2015. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies.

de Soysa, I., de Soysa, A.K., 2017. Do Globalisation & Free Markets Drive Obesity Among Children and Youth? An Empirical Analysis, 1990-2013. Int. Interact.

Deaton, A., Muellbauer, J., 1980a. Economics and consumer behavior. Cambridge university press.

Deaton, A., Muellbauer, J., 1980b. An almost ideal demand system. Am. Econ. Rev. 312–326.

Del Ninno, C., Dorosh, P., Smith, L., 2003. Public policy, markets and household coping strategies in Bangladesh: Avoiding a food security crisis following the 1998 floods. WORLD Dev. 31, 1221–1238. https://doi.org/10.1016/S0305-750X(03)00071-8

Department of Commerce, 2017. Amendment in export policy of edible oils Notification No 43/ 2015-20.

Department of Commerce, GOI, n.d. Export Import Data Bank [WWW Document]. URL http://commerce.nic.in/eidb/icomq.asp

Department of Industrial Policy and Promotion, 2016. Consolidated FDI policy.

Dessus, S., O'Connor, D., 2003. Climate policy without tears: CGE-based ancillary benefits estimates for Chile. Environ. Resour. Econ. 25, 287–317. https://doi.org/10.1023/a:1024469430532

Devarajan, S., Robinson, S., 2002. The impact of computable general equilibrium models on policy. Presented at the a conference on "Frontiers in Applied General Equilibrium Modeling" Sponsored by the Cowles Foundation and held at Yale University, New Haven, CT, April, pp. 5–6.

DFPD, 2016. Annual Report 2015-16. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.

DFPD, 2015. Annual Report 2014-15. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.

DFPD, 2014. Annual Report 2013-14. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.

DFPD, 2013. Annual Report 2012-13. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.

DFPD, 2012. Annual Report 2011-12. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.

DFPD, 2011. Annual Report 2010-11. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.

DFPD, 2010. Annual Report 2009-10. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.

DFPD, 2009. Annual Report 2008-09. Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution.
Director General of Foreign Trade, 2008. Notification NO. 85/2007, DT. 17/03/2008 Ban on export of Edible Oils (Chapter 15).
Dithmer, J., Abdulai, A., 2017. Does trade openness contribute to food security? A dynamic panel analysis. Food Policy 69, 218–230.
Dixon, J., Omwega, A.M., Friel, S., Burns, C., Donati, K., Carlisle, R., 2007. The health equity dimensions of urban food systems. J. Urban Health 84, 118–129.
Dixon, P.B., Jorgenson, D.W., 2013. Handbook of Computable General Equilibrium Modeling: Volume 1A. Newnes.
Djokoto, J.G., 2012. Effects of foreign direct investment inflows into agriculture on food security in Ghana. J. Econ. Sustain. Dev. 3, 81–92.
Dohlman, E.N., Persaud, S., Landes, R., 2003. India's edible oil sector: Imports fill rising demand. US Department of Agriculture, Economic Research Service.
Dorni, C., Sharma, P., Saikia, G., Longvah, T., 2017. Fatty acid profile of edible oils and fats consumed in India. Food Chem.
Downs, Shauna M, Gupta, V., Ghosh-Jerath, S., Lock, K., Thow, A.M., Singh, A., 2013. Reformulating partially hydrogenated vegetable oils to maximise health gains in India: is it feasible and will it meet consumer demand? BMC Public Health 13, 1139.
Downs, S.M., Thow, A.M., Ghosh-Jerath, S., Leeder, S.R., 2015. Identifying the barriers and opportunities for enhanced coherence between agriculture and public health policies: improving the fat supply in India. Ecol. Food Nutr. 54, 603–624.
Downs, S.M., Thow, A.M., Ghosh-Jerath, S., Leeder, S.R., 2014a. Aligning food-processing policies to promote healthier fat consumption in India. Health Promot. Int. dat094.
Downs, S.M., Thow, A.M., Ghosh-Jerath, S., Leeder, S.R., 2014b. Developing interventions to reduce consumption of unhealthy fat in the food retail environment: a case study of India. J. Hunger Environ. Nutr. 9, 210–229.
Downs, Shauna M., Thow, A.M., Ghosh-Jerath, S., McNab, J., Reddy, K.S., Leeder, S.R., 2013. From Denmark to Delhi: the multisectoral challenge of regulating trans fats in India. Public Health Nutr. 16, 2273–2280. https://doi.org/10.1017/s1368980012004995
Dreher, A., 2006. Does globalisation affect growth? Evidence from a new index of globalisation. Appl. Econ. 38, 1091–1110.
Dreher, A., Gaston, N., 2008. Has globalisation increased inequality? Rev. Int. Econ. 16, 516–536.
Drewnowski, A., Hanks, A.S., Smith, T.G., 2010. International trade, food and diet costs, and the global obesity epidemic. Trade Food Diet Health Perspect. Policy Options 77–90.
Dreze, J., Khera, R., 2015. Understanding leakages in the public distribution system. Econ. Polit. Wkly. 50, 39–42.
Edgerton, D.L., 1997. Weak separability and the estimation of elasticities in multistage demand systems. American Journal of Agricultural Economics 79, 62–79.
Engel, 1895. Die Lebenskosten Belgischer Arbeiter-Familien Fruher and jetzt. Int. Stat. Inst. Bull. 9, pp. 1–74.
FAO, 1993. Public distribution system in India-evolution, efficacy and need for reforms. FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome.
FAO, n.d. FAOSTAT [WWW Document]. FAO UN Food Agric. Organ. URL http://www.fao.org/faostat/en/#home

Fattore, E., Bosetti, C., Brighenti, F., Agostoni, C., Fattore, G., 2014. Palm oil and blood lipid–related markers of cardiovascular disease: a systematic review and meta-analysis of dietary intervention trials. Am. J. Clin. Nutr. ajcn. 081190.
Francis, S., 2011. The ASEAN-India Free Trade Agreement: A sectoral impact analysis of increased trade integration in goods. Econ. Polit. Wkly. 46, 46–55.
Friel, Sharon, Gleeson, D., Thow, A.-M., Labonte, R., Stuckler, D., Kay, A., Snowdon, W., 2013. A new generation of trade policy: potential risks to diet-related health from the trans pacific partnership agreement. Glob. Health 9. https://doi.org/10.1186/1744-8603-9-46
Friel, S., Hattersley, L., Snowdon, W., Thow, A.-M., Lobstein, T., Sanders, D., Barquera, S., Mohan, S., Hawkes, C., Kelly, B., Kumanyika, S., L'Abbe, M., Lee, A., Ma, J., Macmullan, J., Monteiro, C., Neal, B., Rayner, M., Sacks, G., Swinburn, B., Vandevijvere, S., Walker, C., INFORMAS, 2013. Monitoring the impacts of trade agreements on food environments. Obes. Rev. 14, 120–134. https://doi.org/10.1111/obr.12081
FSSAI, 2016a. Fortification of Foods Regulation 2016. Ministry of Health and Family Welfare, Government of India.
FSSAI, 2016b. FSSAI Annual Report 2015/16. Ministry of Health and Family Welfare, Government of India.
FSSAI, 2013a. Food Product Standards and Food Additives second amendment Regulations, 2013 (relating to trans fatty acid). Ministry of Health and Family Welfare, Government of India.
FSSAI, 2013b. Regulation of Trans Fatty Acids (TFA) in Partially Hydrogenated Vegetable Oils (PHVO) F. NO. P 15014/1/2011/-PFA/FSSAI. Ministry of Health and Family Welfare, Government of India.
FSSAI, 2013c. Food Safety and Standards Amendment Regulations No. 15014/1/2011/-PFA/FSSAI. Ministry of Health and Family Welfare, Government of India.
FSSAI, 2011a. Food Safety and Standards Prohibition and Restriction on Sales Regulation 2011 and FAQ. Ministry of Health and Family Welfare, Government of India.
FSSAI, 2011b. Food Safety and standards (Packaging and Labelling) regulation, 2011. Ministry of Health and Family Welfare, Government of India.
FSSAI, 2011c. Food Safety and Standards (Prohibition and Restrictions on Sales Regulations 2011). Ministry of Health and Family Welfare, Government of India.
FSSAI, ND. Proposed Regulation of Trans Fatty Acids (TFAs) in Partially Hydrogenated Vegetable Oils (PHVOs). Ministry of Health and Family Welfare, Government of India.
Gacitua, E.A., Bello, R., 1991. Agricultural exports, food production, and food security in Latin America. Rural Sociol. 56, 391–405.
Gaiha, R.K., 2012a. Has Dietary Transition Slowed Down in India: An analysis based on 50th, 61st and 66th Rounds of NSS. Aust. Natl. Univ. Aust. South Asia Res. Cent. ASARC Work. Pap.
Gaiha, R.K., 2012b. Diet Diversification and Diet Quality in India: An Analysis. Res. Inst. Econ. Bus. Adm. Kobe Univ. Discuss. Pap. Ser. DP2012-30.
GAIN, 2017a. Oilseeds and Products Annual. USDA, United States Department of Agriculture, Foreign Agricultural Service, New Delhi.
GAIN, 2017b. India's Food Processing Sector Poised for Growth (No. IN7150). USDA, United States Department of Agriculture, Foreign Agricultural Service, New Delhi.
GATT, 1994. Article XII Restrictions to Safeguard the Balance of Payments.
Gelli, A., Hawkes, C., Donovan, J., Harris, J., Allen, S.L., De Brauw, A., Henson, S., Johnson, N., Garrett, J., Ryckembusch, D., 2015. Value chains and nutrition:

A framework to support the identification, design, and evaluation of interventions.
Gereffi, G., 2001. Beyond the Producer-driven/Buyer-driven Dichotomy The Evolution of Global Value Chains in the Internet Era. IDS Bull. 32, 30–40.
Gereffi, G., Humphrey, J., Sturgeon, T., 2005. The governance of global value chains. Rev. Int. Polit. Econ. 12, 78–104.
Gereffi, G., Lee, J., Christian, M., 2009. US-based food and agricultural value chains and their relevance to healthy diets. J. Hunger Environ. Nutr. 4, 357–374.
Ghafoorunissa, G., 2008. Role of trans fatty acids in health and challenges to their reduction in Indian foods. Asia Pac. J. Clin. Nutr. 17 Suppl 1, 212–5.
Ghosh, A., 2007. Anthropometric, metabolic, and dietary fatty acids characteristics in lean and obese dyslipidemic Asian Indian women in Calcutta. Food Nutr. Bull. 28, 399–405.
Gillson, I., Fouad, A., 2015. Trade policy and food security: improving access to food in developing countries in the wake of high world prices. Washington, DC: World Bank.
Global Trade Analysis Project, Purdue University, n.d. GTAP 9 data base [WWW Document]. URL https://www.gtap.agecon.purdue.edu/databases/v9/
Godrej Industries, 2017. Sustainable Palm Oil. www.godrejindustries.com/Resources/.../Sustainably%20sourcing%20Oil%20 Palm
Golan, A., Judge, G., Robinson, S., 1994. Recovering information from incomplete or partial multisectoral economic data. Rev. Econ. Stat. 76, 541–49.
Goldar, B., 2005. Impact on India of Tariff and Quantitative Restrictions under WTO. Indian Counc. Res. Int. Econ. Relat. 172, 5–27.
Gorman, W.M., 1959. Separable utility and aggregation. Econom. J. Econom. Soc. 469–481.
Goryakin, Y., Lobstein, T., James, W.P.T., Suhrcke, M., 2015. The impact of economic, political and social globalisation on overweight and obesity in the 56 low and middle-income countries. Soc. Sci. Med. 133, 67–76. https://doi.org/10.1016/j.socscimed.2015.03.030
Government of India Archive, 1991. Technology Mission on Oilseeds and Pulses.
Grant, J.H., 2009. Triggers, remedies, and tariff cuts: assessing the impact of a special safeguard mechanism for developing countries. Estey Cent. J. Int. Law Trade Policy 10, 223.
Greene, J.C., Caracelli, V.J., Graham, W.F., 1989. Toward a conceptual framework for mixed-method evaluation designs. Educ. Eval. Policy Anal. 11, 255–274.
Greenfield, J., de Nigris, M., Konandreas, P., 1996. The Uruguay Round Agreement on Agriculture: food security implications for developing countries. Food Policy 21, 365–375.
Greenpeace India, 2012. Frying the forest. How india's use of palm oil is having a devastating impact on indonesia's rainforests, tigers and the global climate.
Grindle, M., Thomas, J., 1991. Public choices and policy change: The political economy of reform in developing countries. Johns Hopkins University Press, 1 Apr 1991 - Business & Economics
GTAP, 2011. GTAP Models: Computable General Equilibrium Modeling and GTAP [WWW Document]. URL https://www.gtap.agecon.purdue.edu/models/cge_gtap_n.asp
Gustafson, D., 2013. Sustainable Nutrition Security, what is it? Food Security Network of Newfoundland and Labrador (http://www.foodsecuritynews.com/What-is-food-security.htm)
Gustafson, D., Gutman, A., Leet, W., Drewnowski, A., Fanzo, J., Ingram, J., 2016. Seven Food System Metrics of Sustainable Nutrition Security. Sustainability 8, 196.

Haddad, L., 2000. A conceptual framework for assessing agriculture–nutrition linkages. Food Nutr. Bull. 21, 367–373.
Hagen-Zanker, J., Mallett, R., 2013. How to do a rigorous, evidence-focused literature review in international development. ODI Working and discussion papers.
Haggblade, S., 2008. Enhancing African Food Security through Improved Regional Marketing Systems for Food Staples. Policy Res. Agenda Common Mark. East. South. Afr. COMESA Mich. State Univ. East Lansing.
Hare, M., Pahl-Wostl, C., 2002. Stakeholder categorisation in participatory integrated assessment processes. Integr. Assess. 3, 50–62.
Hasegawa, T., Fujimori, S., Shin, Y., Takahashi, K., Masui, T., Tanaka, A., 2014. Climate Change Impact and Adaptation Assessment on Food Consumption Utilizing a New Scenario Framework. Environ. Sci. Technol. 48, 438–445. https://doi.org/10.1021/es4034149
Hawkes, C., 2016. Enhancing Coherence between Trade Policy and Nutrition Action.

Hawkes, C., 2009. Identifying innovative interventions to promote healthy eating using consumption-oriented food supply chain analysis. J. Hunger Environ. Nutr. 4, 336–356.
Hawkes, Corinna, 2006. Uneven dietary development: linking the policies and processes of globalisation with the nutrition transition, obesity and diet-related chronic diseases. Glob. Health 2. https://doi.org/10.1186/1744-8603-2-4
Hawkes, C., 2006. Uneven dietary development: Linking the policies and processes of globalisation with the nutrition transition, obesity and diet-related chronic diseases. Glob. Health 2. https://doi.org/10.1186/1744-8603-2-4
Hawkes, C., 2002. Marketing activities of global soft drink and fast food companies in emerging markets: a review. Glob. Diets Noncommunicable Dis. 1–78.
Hawkes, C., Ruel, M.T., 2012. Value chains for nutrition. Ed. Shenggen Fan Rajul Pandya-Lorch 73.
Hertel, S., 2015. Hungry for justice: Social mobilization on the right to food in India. Dev. Change 46, 72–94.
HFSS Working Group, 2015. Report of Working Group on Addressing Consumption of Foods High in Fat, Salt and Sugar (HFSS) and Promotion of Healthy Snacks in Schools of India. Ministry of Women and Child Welfare, Government of India.
Hindustan Unilever, 2017. Jurisdictional sourcing: A new approach for sourcing sustainable palm oil.
Hoda, A., Gulati, A., 2013. India's agricultural trade policy and sustainable development. ICTSD Issue Pap. 49.
Howlett, M., Rayner, J., 2007. Design principles for policy mixes: cohesion and coherence in 'new governance arrangements.' Policy and Society 26, 1–18.
Huang, S., 2004. Global trade patterns in fruits and vegetables.
Huneault, L., Mathieu, M., Tremblay, A., 2011. Globalisation and modernization: an obesogenic combination. Obes. Rev. 12.
Imbs, J., Méjean, I., 2016. Trade elasticities. Rev. Int. Econ.
Jacks, D.S., O'Rourke, K.H., Williamson, J.G., 2011. Commodity price volatility and world market integration since 1700. Rev. Econ. Stat. 93, 800–813.
Jakarta Globe, 2015. Sustainability Pledge Proves an Obstacle for Government Hungry for More Palm Oil.
Jenkins, J.C., Scanlan, S.J., 2001. Food security in less developed countries, 1970 to 1990. Am. Sociol. Rev. 718–744.
Jenkins, R., 2004. Globalisation, production, employment and poverty: debates and evidence. J. Int. Dev. 16, 1–12.
Jensen, H.T., 2000. SAM re-balancing program.

Jensen, H.T., Keogh-Brown, M.R., Smith, R.D., Chalabi, Z., Dangour, A.D., Davies, M., Edwards, P., Garnett, T., Givoni, M., Griffiths, U., 2013. The importance of health co-benefits in macroeconomic assessments of UK Greenhouse Gas emission reduction strategies. Clim. Change 121, 223–237.

Jensen, J.D., Smed, S., 2013. The Danish tax on saturated fat–Short run effects on consumption, substitution patterns and consumer prices of fats. Food Policy 42, 18–31.

Jha, G., Suresh Pal, V.C. Mathur, Geeta Bisaria, P. Anbukkani, R.R. Burman, S.K. Dubey, 2012. Edible Oilseeds Supply and Demand Scenario in India: Implications for Policy, Design and printed at: Venus Printers and Publishers,. ed. Indian Agricultural Research Institute Published by: Director, IARI., B-62/8, Naraina Industrial Area, Phase-II, New Delhi - 110 028 Ph. : 45576780, Mobile: 9810089097, E-mail: pawannanda@gmail.com.

Johnson, R.B., Onwuegbuzie, A.J., 2004. Mixed methods research: A research paradigm whose time has come. Educ. Res. 33, 14–26.

Kadiyala, S., Harris, J., Headey, D., Yosef, S., Gillespie, S., 2014. Agriculture and nutrition in India: mapping evidence to pathways. Ann. N. Y. Acad. Sci. 1331, 43–56.

Kanbur, R., 2015. Globalisation and inequality. Handb. Income Distrib. 2, 1845–81.

Kanter, R., Walls, H.L., Tak, M., Roberts, F., Waage, J., 2015. A conceptual framework for understanding the impacts of agriculture and food system policies on nutrition and health. Food Secur. 7, 767–777.

Kaplinsky, R., Morris, M., 2000. A handbook for value chain research. University of Sussex, Institute of Development Studies.

Khera, R., 2011. Revival of the public distribution system: evidence and explanations.

Khor, Y.L., 2011. The oil palm industry bows to NGO campaigns. Lipid Technol. 23, 102–104.

Khoury, C.K., Bjorkman, A.D., Dempewolf, H., Ramirez-Villegas, J., Guarino, L., Jarvis, A., Rieseberg, L.H., Struik, P.C., 2014. Increasing homogeneity in global food supplies and the implications for food security. Proc. Natl. Acad. Sci. 111, 4001–4006.

Konandreas, P., Greenfield, J., 1996. Uruguay Round commitments on domestic support: their implications for developing countries. Food Policy 21, 433–446.

Krugman, P., 2011. Callibration and all that wonkish. N. Y. Times.

Kumar, 2017. Food security and nutrition in India: the way forward. Vol 30 No1 January-June 2017 Pp 1-21. https://doi.org/DOI: 10.5958/0974-0279.2017.00001.5

Kumar, P., Kumar, A., Parappurathu, S., Raju, S., 2011. Estimation of Demand Elasticity for Food Commodities in India. Agric. Econ. Res. Rev. 24.

Kumar, R., Gautam, H.R., 2014. Climate change and its impact on agricultural productivity in India. J. Climatol. Weather Forecast. 2014.

Kumbla, D., Dharmalingam, M., Dalvi, K., Ray, S., Shah, M.K., Gupta, S., Sadhanandham, S., Ajmani, A., Nag, S., Murthy, S., 2016. A Study of salt and fat Consumption pattern in Regional Indian diet among hypertensive and dyslipidemic Patients-SCRIPT study. J Assoc Physicians India 64, 47–54.

L'Abbe, M.R., Stender, S., Skeaff, M., Ghafoorunissa, Tavella, M., 2009. Approaches to removing trans fats from the food supply in industrialized and developing countries. Eur. J. Clin. Nutr. 63, S50–S67. https://doi.org/10.1038/ejcn.2009.14

Labonte, R., Mohindra, K.S., Lencucha, R., 2011. Framing international trade and chronic disease. Glob. Health 7. https://doi.org/10.1186/1744-8603-7-21

Labonté, R., Schrecker, T., 2007. Globalisation and social determinants of health: Introduction and methodological background (part 1 of 3). Glob. Health 3, 5.

Lapola, D.M., Schaldach, R., Alcamo, J., Bondeau, A., Koch, J., Koelking, C., Priess, J.A., 2010. Indirect land-use changes can overcome carbon savings from biofuels in Brazil. Proc. Natl. Acad. Sci. 107, 3388–3393.

Lewbel, A., 2008. Engel curves. New Palgrave Dict. Econ. 2.

Lindblom, C.E., 1959. The science of" muddling through". Public Adm. Rev. 79–88.

Lipsey, R.G., Lancaster, K., 1956. The general theory of second best. Rev. Econ. Stud. 24, 11–32.

Lock, K., Smith, R.D., Dangour, A.D., Keogh-Brown, M., Pigatto, G., Hawkes, C., Fisberg, R.M., Chalabi, Z., 2010. Health, agricultural, and economic effects of adoption of healthy diet recommendations. The Lancet 376, 1699–1709.

Lofgren, H., Harris, R.L., Robinson, S., 2002. A standard computable general equilibrium (CGE) model in GAMS. Intl Food Policy Res Inst.

Mall, R., Singh, R., Gupta, A., Srinivasan, G., Rathore, L., 2006. Impact of climate change on Indian agriculture: a review. Clim. Change 78, 445–478.

Mallett, R., Hagen-Zanker, J., Slater, R., Duvendack, M., 2012. The benefits and challenges of using systematic reviews in international development research. J. Dev. Eff. 4, 445–455.

Malterud, K., Siersma, V.D., Guassora, A.D., 2016. Sample size in qualitative interview studies: guided by information power. Qual. Health Res. 26, 1753–1760.

Marshall, M.N., 1996. Sampling for qualitative research. Fam. Pract. 13, 522–526.

Matthews, A., 2014. Food security and WTO domestic support disciplines post-Bali. Geneva Int. Cent. Trade Sustain. Dev.

McCarthy, J.F., Cramb, R.A., 2009. Policy narratives, landholder engagement, and oil palm expansion on the Malaysian and Indonesian frontiers. Geogr. J. 175, 112–123.

McChesney, R.W., Schiller, D., 2003. The political economy of international communications: Foundations for the emerging global debate about media ownership and regulation. United Nations Research Institute for Social Development Geneva.

McConnell, G., 1966. Private power & American democracy. Cambridge Univ Press.

McCorriston, S., Hemming, D.J., Lamontagne-Godwin, J.D., Parr, M., Osborn, J., Roberts, P.D., 2013. What is the evidence of the impact of agricultural trade liberalisation on food security in developing countries. Syst. Rev. Lond. EPPI Cent. Univ. Lond.

MCI, 2015. De-Reservation of remaining 20 items reserved for Micro and Small Enterprises Sector.

McKitrick, R.R., 1998. The econometric critique of computable general equilibrium modeling: the role of functional forms. Econ. Model. 15, 543–573.

Meenakshi, J., 2016. Trends and patterns in the triple burden of malnutrition in India. Agric. Econ. 47, 115–134.

Mekhilef, S., Siga, S., Saidur, R., 2011. A review on palm oil biodiesel as a source of renewable fuel. Renew. Sustain. Energy Rev. 15, 1937–1949.

Mensink, R.P., Katan, M.B., 1992. Effect of dietary fatty acids on serum lipids and lipoproteins. A meta-analysis of 27 trials. Arterioscler. Thromb. Vasc. Biol. 12, 911–919.

Meyer, S., Yu, X., Abler, D.G., 2011. Comparison of several demand systems. Presented at the 2011 Annual Meeting, July 24-26, 2011, Pittsburgh, Pennsylvania, Agricultural and Applied Economics Association.

Miao, Z., Beghin, J.C., Jensen, H.H., 2013. Accounting for product substitution in the analysis of food taxes targeting obesity. Health Econ. 22, 1318–1343.

Miao, Z., Beghin, J.C., Jensen, H.H., 2012. Taxing sweets: sweetener input tax or final consumption tax? Contemp. Econ. Policy 30, 344–361.

Michail, N., 2016. French-MPs-drop-palm-oil-tax-but-accuse-producer-countries-of-blackmail.

Mihalache-O'keef, A., Li, Q., 2011. Modernization vs. Dependency Revisited: Effects of Foreign Direct Investment on Food Security in Less Developed Countries1. Int. Stud. Q. 55, 71–93.
Miljkovic, D., Shaik, S., Miranda, S., Barabanov, N., Liogier, A., 2015. Globalisation and Obesity. WORLD Econ. 38, 1278–1294. https://doi.org/10.1111/twec.12260
Ministry of Agriculture, 2017a. Price Support Scheme Operational Guidelines. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2017b. Oil Palm Scenario 2017. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2017c. Annual Report 2016-17. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2016. Annual Report 2015-16. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2015. Annual Report 2014-15. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2014a. National Mission on Oilseeds and Oil Palm, Operational Guidelines. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2014b. National Mission for Sustainable Agriculture Operational Guidelines. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2014c. Annual Report 2013-14. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Agriculture, 2013. Formula for the pricing of Fresh Fruit Bunches of Oil Palm. Ministry of Agriculture and Farmers Welfare, Government of India.
Ministry of Commerce & Industry, 2017. FDI in Food Processing Industries. Government of India
Ministry of Finance, 2016. Economic Survey 2016-17. Government of India.
Ministry of Health, WHO, 2016. Inter-ministerial Consultation on National Multisectoral Action Plan for Prevention and Control of NCDs in India. Ministry of Health and Family Welfare, Government of India.
Ministry of Law and Justice, 2013. The National Food Security Act.
Minot, N.W., 1998. Distributional and nutritional impact of devaluation in Rwanda. Econ. Dev. Cult. Change 46, 379–402.
Misra, A., Singhal, N., Sivakumar, B., Bhagat, N., Jaiswal, A., Khurana, L., 2011. Nutrition transition in India: Secular trends in dietary intake and their relationship to diet-related non-communicable diseases. J. Diabetes 3, 278–292. https://doi.org/10.1111/j.1753-0407.2011.00139.x
MOFPI, 2017a. World Food India: Transforming the food economy. Ministry of Food Processing Industries. Government of India.
MOFPI, 2017b. Opportunities in Cold Chain Sector in India. Ministry of Food Processing Industries, Delhi, India. . Ministry of Food Processing Industries. Government of India.
MOFPI, 2017c. Ministry of Food Processing Industries annual report, 2016-17. . Ministry of Food Processing Industries. Government of India.
Mogalakwe, M., 2006. The use of documentary research methods in social research. Afr. Sociol. Rev. 10, 221–230.
Monteiro, C., 2011. The big issue is ultra-processing. There is no such thing as a health ultra-processed product. World Nutr. 2, 7: 333-349. Obtainable at www.wphna.org.
Monteiro, C.A., Levy, R.B., Claro, R.M., de Castro, I.R.R., Cannon, G., 2010. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. Public Health Nutr. 14, 5–13.

Morgan, E.H., Hawkes, C., Dangour, A.D., Lock, K., 2018. Analyzing food value chains for nutrition goals. Journal of hunger & environmental nutrition 1–19.
Mozaffarian, D., 2011. The great fat debate: taking the focus off of saturated fat. J. Am. Diet. Assoc. 111, 665–666.
Mozaffarian, D., Micha, R., Wallace, S., 2010. Effects on coronary heart disease of increasing polyunsaturated fat in place of saturated fat: a systematic review and meta-analysis of randomized controlled trials. PLoS Med. 7, e1000252.
MPOC, n.d. Saturated Fats and Coronary Heart Disease [WWW Document]. MPOC Malays. Palm Oil Counc. URL http://www.mpoc.org.my/Saturated_Fats_and_Coronary_Heart_Disease.aspx (accessed 6.2.18).
Mujeri, M.K., Khandaker, B., 1998. Impact of Macroeconomic Policy Reforms in Bangladesh: A General Equilibrium Framework for Analysis. Presented at the Micro Impacts of Macroeconomic and Adjustment Policies (MIMAP), Third Annual Meeting, November, pp. 2–6.
Mulik, K., O'Hara, J.K., 2015. Cropland implications of healthier diets in the United States. J. Hunger 10, 115–131.
Nandi, A., Sweet, E., Kawachi, I., Heymann, J., Galea, S., 2014a. Associations Between Macrolevel Economic Factors and Weight Distributions in Low- and Middle-Income Countries: A Multilevel Analysis of 200 000 Adults in 40 Countries. Am. J. PUBLIC Health 104, E162–E171. https://doi.org/10.2105/AJPH.2013.301392
Nandi, A., Sweet, E., Kawachi, I., Heymann, J., Galea, S., 2014b. Associations Between Macrolevel Economic Factors and Weight Distributions in Low- and Middle-Income Countries: A Multilevel Analysis of 200 000 Adults in 40 Countries. Am. J. PUBLIC Health 104, E162–E171. https://doi.org/10.2105/AJPH.2013.301392
Narayanan, S., 2014. The National Food Security Act vis-à-vis the WTO agreement on agriculture. Econ. Polit. Wkly. 49, 41.
NASVI, 2017. National Association of Street Vendors of India [WWW Document]. URL http://nasvinet.org/newsite/about-nasvi/
Nayik, G.A., Majid, I., Gull, A., Muzaffar, K., 2015. Rice bran oil, the Future Edible Oil of India: A mini Review. Rice Res. Open Access 2015.
Nestle, 2010. Progress in the Nestlé TFT Palm Oil Project. www.tft-earth.org/wp-content/uploads/2015/01/Nestlé-progress-report
Neuman, M., Kawachi, I., Gortmaker, S., Subramanian, S.V., 2014. National Economic Development and Disparities in Body Mass Index: A Cross-Sectional Study of Data from 38 Countries. PLOS ONE 9. https://doi.org/10.1371/journal.pone.0099327
NHS, 2016. Report attacks official guidance on low-fat diets.
Noland, M., Robinson, S., Tao, W., 2001. Famine in North Korea: causes and cures. Econ. Dev. Cult. Change 49, 741–767.
Nordlinger, E., 1987. Taking the state seriously. Underst. Polit. Dev. 353–90.
NSSO, 2014. Nutritional Intake in India, 2011-2012 (No. 560). National Sample Survey Organization, Government of India.
NSSO, Government of India, 2012a. Nutritional Intake in India 2009 2010 (No. 540). National Sample Survey Organisation, Government of India.
NSSO, Government of India, 2012b. Household Consumer Expenditure Across Socio-Economic Groups Round 2009 2010. National Sample Survey Organisation, Government of India.
NSSO, Government of India, n.d. National Sample Survey Organization Household Consumer expenditure Survey, Round 66th [WWW Document]. URL https://data.gov.in/dataset-group-name/national-sample-survey

Oberländer, L., Disdier, A.-C., Etilé, F., 2016. Globalisation and national trends in nutrition and health-a grouped fixed-effects approach to inter-country heterogeneity.

Ogundari, K., Ito, S., 2015. Convergence and determinants of change in nutrient supply Evidence from sub-Saharan African countries. Br. Food J. 117, 2880–2898.

O'Mara-Eves, A., Brunton, G., McDaid, D., Kavanagh, J., Oliver, S., Thomas, J., 2014. Techniques for identifying cross-disciplinary and 'hard-to-detect'evidence for systematic review. Res. Synth. Methods 5, 50–59.

Paltsev, S., Viguier, L., Babiker, M., Reilly, J., Tay, K., 2004. Disaggregating household transport in the MIT-EPPA model, in: Joint Program on the Science and Policy of Global Change. Technical Note No. 5.

Pan, S., Mohanty, S., Welch, M., 2008. India edible oil consumption: A censored incomplete demand approach. J. Agric. Appl. Econ. 40, 821–835.

Panagariya, A., 2002. Trade and food security: Conceptualizing the linkages. Presented at the presentation at the Conference on Trade, Agricultural Development, and Food Security: The Impact of Recent Economic and Trade Policy Reform, Food and Agricultural Organization, Rome, July, Citeseer, pp. 11–12.

Panda, M., Ganesh-Kumar, A., 2009. Trade liberalisation, poverty, and food security in India. Intl Food Policy Res Inst.

Pande, S., P Houtzager, P., 2016. Civil Society Innovation and Resilience in the Struggle for the Right to Food in India.

Pant, K.P., 2014. The SAARC food bank for fod security in South Asia. South Asia Watch on Trade Economics and Environment (SAWTEE).

Pauw, K., Thurlow, J., 2011. Agricultural growth, poverty, and nutrition in Tanzania. Food Policy 36, 795–804. https://doi.org/10.1016/j.foodpol.2011.09.002

Pengue, W.A., 2005. Transgenic crops in Argentina: the ecological and social debt. Bull. Sci. Technol. Soc. 25, 314–322.

Persaud, S.C., Landes, M., others, 2006. The role of policy and industry structure in India's Oilseed markets. US Department of Agriculture, Economic Research Service.

Pingali, P., Khwaja, Y., 2004. Globalisation of Indian diets and the transformation of food supply systems. Indian J. Agric. Mark. 18, 2004.

Popkin, B.M., 2006a. Technology, transport, globalisation and the nutrition transition food policy. Food Policy 31, 554–569.

Popkin, B.M., 2006b. Technology, transport, globalisation and the nutrition transition food policy. Food Policy 31, 554–569.

Popkin, B.M., 2003. The nutrition transition in the developing world. Dev. Policy Rev. 21, 581–597.

POSHE, n.d. Palm oil sustainability, health and economics [WWW Document]. LSHTM SOAS Sustain. Health Proj. URL http://sustaininghealth.lshtm.ac.uk/poshe/

Pradhan, B.K., Saluja, M.R., Sharma, A.K., 2013. Social Accounting Matrix of India 2007 2008. IAG Work. Pap.

Press Information Bureau, 2017. Measures to increase oil palm area and production in India.

Rasiah, R., 2006. Explaining Malaysia's export expansion in palm oil and related products. Technol. Adapt. EXPORTS 163.

Reardon, T., Minten, B., 2011a. The quiet revolution in India's food supply chains. IFPRI Discussion Paper.

Reardon, T., Minten, B., 2011b. Surprised by supermarkets: diffusion of modern food retail in India. J. Agribus. Dev. Emerg. Econ. 1, 134–161.

Reddy, A.A., 2009. Policy Options for India's Edible Oil Complex. Econ. Polit. Wkly. 22–24.

Rival, A., 2017. The endless palm oil debate: Science-based solutions beyond controversies. Mod. Nutr. Today.
Robinson, 1991. Handbook of Development Economics Vol 2.
Robinson, S., Cattaneo, A., El-Said, M., 2001. Updating and estimating a social accounting matrix using cross entropy methods. Econ. Syst. Res. 13, 47–64.
Rosati, J.A., 1981. Developing a systematic decision-making framework: Bureaucratic politics in perspective. World Polit. 33, 234–252.
Roudometof, V., 2005. Transnationalism, cosmopolitanism and glocalization. Curr. Sociol. 53, 113–135.
RSPO, 2013. RSPO Supply Chain Certification: A primer.
Ruchi Soya Industries Ltd, 2016. From farm to Fork. Annual report 2015-16.
Ruel, M.T., Garrett, J.L., Haddad, L., 2008. Rapid urbanization and the challenges of obtaining food and nutrition security, in: Nutrition and Health in Developing Countries. Springer, pp. 639–656.
Rutten, M., Tabeau, A., Godeschalk, F.E., 2014. We are what we eat: An economic tool for tracing the origins of nutrients with entry points for action. LEI Wageningen UR, FOODSECURE project office.
Rutten, M., Tabeau, A., Godeschalk, F.E., 2013. A New Methodology for Incorporating Nutrition Indicators in Economy-wide Scenario Analyses. LEI Wageningen UR, FOODSECURE project office.
Sadoulet, E., De Janvry, A., 1995. Quantitative development policy analysis. Johns Hopkins University Press Baltimore.
Saini, K.S., Ahlawat, S., 2016. An Overview of Food Policy in India. Indian J. Appl. Res. 5.
Schleifer, P., 2016. Private governance undermined: India and the roundtable on sustainable palm oil. Glob. Environ. Polit.
Schmitt, N.M., Wagner, N., Kirch, W., 2007. Consumers' freedom of choice—advertising aimed at children, product placement, and food labeling. J. Public Health 15, 57–62.
Schneider, M.B., Benjamin, H.J., 2011. Sports drinks and energy drinks for children and adolescents: are they appropriate? Pediatrics 127, 1182–1189.
Schouten, G., Glasbergen, P., 2011. Creating legitimacy in global private governance: The case of the Roundtable on Sustainable Palm Oil. Ecol. Econ. 70, 1891–1899.
Schram, A., Labonte, R., Baker, P., Friel, S., Reeves, A., Stuckler, D., 2015. The role of trade and investment liberalisation in the sugar-sweetened carbonated beverages market: a natural experiment contrasting Vietnam and the Philippines. Glob. Health 11.
Scott-Thomas, C., 2012. French-MPs-drop-palm-oil-tax-but-accuse-producer-countries-of-blackmail.
Shama, R., 2011. Food export restrictions: review of the 2007-2010 experience and considerations for disciplining restrictive measures. FAO Rome.
Shankar, B., Hawkes, C., 2013. India has a problem with palm oil A substantial tax could be part of the solution. Bmj-Br. Med. J. 347. https://doi.org/10.1136/bmj.f6065
Shankar, B., Thaiprasert, N., Gheewala, S., Smith, R., 2017. Policies for healthy and sustainable edible oil consumption: a stakeholder analysis for Thailand. Public Health Nutr. 20, 1126–1134.
Shannon, C.E., 1948. A mathematical theory of communication. Bell Syst. Tech. J. 27, 379–423.
Shivakumar, K.M., Kombairaju, S., Chandrasekaran, M., others, 2007. Trade Policy Analysis of Edible Oil Imports of India under CGE Framework, in: Ecomod Conference Proceedings, 2007. Presented at the ECOMOD, Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, India.

Sims, L.S., 1998. The politics of fat: food and nutrition policy in America. M.E. Sharpe, Inc, NY.
Singh, A., Zammit, A., 2004. Labour standards and the 'Race to the Bottom': Rethinking globalisation and workers' rights from developmental and solidaristic perspectives. Oxf. Rev. Econ. Policy 20, 85–104.
Singh, R.B., Niaz, M.A., Ghosh, S., Beegom, R., Rastogi, V., Sharma, J.P., Dube, G.K., 1996. Association of trans fatty acids (vegetable ghee) and clarified butter (Indian ghee) intake with higher risk of coronary artery disease in rural and urban populations with low fat consumption. Int. J. Cardiol. 56, 289–298. https://doi.org/10.1016/s0167-5273(96)02760-x
Singh, S., 2015. India's Approach towards Bilateral, Regional and Multilateral Negotiations. CUTS Int. Dev. Pap.
Solidaridad, 2017. Indian Palm Oil Sustainability Framework. https://www.solidaridadnetwork.org/
Soon, G., Koh, Y.H., Wong, M.L., Lam, P.W., 2008. Obesity prevention and control efforts in Singapore. Wash. DC Cent. Health Aging.
Srinivasan, P., 2012. Impact of trade liberalisation on India's oilseed and edible oils sector. Report prepared for IGIDR-ERS/USDA Project: Indian Agricultural Markets and Policy, February 2005.
Stone, R., 1954. Linear expenditure systems and demand analysis: an application to the pattern of British demand. Econ. J. 64, 511–527.
Stuckler, David, McKee, M., Ebrahim, S., Basu, S., 2012. Manufacturing epidemics: the role of global producers in increased consumption of unhealthy commodities including processed foods, alcohol, and tobacco. PLoS Med. 9, e1001235.
Stuckler, D., McKee, M., Ebrahim, S., Basu, S., 2012. Manufacturing epidemics: the role of global producers in increased consumption of unhealthy commodities including processed foods, alcohol, and tobacco. PLoS Med. 9.
Stuckler, D., Nestle, M., 2012. Big food, food systems, and global health. PLoS Med. 9, e1001242.
Subramanian, S., Deaton, A., 1996. The demand for food and calories. J. Polit. Econ. 133–162.
Sudharsanan, N., Ali, M.K., Mehta, N.K., Narayan, K.M.V., 2015. Population aging, macroeconomic changes, and global diabetes prevalence, 1990-2008. Popul. Health Metr. 13. https://doi.org/10.1186/s12963-015-0065-x
Sun, Y., Neelakantan, N., Wu, Y., Lote-Oke, R., Pan, A., van Dam, R.M., 2015. Palm Oil Consumption Increases LDL Cholesterol Compared With Vegetable Oils Low in Saturated Fat in a Meta-Analysis of Clinical Trials. J. Nutr. jn210575.
Suneja, K., 2017. No breach of farm subsidy limits, India tells WTO. Econ. Times.
Sustainable Development Commission, 2007. You are what you sell: product roadmapping: driving sustainability.
Sutton, R., 1999. The policy process. Overseas Development Institute.
Tandon, S., Landes, M., 2012. Estimating the Range of Food-Insecure Households in India. US Department of Agriculture, Economic Research Service.
Taneja, N., Ray, S., Kaushal, N., Chowdhury, D.R., 2011. Enhancing intra-SAARC trade: pruning India's sensitive list under SAFTA. Work. Res. Pap.-255 Indian Counc. Res. Int. Econ. Relat. New Delhi.
Taylor, L., 2016. CGE applications in development economics. J. Policy Model. 38, 495–514. https://doi.org/10.1016/j.jpolmod.2016.02.010
Teli, R., 2014. A critical analysis of foreign direct investment inflows in India. Procedia-Soc. Behav. Sci. 133, 447–455.
Temu, A., Waized, B., Ndyetabula, D., Robinson, E., Humphrey, J., Henson, S., 2014.

Mapping value chains for nutrient-dense foods in Tanzania. IDS.

The Economic Times of India, 2017a. FDI in food processing jumps 43% in FY17 to $727 million. https://economictimes.indiatimes.com/industry/cons-products/food/fdi-in-food-processing-jumps-43-in-fy17-to-727-million/articleshow/59796079.cms

The Economic Times of India, 2017b. Oils surpass dairy as India's largest packaged food item, as consumers prioritise health over expenses. https://economictimes.indiatimes.com/industry/cons-products/food/oils-surpass-dairy-as-indias-largest-packaged-food-item-as-consumers-prioritise-health-over-expenses/articleshow/57280161.cms

The Times of India, 2016. Organised wholesale makes a splash. https://timesofindia.indiatimes.com/business/india-business/Organised-wholesale-makes-a-splash/articleshow/53748020.cms

Thomas, H.C., 2006. Trade reforms and food security: country case studies and synthesis. Food & Agriculture Org.

Thompson, T.M., Rausch, S., Saari, R.K., Selin, N.E., 2014. A systems approach to evaluating the air quality co-benefits of US carbon policies. Nat. Clim. Change.

Thow, A.M., 2009. Trade liberalisation and the nutrition transition: mapping the pathways for public health nutritionists. Public Health Nutr. 12, 2150–2158.

Thow, A.M., Kadiyala, S., Khandelwal, S., Menon, P., Downs, S., Reddy, K.S., 2016. Toward Food Policy for the Dual Burden of Malnutrition An Exploratory Policy Space Analysis in India. Food Nutr. Bull. 0379572116653863.

Thow, A.M., Snowdon, W., Labonté, R., Gleeson, D., Stuckler, D., Hattersley, L., Schram, A., Kay, A., Friel, S., 2015. Will the next generation of preferential trade and investment agreements undermine prevention of noncommunicable diseases? A prospective policy analysis of the Trans Pacific Partnership Agreement. Health Policy 119, 88–96.

Thow, A.M., Swinburn, B., Colagiuri, S., Diligolevu, M., Quested, C., Vivili, P., Leeder, S., 2010. Trade and food policy: case studies from three Pacific Island countries. Food Policy 35, 556–564.

Tiffen, M., 2003. Transition in sub-Saharan Africa: agriculture, urbanization and income growth. World Dev. 31, 1343–1366.

Tinbergen, J., 1952. On the theory of economic policy. Books (Jan Tinbergen).

Traore, M., Thomas, G., Thompson, B., 2015. Sustainable Nutrition Security: Restoring the Bridge Between Agriculture and Health.

USDA, US Department of Agriculture, n.d. USDA Production, Supply and Distribution database [WWW Document]. URL https://apps.fas.usda.gov/psdonline/app/index.html#/app/home

USDA, US Department of Agriculture, n.d. USDA nutritional content database [WWW Document]. URL http://ndb.nal.usda.gov/ndb/foods

Vafeiadou, K., Weech, M., Altowaijri, H., Todd, S., Yaqoob, P., Jackson, K.G., Lovegrove, J.A., 2015. Replacement of saturated with unsaturated fats had no impact on vascular function but beneficial effects on lipid biomarkers, E-selectin, and blood pressure: results from the randomized, controlled Dietary Intervention and VAScular function (DIVAS) study. Am. J. Clin. Nutr. ajcn097089.

Varian, H.R., 1992. Microeconomic analysis.

Velupillai, K.V., Zambelli, S., 2010. Computation in Economics. ASSRU-Algorithmic Social Science Research Unit.

Vepa, S.S., 2004. Impact of globalisation on the food consumption of urban India. Glob. Food Syst. Dev. Ctries. Impact Food Secur. Nutr. 83, 215.

Verma, M., Hertel, T.W., 2009. Commodity price volatility and nutrition vulnerability. International Food Policy Research Institute (IFPRI).

Villoria, N.B., Golub, A., Byerlee, D., Stevenson, J., 2013. Will yield improvements on the forest frontier reduce greenhouse gas emissions? A global analysis of oil palm. Am. J. Agric. Econ. 95, 1301–1308.
Von Geibler, J., 2013. Market-based governance for sustainability in value chains: conditions for successful standard setting in the palm oil sector. J. Clean. Prod. 56, 39–53.
W, H., Thomas, Monika Verma Hertel, Cranfield, J.A., Preckel, P.V., 2007. Global Nutrition Impacts of Rapid Economic Growth in China and India.
Wahlqvist, M.L., 2006. Weight management in transitional economies: the" double burden of disease" dilemma. Asia Pac. J. Clin. Nutr. 15, 21.
Walls, H.L., Hanefeld, J., Smith, R.D., 2017. The Trans-Pacific Partnership: Should We" Fear the Fear"?: Comment on" The Trans-Pacific Partnership: Is It Everything We Feared for Health?". Int. J. Health Policy Manag. 6, 353.
Walls, H.L., Kadiyala, S., Smith, R.D., 2016. Research and policy for addressing malnutrition in all its forms. Obes. Silver Spring Md 24, 2032–2032.
Walls, H.L., Smith, R.D., Drahos, P., 2015. Improving regulatory capacity to manage risks associated with trade agreements. Glob. Health 11, 14.
Wang, D.D., Li, Y., Chiuve, S.E., Stampfer, M.J., Manson, J.E., Rimm, E.B., Willett, W.C., Hu, F.B., 2016. Association of specific dietary fats with total and cause-specific mortality. JAMA Intern. Med. 176, 1134–1145.
Watkiss, P., 2009. Comparative life-cycle assessment of food commodities procured for UK consumption through a diversity of supply chains. Rep. Prep. Dep. Environ. Food Rural Aff. Defra Proj. FO0103 Watkiss Assoc.
Wiebelt, M., Breisinger, C., Ecker, O., Al-Riffai, P., Robertson, R., Thiele, R., 2011. Climate Change and Floods in Yemen.
Wimberley, D.W., 1991. Transnational Corporate Investment and Food the Third World: A Cross-National Analysis. Rural Sociol. 56, 406–431.
Wimberley, D.W., Bello, R., 1992. Effects of foreign investment, exports, and economic growth on third world food consumption. Soc. Forces 70, 895–921. https://doi.org/10.1093/sf/70.4.895
Wong, G., Greenhalgh, T., Westhorp, G., Buckingham, J., Pawson, R., 2013. RAMESES publication standards: realist syntheses. BMC Med. 11, 21.
Woodward, D., Drager, N., Beaglehole, R., Lipson, D., 2001. Globalisation and health: a framework for analysis and action. Bull. World Health Organ. 79, 875–881.
Working Group on HFSS, 2014. Junk Food Guidelines Draft. Working Group set up by the Expert Group set up as per the order dated September 4, 2013 of the Honorable High Court of Delhi on guidelines for making available quality and safe food in schools.
World Bank, 1991. India 1991 Country Economic Memorandum.
World Bank, n.d. World Bank open data [WWW Document]. URL http://data.worldbank.org/ (accessed 4.27.17).
WTO, 2018. Minutes of the meeting of 21-22 March 2018.
WTO, 2016. Statement by Indonesia to the committee on technical barriers to trade 9-10 March 2016.
WTO, 2013. Public Stockholding for Food Security Purposes. Ministerial Decision. World Trade Organisation.Ministerial Decision of 7 December 2013, Bali. https://www.wto.org/english/thewto_e/minist_e/mc9_e/desci38_e.htm
WTO, 2008. Revised draft: Modalities for agriculture. https://www.wto.org/english/tratop_e/agric_e/agchairtxt_feb08_e.doc
WWF, 2013. Palm oil markets and sustainability in India. WWF India, New Delhi, India
WWF India, 2017. Palm lines: Envisioning a sustainable future for the Indian Palm oil Industry. New Delhi, India.
Zakaria, M., Xi, J., 2014. Food Security in South Asian Countries: 1972 to 2013. Afr. Asian Stud. 13, 479–503.

Appendix 1: Qualitative policy analysis

A 1.1 Figures and tables

Figure A1-1 Value Chain of edible oils. Organisational Characteristics

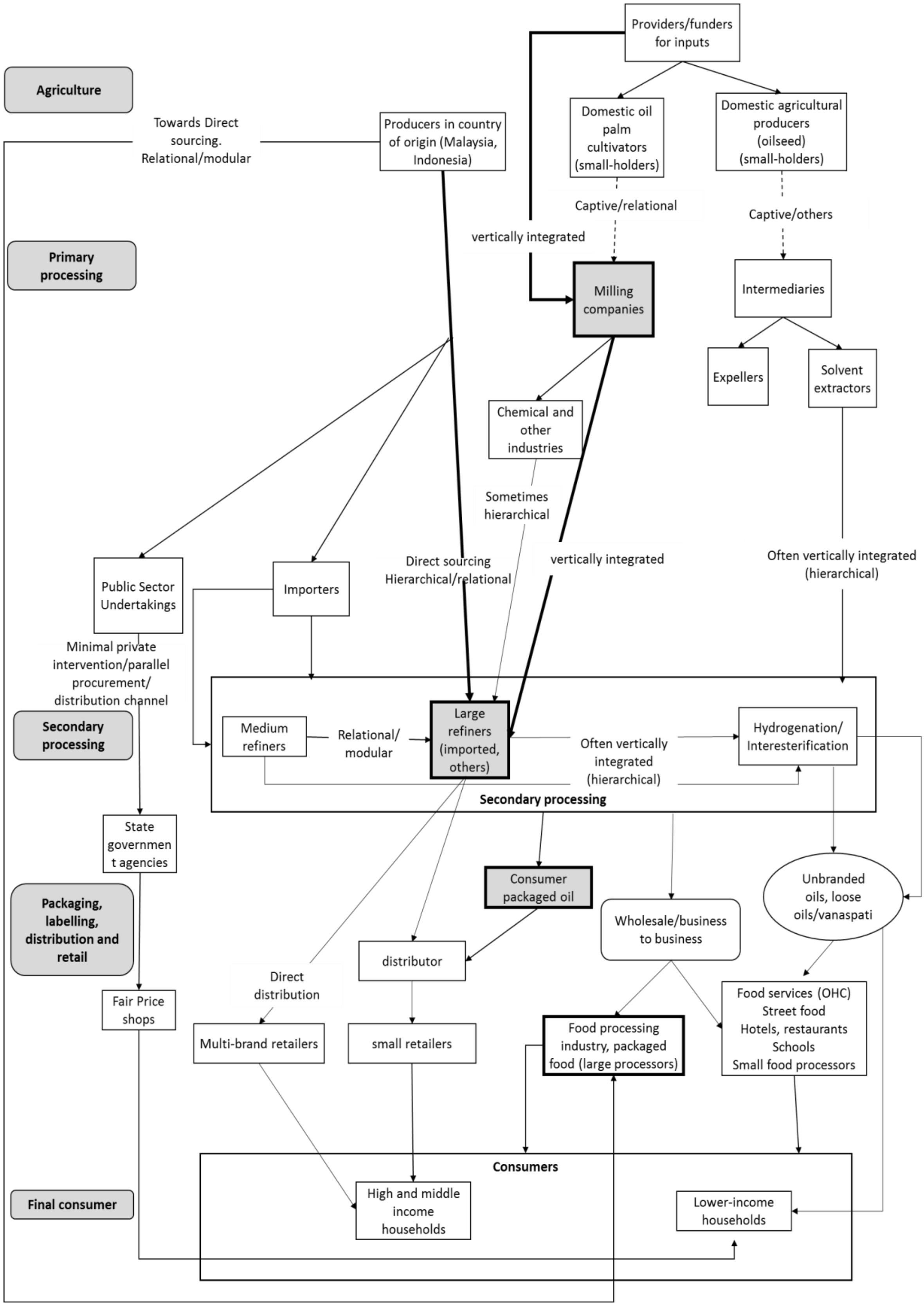


Figure A1-2 Value Chain for edible oils: Policy mapping

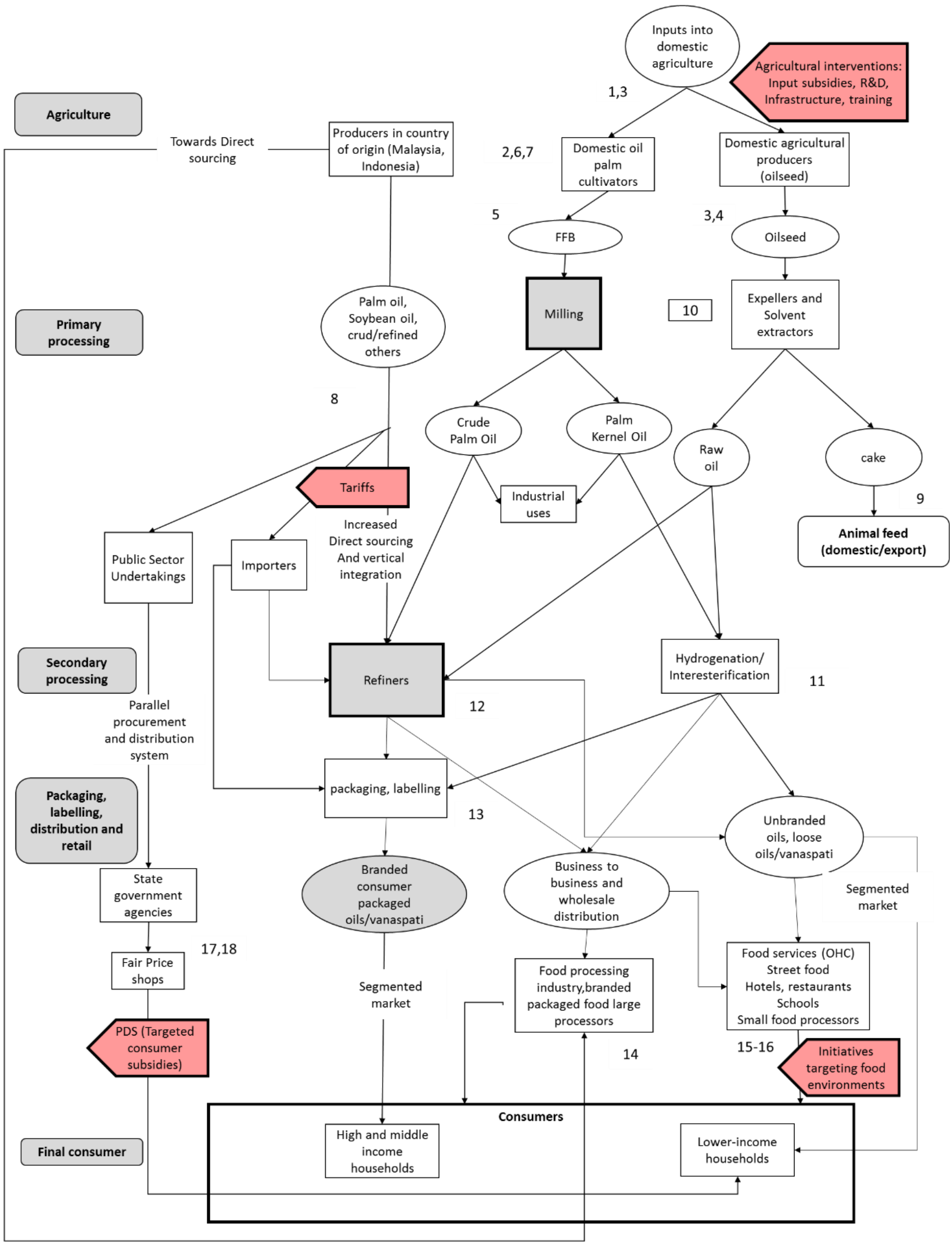


Table A1-1 Policy documents

VC Segment	Year	Main Documents
Domestic production of oilseeds and oil palm	2014	**National Mission on Oilseeds and Oil Palm (operational guidelines)** (Ministry of Agriculture, 2014a)
	2017	**Measures to increase oil palm area and production in India** (Press Information Bureau, 2017)
	2017	**Ministry of Agriculture, Cooperation and Farmers Welfare, annual reports** (2013-14/2016-17) (2017c, 2016, 2015, 2014c). [Price support, National Mission on Sustainable Agriculture.]
	2013	**Formula for the Pricing of Fresh Fruit Bunches of Oil Palm** (Ministry of Agriculture, 2013)
	2017	**Indian Palm Oil Sustainability Framework** (Solidaridad, 2017)
Foreign Trade and Investment	2016	**Consolidated FDI policy** (Effective from June 07, 2016) (Department of Industrial Policy and Promotion, 2016)
	2012-16	**Department of Food and Public Distribution, annual reports** (DFPD, 2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009) [Policy on edible oils and commodity monitoring and central scheme for distribution.]
	2008-2017	**Ban of exports of edible oils, amendments** (Director General of Foreign Trade, 2008). Amendment notifications: No 03/3015-20, N0 43/2015-20
Oil processing	2013	**Regulation of Trans Fatty Acids (TFA) in Partially Hydrogenated Vegetable Oils (PHVO)** (FSSAI, 2013b)
	2016	**Fortification of essential food commodities.** (FSSAI, 2016a)
Food processing	2016	**Ministry of Food Processing Industries annual report 2016-17** (MOFPI, 2017c)
Labelling, advertising	2011	**Food safety and standards (packaging and labelling) regulations**, (FSSAI, 2011b)
Street food	2016	**Food Safety and Standards Authority of India annual report 2015-16** (FSSAI, 2016b)
School food environments	2015	**Initiative to address the Consumption of Foods High in Fat, Salt and Sugar (HFSS) and Promotion of Healthy Snacks in Schools of India**. (Working Group on HFSS, 2014), (HFSS Working Group, 2015)
Public Food Distribution	2013	**National food security act, 2013** (Ministry of Law and Justice, 2013)

Table A1-2 Value chain for edible oils: Policy mapping

VC Segment		Year	Main Policies and corresponding documents
Domestic production of oilseeds and oil palm, pricing of oilseeds and FFB	1	2014 2017	**National Mission on Oilseeds and Oil Palm** (NMOOP). (Ministry of Agriculture, 2014a), (operational guidelines), (Ministry of Agriculture, 2017c) p(43-48)
	2	2017	**Measures to increase oil palm area and production in India** (Press Information Bureau, 2017)
	3	2017	**National Mission for Sustainable Agriculture** (NMSA) (Ministry of Agriculture, 2017c) (p. 49-64)
	4	2017	**Price support and price fixation schemes** (Ministry of Agriculture, 2017c) Sections 12.27-12-29
	5	2013	**Pricing of Fresh Fruit Bunches of Oil Palm** (Ministry of Agriculture, 2013)
	6	2017	**Indian Palm Oil Sustainability Framework** (Solidaridad, 2017)
Foreign Trade and Investment	7	2016	**FDI restrictions (100% FDI for palm oil)** (Effective from June 07, 2016) (Department of Industrial Policy and Promotion, 2016)
	8	2012-16	**Tariff setting and commodity price and output monitoring for oils** DFPD (DFPD, 2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009)
	9	2008-2017	**Ban of exports of edible oils, lift of ban**. (Director General of Foreign Trade, 2008). Amendment notifications N0 43/2015-20
Oil processing	10	2015	**End of Small-Scale Industry reservation policy** (MCI, 2015)
	11	2013	**Regulation of Trans Fatty Acids (TFA) in Partially Hydrogenated Vegetable Oils (PHVO)** (FSSAI, 2013b)
	12	2016	**Fortification of essential food commodities**. (FSSAI, 2016a)

Labelling, advertising	13	2011	**Regulations on packaging, labelling, health claims for edible oils. Ban on sales of loose oil** (FSSAI, 2011b), (FSSAI, 2013c)
Processing	14	2017	**Promotion of food processing** (MOFPI, 2017c)
Street food	15	2016	**Clean Street Food in Delhi** (FSSAI, 2016b) Section 8.6
School food environments	16	2015	**Initiative to address the Consumption of Foods High in Fat, Salt and Sugar (HFSS)** and Promotion of Healthy Snacks in Schools of India. (Working Group on HFSS, 2014), (HFSS Working Group, 2015)
Public Food Distribution	17	2013	**"Right to Food", Targeted PDS** (Ministry of Law and Justice, 2013)
	18	2008-14	**Central Scheme for distribution of edible oils**. DFPD annual reports 2008 to 2014 (DFPD, 2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009) .

Table A1-3 Framing sustainability and nutrition outcomes in the edible oils sector: Dimensions of Sustainable Nutrition Security

SNS dimensions	The edible oils sector in India: Context-relevant goals	Key related "intermediate" objectives
(1) food nutrient adequacy	Adequate levels of fat (and calorie) intake	Reduce % population with insufficient fat intake. (below WHO/USDA recommendations) (N) . (Kumar 2017), NSSO survey reports.
	Consumption of a balanced mix of fatty acids (SFA, UFA).	Reduce % population with excessive intake of fats, SFA, TFA (N). Promote balanced fat and FA intakes. (Downs 2015, 2013), (Popkin 2006).
(2) ecosystem stability	Global, Supplier countries: Reduced deforestation, forest and peat-land fires,	Reduce imports of unsustainable oil (mainly palm oil). Encourage imports of

	ecosystem degradation in supplying countries. (Malaysia and Indonesia for palm oil, Brazil and Argentina for soybean)	sustainable certified oils. (S). (Shleifer 2016); (Byerlee et al. 2017).
	Local: Water resource use, soil degradation, deforestation, diverse ecosystems	Avoid environmental damage from unsustainable agricultural practices (S). (GK Jha et al. 2012)
(3) food affordability, availability	Availability, affordability and price stability of edible oils for low-income households	Ensure access and affordability of sufficient energy from fats for low income households (Kumar 2017), NSSO survey reports.
	Reduced inequalities in oil consumption level and patterns	Ensure access and affordability to a healthy mix of edible oils, providing a balanced fatty acid intake for low-income households. (Downs 2015, 2013), (Popkin 2006).
(4) sociocultural wellbeing	Small-holders income and rights	Improve income and income stability for oilseed/oil palm farmers (S/E) (GK Jha et al. 2012)
	Availability of local oils, used in traditional cooking	Promote consumption of traditional, unrefined cooking oils. (Complementary goal). (Downs 2015, 2013).
(5) food safety	Trans fat intakes	Monitoring of trans fat intakes and implementation of regulation (N) (Downs 2013)
	Other: Erucic acid content, re-usage of cooking oil (secondary)	Promote safe varieties, safe practices in oil processing. (Complementary technical measures and regulations) (Dorni, 2017)

(6) resilience	Import dependence	Reduce demand-supply gap, diversify imports (S/E), improve price stability, (Persaud et al, 2006)
	Export dependence	(longer term, not currently an issue)
	Climate change adaptation, drought resilience	Improved adaption of oilseed crops (S/E) (GK Jha et al. 2012)
(7) waste and loss reduction	Wastage of oilseed (pre-consumer)	Reduced wastage (S/E). (Downs 2015)
	Wastage of cooking oil (post-consumer)	

Table A1-4 Actors

Main actor types (only national/transnational level)	**Characteristics**	**Engagement with dimensions of Nutrition and Sustainability**
Industry		
Oil palm companies (Domestic) (Segment controlled by 4 companies)		
Godrej Agrovet	Vertically integrated. From agri-inputs to packaged food products.	RSPO commitments to 100% sustainable palm oil sourcing for 2020. IPOS "stakeholder" (member).
Ruchi Soya	Oil processing. Palm, soybean and vanaspati. Large share of consumer-packaged oils (20%). Market leader in south States.	RSPO member, sustainability commitments (100% sustainable palm oil) (2026). IPOS

	Currently under insolvency process.	stakeholder. Health-oriented advertising: Healthy for heart product range.
3F Oil Palm Agrotech	R&D and production of agricultural inputs, palm oil milling and refining, energy from FB waste. Have expanded to South America, Africa.	IPOS stakeholder RSPO member, sustainability commitments (100% sustainable palm oil) (2020)
Navabharat Agrotech Pvt. Ltd		
Oil processing		
Solvent Extractors Association (industry representative association)	Over 800 members. Promoter of IPOS.	Highly influential. Increased engagement with RSPO, co-promoter of IPOS
Adani-Wilmar	Joint venture with Singapore palm oil company Wilmar. Market leader for consumer-packaged oils (soybean, palm oil, sunflower, rice bran) (20% market share for consumer branded oils).	Health-oriented advertisement (light oils range). Flagship brand Fortune. IPOS stakeholder. RSPO member, sustainability commitments (100% sustainable palm oil) (2020)
Ruchi Soya, Godrej Agrovet, 3F Oil Palm Agrotech	(see above)	
Mother Dairy	Created in 1974 as a Subsidiary of the National	

	Dairy Development Board (NDDB) Around 10% of market for consumer-packaged oils (sells packaged mustard oil brand Dhara. Supplier for main global brands.	
Cargill	Around 10% of market for consumer-packaged oils.	RSPO member, sustainability commitments (100% sustainable palm oil) (2026)
Non-food		
Hindustan unilever, Godrej Agrovet others	Trend towards direct oil sourcing, vertical integration. Non-food products often obtained as a by-product of processing for food	Non-food sector has shown leadership in engaging with sustainability initiatives but imports of sustainable oil are still low
Food processing		
Hindustan unilever, Godrej Agrovet, Nestle India, others	(see above)	
Policy Actors		
Directorate of sugar and vegetable oils (oil division). (Ministry of Consumer Affairs, Food and Public Distribution.)	Operates within the ministry of consumer affairs. Responsible for coordinated management of edible oils. National and international price monitoring. Assessment of supply and demand. Initiate necessary interventions.	Support for health-oriented regulation of labelling, advertising. Food security and farmer livelihoods and the main SNS priorities.
Food Safety and Standards Association of India, (FSSAI) (Ministry	Independent body within Ministry of Health. Regulate and carry out initiatives to	Focus on NCD prevention, reduced dual burden of

of health and family welfare)	improve food safety and quality, including labelling, advertisement, packaging, practices in informal sector. Since 2011 FSSAI is responsible for license, safety and standard parameters in the edible oils industry.	malnutrition, reduction of micronutrient malnutrition.
Supreme court commissioner on Right to Food	Monitoring the implementation of all orders relating to the right to food and preparing reports on progress and implementation	Promotion of rights-based approaches to food. Promote a shift towards a broader perspective of nutrition security. Support local sourcing,
Oilseeds Division (Ministry of Agriculture, Cooperation and Farmers Welfare)	Formulates, manages and implements agricultural development schemes for oilseed, oil palm and tree-borne oilseeds. Currently responsible for the National Mission of Oilseeds and Oil Palm (NMOOP)	Focus on local environmental sustainability (water). Other priorities include farmers livelihoods, agricultural development, food security.
Others: Ministry of Food Processing Industries, Ministry of Commerce and Industry, department of food and public distribution	Developing the food processing industry, attracting domestic and foreign capital, funding infrastructure and R&D for food processing; Formulating foreign trade policy, which provides a framework for trade policy and exports promotion. Managing multilateral and bilateral trade relationships	Focus on: reduced food wastage, agricultural growth and development, others

Social Actors		
Sustainability-oriented		
RSPO, collaborating NGOs	RSPO is a non-profit multi-stakeholder platform created with the aim to develop and implement global standards for sustainable palm oil. It includes industry, NGO and banks of investors. RSPO and associated NGO engage with companies to encourage adoption of corporate social responsibility instruments	Promotion of engagement of industry with global corporate sustainability standards, including climate, water and biodiversity, (increasingly include land and labour rights)
Solidaridad South and South East Asia	Non-profit. Work on providing "economically efficient sustainability solutions" in collaboration with governments, business and local communities. Strong focus on labour, gender.	Promotion of context-adapted sustainability initiatives, with a strong focus on labour, gender and social dimensions.
Nutrition-oriented social actors, expert coalitions or professional bodies		
Coalition for food and nutrition security, others	Multi-stakeholder alliance of diverse organizations and individuals in the food and nutrition space – including the Government of India, foreign governments' aid agencies, UN organizations, non-governmental development organizations, academia	Food and nutrition security. Double burden of malnutrition
Institute of home economics, Lady Irwin college, All India	Academics and experts have access and influence in policy making in the edible oils sector,	Promotion of NCD prevention, micronutrient

Institute of Medical Science (AIMS), others	mainly through direct involvement with FSSAI.	malnutrition and food security through policy advice and direct collaboration in the design and evaluation of interventions
Right to food campaign	Informal network of organisations and individuals promoting rights-based approach to food security and livelihoods. Originated in the 2001 litigation case on the issue of "right to food"	Promotion of rights-based approaches to food and nutrition security. Complementary focus on livelihoods, labour
Ifpri India, others.		

Table A1-5 Document search. For typology of documents see Mogalakwe 2006

Sources	Types of documents	Inclusion criteria	Search terms
We searched for documents in the official websites of relevant government departments and the web pages of the key actors identified during our research. These include: • Ministry of consumer affairs, food and public distribution, • Food safety and Standards Authority of India, • Ministry of Agriculture, Cooperation and Farmers Welfare • Others: Ministry of Food Processing industries, Department of Foreign Trade • RSPO and associated NGOs • Solidaridad South and South-East Asia • Right to Food Campaign • Corporate actors and representative bodies: Solvent extractors association, Adani Wilmar, Ruchi Soya, Godrej Agrovet, 3F, Cargill, Kamani oils, Mother Dairy, Hindustan Unilever, Nestle.	*Primary documents:* Annual reports (19) Resolutions, notifications, regulations and acts (35) Official press releases (1), Minutes of meetings (1) draft regulations (1) Government presentations (1). Corporate reports (11) *Secondary documents:* Reports from non-governmental organizations (1). Total (70)	Documents from the year 2010-June 2017, and in one case annual reports from the year 2009 (for convenience, since these reflected the duration of the scheme for distribution of edible oils). We included documents that would reflect: • The main policies affecting each value chain segment (policy mapping). • The approaches of key actors to different dimensions of sustainable nutrition security (particularly in relation to edible oils). In addition, we applied criteria of: • Authenticity: all documents were obtained from trustworthy sources. • Credibility: The types of documents included are in general typical of their category. • Representativeness: The documents included represent in general the official position of key actors. In one instance, we have analysed the minutes of a meeting. It is hard to determine the representativeness of this document. • Meaning: Although the documents occasionally contained highly technical information, the relevant information	Search terms were adapted to each source, depending on the value chain segment and actor type that the search referred to. If the website did not include a search tool or this tool did not provide satisfactory results we manually searched and obtained annual reports or relevant documents. Depending on the relevant value chain segment we searched for terms related to the following concepts: • Edible oils sector (edible oils, vegetable oils, vanaspati, hydrogenated fats and oils, palm oil, soybean oil, mustard oil, rapeseed oil, groundnut

We complemented this search with internet searches referring to specific regulations or policies which were either mentioned by interviewees or mentioned in the documents initially retrieved.		was generally comprehensible. Actors' approaches were often either explicitly stated or relatively easy to infer from the information provided.	oil, coconut oil, oilseeds, oil palm) • Nutritional aspects of fat consumption: saturated fat, trans fat, fatty acids. • Sustainability in the oils sector (sustainable, sustainability, certified, RSPO)

A 1.2 Interview guideline

Interview guideline (general)

1. Questions about current position, previous position and functions
2. Perceptions about drivers of edible oil (palm oil) consumption
    - *Palm oil consumption has increased a lot over the past few decades in India. What do you think explains this increase?*
    - *Perceived importance of supply-side versus demand-side factors. (Importance of consumer awareness, consumer-oriented campaigns with respect to other factors)*
3. Introducing simplified value chain diagram
    - *This is a very simplified diagram of the palm oil value chain.*
    - *Where would you situate your institution? (can pick several segments, if that's the case). Is the diagram clear? Any obvious changes?*
4. Role of organization/individual and relationship to policy-making
    - *What is the main role of (your organization)?*
5. Perceived importance of different dimensions of Sustainable Nutrition Security and policy approaches (mainly nutrition and environmental impacts). Pay attention to perceived trade-offs and synergies, both general and specific.
    - *In your opinion, what are the main factors that that are taken into account when designing policies that affect the palm oil sector?*
    - *To what extent does (industry/consumers/policy makers) take into account health/nutrition/environmental sustainability? How?*
    - *Do you think palm oil is an important source of calories for low income households?*
    - *What to do think is the perception of (relevant actors) about nutrition and health impacts of oil/palm oil consumption? Prompt if necessary: (food security and affordability/ fat consumption/ saturated fat/ processed food/ trans fat /street food).*
    - *How do these factors affect policy (in relevant segment)?*
    - *What about environmental factors? (global/national*) *What to do think is the perception of (relevant actors)? How do these factors affect policy/actor decisions (in relevant segment)?*
6. Main characteristics, incentives, trends and future changes in the sector (specific segments) *(Using value chain diagram again)*
    - *What are the main changes in the sector/segment right now? (vertical integration, consolidation, product diversification, marketing strategies, other)*
    - *What is driving those changes? / Why?*

If interviewee has relevant technical knowledge:

- *Alternative uses of palm oil: Cooking oil, blends, vanaspati, food processing, food services, street food, non-food, biofuels. Relative percentages, trends. What percentage of palm oil is used directly used by households for cooking, approximately? What proportion is used as vanaspati?*

- *Links to trans fat regulation: Is trans fat regulation implemented? Is it costly for the industry? How has it affected use of palm oil/other oils?*
- *Enquire further about specific topics of interest/knowledge for interviewee: Sustainability certification, role of PDS, role of global versus national brands etc.*

7. Relevant policy interventions and impacts, actor priorities.
    - *What are the most relevant policy interventions/regulations in this segment?*
    - *How do they affect your organization/the segment/SNS goals?*
    - *If you had to propose one policy intervention to improve nutrition/environmental outcomes (or both), what would that be?*
8. Actor influence
    - *What would be the barriers for this policy? Who would support it? Who would oppose?*

A 1.3 Themes for analysis of interviews and documents

Understanding the context, characteristics and incentives in the Value Chain

Drivers of consumption patterns

Constraints for domestic expansion (and current/potential impacts of expansion)

Technology: Modernization, capacity, capacity utilization and efficiency

Financial, ownership and governance structure: mergers, consolidation, network types

Marketing strategies and market segmentation

Sourcing

Key policies/key areas for intervention

Understanding the policy context

International factors, trade/others

National priorities sustainability

National priorities nutrition/NCD prevention/ healthy fats

Understanding policy process, circumstance and priorities

State actors, policy-makers

Role/main actors

Priorities and problem framing

Policy process type

Non-state actors

Actor priorities

Actor influence

Perception of SNS dimensions (importance, trade-offs or synergies)

Theories of change/approach with respect to SNS (demand-driven vs. supply driven, corporate-led vs. state-led, downstream focus vs. upstream focus)

Understanding the characteristics of key policy interventions

Value chain segment/area of intervention

Actors involved

Stated goals

Impact distribution: socioeconomic, geographical, stakeholders

Distribution of costs

Long/term versus short/term

Market-oriented versus state-led

Appendix 2: Results from quick review: the use of CGE models in nutrition

Table A2-1 The use of CGE models in nutrition. Results from quick review

Authors	Year	Country/Region	Exogenous Shock	Nutrition or diet related variables	Main findings
Mujeri and Khandaker	1998	Bangladesh	Macroeconomic policy reforms: Reduced nominal rates of protection, tariffs, increased VAT, sectoral growth	Protein and calorie availability at the household level	Tariff liberalisation is regressive in terms of its nutritional impacts
Anderson and Jackson	2005	Sub-Saharan Africa	Consumption of GM golden rice	Vitamin A deficiency	The adoption of golden rice would result in welfare gains
Anderson	2005	Asia	Consumption of GM golden rice	Vitamin A deficiency	The adoption of golden rice would result in large welfare gains
Hertel et al.	2007	Bangladesh*	Economic growth in large trade partners of a small country	Daily Kcal consumption by households at the poverty line	The impacts of globalisation on nutritional outcomes for poor households depend crucially on the growth trends in specific trade partners. In this case, growth in India improves nutrition for all households except self-employed non-agricultural households. Growth in China improves nutrition for the average household but has negative effects for households on the poverty line

Panda and Ganesh-Kumar	2009	India	Partial trade liberalisation	Consumption of Kcal, protein and fat	Trade liberalisation increases incomes but reduces calorie and protein consumption in the bottom 30% of the income distribution. Fat consumption increases across households
Verma and Hertel	2009	Banglades h	Output volatility and associated price volatility for rice, wheat, coarse grains and oilseeds, with and without Special Safeguard Mechanism	Calorie intake per capita per day for households on the nutritional poverty line	SSM does not lead to significant nutritional improvements in Bangladesh
Balma	2010	West and Central Africa	Economic crisis and five policy responses (including targeted and non-targeted transfer policies and food subsidies)	Caloric poverty for children	Economic crisis reduced caloric poverty compared to a non-crisis scenario. Cash transfers are more effective than food subsidies.
Lock et al.	2010	UK and Brazil	Adoption of WHO healthy diet recommendations	Proportion of energy from fat, SFA, trans fatty acids, carbohydrate and protein from animal and plant sources. Grams of salt, fruit and vegetables	The effects depend on the baseline diets of the population and on the productive structure of the country. Dietary changes would lead to large reductions in labour requirements in the agricultural sector in Brazil.
Pauw and Thurlow	2011	Tanzania	Agricultural economic growth and its composition	Household caloric availability	Growth in the agriculture and maize sectors enhances caloric availability
Wiebelt et al.	2011	Yemen	Climate change, floods	Caloric consumption	Floods lead to a 15% increase in hungry people living from agriculture
Jensen et al.	2013	UK	Climate mitigation, reduced meat consumption	Fatty acid intakes, morbidity and mortality	Reduced intakes of saturated fat have a positive economic impact, through health care costs and labour market effects

Breisinger and Ecker	2014	Yemen	Economic crisis and alternative recovery scenarios	Calorie deficiency and child stunting	Even under a scenario of accelerated growth, it would take six years to make up for the nutritional impact of the crisis
Cockburn et al.	2014	Cameroon	Economic crisis and alternative policy responses including cash transfers and reduction of VAT or tariffs on food products	Caloric poverty	Economic crisis led to a slight increase in child caloric poverty. The most cost-effective policies are targeted cash transfers and a school feeding program.
Hasegawa et al.	2014	Unknown (no full text)	Climate change and adaptation strategies (crop variety and planting dates)	Calorie consumption, risk of hunger	Adaptation measures substantially reduce the impacts of climate change on food security
Rutten et al.	2014	Global	Projection of the Shared Socio-economic Pathway "middle of the road". (SSP2)	Availability of macronutrients: calories, proteins, fats. Direct consumption and indirect consumption through processed foods	Nutrient regional origins change slowly, with the changes in fat consumption being more extreme than for proteins or calories. Indirect consumption through processed food increases in importance, particularly in the US. Southern africa lags behind in terms of dietary convergence and importance of processed food
Mulik and O'Hara	2015	US	Adoption of healthy diet recommendations	Consumption of fruits, vegetables, meat, dairy	Land use for vegetable production increases. Changes in land use for cereals associated to healthier dairy intake depends on the specific scenario
Banerjee	2015	Banglades h	Climate change, increased temperatures	Calorie intake	Although the GDP impacts are small, climate change could reduce calorie intake by 17%

Appendix 3: Data for modelling

A 3.1 Splitting commodity and activity accounts and disaggregating IEG Indirect Taxes based on GTAP9.1 SAM

This appendix documents adjustments to the 2007-08 IEG India SAM, which are necessary to (1) allow for separate modelling of individual indirect tax types and (2) ensure compatibility with the SAM matrix structure required by IFPRI's 'standard model' CGE model framework.

The adjustments include the establishment of separate activity and commodity accounts. Furthermore, tax-related adjustments include (1) disaggregation of the aggregate Indirect Tax (IT) account between production taxes, sales taxes, import tariffs and export taxes, and (2) the reallocation of indirect tax payments from institutional accounts to activity and commodity accounts.

The adjustments to the 2007-08 IEG India SAM are based on the structure of tax payments in the GTAP India SAM (GTAP9.1 database).

In the first place, we split the IEG sectors into activity and commodity accounts. We assign production taxes to activity accounts and other indirect taxes to commodity accounts.

In the second place, we match GTAP and IEG sectors. This is straightforward, since both data sets provide their respective matching in terms of Input Output (IO) sectors. Even though they are based on different rounds of IO tables, both IO tables keep the same classification. We will denote GTAP sectors by the subindex j and IEG sectors by subindex i.

We define a variable, K, which identifies 40 different sectors that correspond exactly to aggregations of GTAP and IEG sectors.

The correspondence to IO sectors in GTAP is provided for a semi-aggregated version, containing only 50 sectors. The GTAP SAM that we have been using contains 57 sectors, and the IEG SAM contains 78 sectors.

Once we have aggregated the GTAP data to $K=40$ sectors and matched these sectors to the 78 IEG sectors we proceed to disaggregate the Indirect Taxes accounts.

The GTAP SAM includes separate accounts for indirect taxes on intermediate and final demand components. Due to difference in methodology, we describe the disaggregation and reallocation of indirect tax payments from final demand components in the next sub-section, while the disaggregation of indirect tax payments from intermediate demand is described in the subsequent sub-section.

A 3.1.1 Distributing indirect sales taxes and tariffs across commodities

Payments from production sectors into the IT account correspond to production taxes and import tariffs. We assume that the taxes paid by institutions to the IT account in the India tax correspond to sales taxes, except for the ROW account, where we assume they correspond to export taxes.

The GTAP SAM includes separate accounts for sales taxes on domestic production and imported goods + separate sales tax payments for all intermediate and domestic final demand components. We use the full information of this data set, and therefore proceed with the disaggregation in two steps: (1) construction of aggregate weights (Weight3) to disaggregate institution-specific indirect taxes between three aggregate tax types (sales tax on domestic production, sales tax on imports, and export tax on exports), and (2) construction of commodity- institution-, and tax-specific weights (Weight78) to disaggregate the aggregate institution-specific taxes among commodity types.

First, we construct aggregate weights (Weight3) to disaggregate institution-specific indirect taxes between three aggregate tax types based on the 40-sector aggregation of the GTAP SAM (‘40-sector’ commodities, institutions and ‘3-type’ taxes are indexed by respectively s40, ins and t3):

$$\text{Weight3}_{\text{ins,t3}} = \frac{\sum_{s40=1}^{40} \text{TaxGTAP}_{\text{s40,ins,t3}}}{\sum_{t3=1}^{3} \sum_{s40=1}^{40} \text{TaxGTAP}_{\text{s40,ins,t3}}}$$

These weights are employed to disaggregate aggregate institution-specific IEG taxes between the three aggregate types of taxes (sales tax on domestic production, sales tax on imports, and export tax on exports).

Next, we construct an intermediate set of aggregate GTAP weights (Weight40) based on the 40-sector aggregation of the GTAP SAM. These weights are based on the ‘40-sector’ aggregation, and they are ‘40-sector’-, institution-, and ‘3-type’ tax-specific:

$$\text{Weight40}_{\text{s40,ins,t3}} = \frac{\text{TaxGTAP}_{\text{s40,ins,t3}}}{\sum_{s40=1}^{40} \text{TaxGTAP}_{\text{s40,ins,t3}}}$$

$\text{Weight40}_{\text{s40,ins,t3}}$ will add up to 1 for each institution and each '3-type' tax.

In order to derive our desired set of 78-sector weights (Weights78), we construct an additional set of weights (WeightIEG) which further disaggregates taxes from the 40-sector GTAP disaggregation to the ultimate 78-sector IEG disaggregation. The WeightIEG weights are based on the 78-sector IEG India SAM (78-sector commodities are indexed by s78):

$$\text{WeightIEG}_{\text{s78|s40,ins}} = \frac{\text{IEGfinaldemand}_{\text{s78,s40,ins}}}{\sum_{\text{s78|s78}\in\text{s40}} \text{IEGfinaldemand}_{\text{s78,s40,ins}}}$$

The 'IEGfinaldemand' numbers refer, in the case of ins=ROW, to exports, and for all remaining (domestic) institutions to consumption and investment. The $\text{WeightIEG}_{\text{s78,s40,h}}$ parameters are institution-, '78-sector'-, and '40-sector'-specific, and they will add up to 1 for each '40-sector' commodity and each institution.

In order to arrive at our desired set of 78-sector weights (Weights78), we multiply the three above sets of weights, and thereby obtain our final set of weights:

$$\text{Weight78}_{\text{s78,ins,t3}} = \text{Weight3}_{\text{ins,t3}} * \sum_{s40=1}^{40} \text{Weight40}_{\text{s40,ins,t3}} * \text{WeightIEG}_{\text{s78,s40,ins}}$$

The above weights are '78-sector'-, institution-, and '3-type tax'-specific, and the application of these weights to institution-specific IEG tax payments allows us to derive institution-specific tax payments across our desired 78 commodity types and our 3 aggregate tax types. Following the separate derivation of sales taxes on domestic production and imports, we add the two types of sales taxes together. The final result is a new set of institution-specific sales tax and export tax vectors.

These vectors of sales and export taxes are added to their respective final demand components to derive final demand vectors at market prices. At the same time, the export and sales tax payments are included into two new indirect tax accounts in the commodities columns (labelled resp. T02 and T03). This ensures that that each commodity account remains balanced in the adjusted 2007-08 IEG India SAM. Finally, the aggregate tax revenues from the sales tax and export tax accounts are added into the government budget account, to ensure that the government budget remains balanced as well.

A 3.1.2 Splitting each payment from institutional accounts to the indirect tax account into different producer and commodity taxes

Indirect taxes (IT) for each production sector in the IEG SAM are assumed to correspond to producer taxes, import tariffs and sales taxes on account of intermediate consumption. We denote these three types of taxes '3 type int.' paid on account of intermediate consumption, by the sub-index i3, to distinguish them from the taxes paid by final consumption. As before, we will split these out based on the proportions from GTAP9.1 SAM.

We use the amounts of each type of tax paid by each sector in the GTAP SAM, which we denote $TaxGTAP_{s57,i3}$

We aggregate these based on the '40 sectors' classification. We then need to further disaggregate into the '78 sectors' classification. For this purpose, we generate a set of weights $\text{Weight3int}_{i3,s78}$ that are specific to each type of tax '3 type int.' And for each commodity in '78 sectors' classification

$$\text{Weight3int}_{i3,S78,s40\ |i3=ProdTax;s78\in s40} = \frac{\text{IEGDomesticProduction}_{s78,s40}}{\sum_{s78\ |\ s78\ \in\ s40}(\text{IEG DomesticProduction}_{s78,s40})}$$

$$\text{Weight3int}_{i3,S78,s40\ |i3=imports;s78\in s40} = \frac{\text{IEGImports}_{s78,s40}}{\sum_{s78|\ s78\ \in\ s40}(\text{IEGImports}_{s78,s40})}$$

$$\text{Weight3int}_{i3,S78,s40\ |i3=SalesTax;s78\in s40} = \frac{\text{IEGIntConsumption}_{s78,s40}}{\sum_{s78\ |\ s78\ \in\ s40}(\text{IEGIntConsumption}_{s78,s40})}$$

These weights will add up to 1 for each '40 sector' commodity and each tax type.

We multiply these weights by their corresponding tax type obtained from GTAP.

$WeightedGTAPTax_{s78,i3} = Weight3int_{i3, s78, s40} * GTAPTax_{s78, i3}$

We sum up all weighted taxes for each commodity in '78 sectors' and obtain a total weighted amount of Indirect taxes for each commodity:

$$\text{WeightedIT}_{s78} = \sum_{i3} \text{WeightedGTAPTax}_{s78,i3}$$

We then generate the proportions for each tax type. This is a set of weights that are specific to each commodity in '78 sectors' and to each type of tax 'Type3int'

$$Proportion_{s78,i3} = WeightedGTAPTax_{s78,i3} / WeightedIT_{s78}$$

These weights will add up to 1 for each commodity in '78 sectors'.

We multiply the total indirect taxes on intermediate consumption provided by IEG (IEGIT) by this set of weights, obtaining the final tax disaggregation.

$$\text{IEGTax}_{s78,i3} = \text{Proportion}_{s78,i3} * \text{IEGIT}_{s78,i3}$$

A 3.1.3 Additional Adjustments

This method produces reasonable imputed amounts in almost all cases. The imputation is not perfect, however, and there are some discrepancies in methodology and structure of the database between GTAP and IEG that give rise to a few problematic imputations. These have been dealt with in the following way:

In the first place, after distributing export taxes across commodities, the resulting amounts in the ROW column exceed domestic production for three accounts: Bauxite, Other non-metallic minerals and Water Transport. This creates an error when reading in to GAMS. Our assumption that all of the payments of indirect taxes from ROW are in fact export taxes seems to be correct, since total Indirect taxes paid by ROW in IEG SAM are around 90% of the total export taxes in the GTAP9.1 SAM.

In order to deal with this problem, we aggregate the existing Mining sectors into one and do the same for all the different transport sectors, creating a new general Transport sector.

In addition, our method imputes excessive and negative import tariffs to sector Sugar and Khandasri. In order to deal with this problem, we estimate the implicit tariff rate paid by this sector in the GTAP SAM and apply the same rate to the total Indirect Taxes assigned to the IEG sector. We distribute the remaining taxes proportionately according to the above described methodology.

Finally, there are some very minor imbalances remaining in the SAM. We correct this by adding and subtracting the necessary (very small) amounts to the H01, GOV and ROW columns and to the S-I row.

In the later version of the SAM, where the oil sector and commodities have been disaggregated, we perform an additional adjustment. Since neither IEG nor GTAP provide information on oil-specific taxes, we use the information on import duties provided in the annual USDA attache reports for years 2007 and 2008. Food commodity tariffs experienced considerable changes in this year, in the context of a process of liberalisation that coincided with the international food crisis. We apply tariffs corresponding to the intermediate rates set at 20% on crude palm and soybean oil. This is the applied level after the duty revision on July 23, 2007. At the same time, the Government of India reduced the duty on refined palm oil, including RBD palm olein, to 27.5% from 52.5%. These rates were higher at the beginning of the period and were later set to zero for crude oil, towards the end of the period. The duties on refined oils are higher, but these represent less than 5% of imports over the relevant period, with crude oils making up the majority of imports (USDA, 2008) (See USDA Annual Attache report for 2008). The remaining taxes (subsidy in this case) is included as a producer subsidy for the activity as a whole.

Table A3-1 Correspondence table IEG, ASI/NIC2004 input output classification NSSO

IEG sector code	IEG labels	ASI NIC2004 codes	ASI National Industrial Classification 2004 NIC2004 description	IO code	NSSO code
S33	PHVO/vanaspati and Edible Oil	15141	Manufacture of hydrogenated oils and vanaspati ghee etc.	40	190-194
S33	PHVO/vanaspati and Edible Oil	15142	Manufacture of vegetable oils and fats (excluding corn oil)	41	190-194
S33	PHVO/vanaspati and Edible Oil	15143	Manufacture of vegetable oils and fats through solvent extraction process	41	190-194
S33	PHVO/vanaspati and Edible Oil	15146	Manufacture of cakes & meals incl. residual products, e.g. Oleostearin, Palmstearin	41	190-194
S33	PHVO/vanaspati and Edible Oil	15147	Manufacture of non-defatted flour or meals of oilseeds, oilnuts or kernels	41	190-194

Table A3-2 SAM classification

SAM activity labels	SAM acts.	SAM com	
Paddy	a001	c0001	Paddy
Wheat	a002	c0002	Wheat
Jowar	a003	c0003	Jowar
Bajara	a004	c0004	Bajara
Maize	a005	c0005	Maize
Gram and Pulses	a006	c0006	Gram and Pulses
Sugarcane	a007	c0007	Sugarcane
Groundnut	a008	c0008	Groundnut
Coconut	a009	c0009	Coconut
Other Oil Seeds	a010	c0010	Other Oil Seeds
Jute	a011	c0011	Jute
Cotton	a012	c0012	Cotton
Tea	a013	c0013	Tea
Coffee	a014	c0014	Coffee
Rubber	a015	c0015	Rubber
Tobacco	a016	c0016	Tobacco
Fruits	a017	c0017	Fruits
Vegetables	a018	c0018	Vegetables
Other Crops	a019	c0019	Other Crops
Animal Husbandry and Livestock	a020	c0020	Animal Husbandry and Livestock
Forestry and Logging	a021	c0021	Forestry and Logging
Fishing	a022	c0022	Fishing
Mining	a023	c0023	Mining
Sugar and Khandsari	a024	c0024	Sugar and Khandsari
PHVO/vanaspati	a025	c025V	PHVO/vanaspati
Other vegetable oils	a026	c026L	Local/other edible oils
Other vegetable oils	a026	c026P	Palm oil
Other vegetable oils	a026	c026S	Soybean
Other vegetable oils	a026	c026O	Oil Cake
Tea and Coffee Processing	a027	c0027	Tea and Coffee Processing
Processed Foods	a028	c0028	Processed Foods
Beverages	a029	c0029	Beverages
Tobacco Products	a030	c0030	Tobacco Products
Textile	a031	c0031	Textile
Textile Products	a032	c0032	Textile Products
Furniture and Fixture Wooden	a033	c0033	Furniture and Fixture Wooden
Wood and Wooden Prod-ucts except Furniture	a034	c0034	Wood and Wooden Prod-ucts except Furniture

Paper, paper products and newsprint	a035	c0035	Paper, paper products and newsprint
Printing, publishing and allied activities	a036	c0036	Printing, publishing and allied activities
Leather and Leather Prod-ucts	a037	c0037	Leather and Leather Prod-ucts
Rubber Products	a038	c0038	Rubber Products
Plastic Products	a039	c0039	Plastic Products
Petroleum Products	a040	c0040	Petroleum Products
Coal Tar Products	a041	c0041	Coal Tar Products
Chemicals	a042	c0042	Chemicals
Fertilizers	a043	c0043	Fertilizers
Cement	a044	c0044	Cement
Non Metallic Mineral Products	a045	c0045	Non Metallic Mineral Products
Metals	a046	c0046	Metals
Metal Products	a047	c0047	Metal Products
Non Electrical Machinery	a048	c0048	Non Electrical Machinery
Electrical Machinery	a049	c0049	Electrical Machinery
Transport Equipments	a050	c0050	Transport Equipments
Other Manufacturing	a051	c0051	Other Manufacturing
Construction	a052	c0052	Construction
Electricity	a053	c0053	Electricity
Water Supply	a054	c0054	Water Supply
Transport	a055	c0055	Transport
Supporting and Auxiliary Transport Services	a056	c0056	Supporting and Auxiliary Transport Services
Storage and Warehousing	a057	c0057	Storage and Warehousing
Communication	a058	c0058	Communication
Trade	a059	c0059	Trade
Hotel and Restaurants	a060	c0060	Hotel and Restaurants
Banking and Insurance	a061	c0061	Banking and Insurance
Ownership of Dwellings	a062	c0062	Ownership of Dwellings
Education and Research	a063	c0063	Education and Research
Medical and Health Ser-vices	a064	c0064	Medical and Health Ser-vices
Business Services	a065	c0065	Business Services
Real Estate Activities	a066	c0066	Real Estate Activities
Other Services	a067	c0067	Other Services
Public Administration	a068	c0068	Public Administration

Table A3-3 Correspondence table NSSO SAM ASICC04

NSSO 66 Round_Code	NSSO 66 Round_label	SAM code	Descr	ASICC04_code	ASICC04_label
190	vanaspati	c025	PHVO/vanaspati	12561	vanaspati
190		c025	PHVO/vanaspati	12563	margerine
191	Mustard	c026L	Mustard	12515	oil, mustard
191		c026L	Mustard	12534	mustard oil, refined
191		c026L	Mustard	12542	solvent extracted mastard oil
191		c026L	Mustard	12543	solvent extracted rapeseed oil
191		c026L	Mustard	12518	oil, rapeseed
191		c026L	Mustard	12536	rapeseed oil, refined
192	Groundnut	c026L	Groundnut	12507	oil, groundnut
192		c026L	Groundnut	12532	groundnut oil, refined
192		c026L	Groundnut	12541	solvent extracted groundnut oil
193	Coconut	c026L	Coconut	12531	coconut oil, refined
194	Other Edible Oils	c026P	Palm Oil	12517	oil, palm
194		c026P	Palm Oil	12535	palm oil, refined
194		c026S	Soybean Oil	12521	oil, soyabeans
194		c026S	Soybean Oil	12537	soyabeen oil, refined
194		c026L	Cottonseed	12505	oil, cotton
194		c026L	Rest	12501	oil, chilli
194		c026L	Rest	12502	oil, rice bran
194		c026L	Rest	12503	oil, castor
194		c026L	Rest	12504	oil, corpra
194		c026L	Rest	12506	oil, sesame(gingelly/til)
194		c026L	Rest	12508	oil, kardi

194		c026L	Rest	12511	oil, linseed
194		c026L	Rest	12512	oil, mahua
194		c026L	Rest	12513	oil, maize
194		c026L	Rest	12514	oil, mowrah
194		c026L	Rest	12516	oil, neem
194		c026L	Rest	12522	oil, sunflower
194		c026L	Rest	12524	oil, sal
194		c026L	Rest	12529	other refined oil, n.e.c
194		c026L	Rest	12533	kardi oil, refined
194		c026L	Rest	12538	sunflower oil, refined
194		c026L	Rest	12539	oil, vegetable, n.e.c
194		c026L	Rest	12544	solvent extracted sunflower oil
194		c026L	Rest	12549	solvent extracted oil n.e.c
194		c026L	Rest	12569	fat & related product of vegetable origin, n.e.c
	Oil-Cake	c026O	Oil-Cake	12671	oil-cake, cotton seed
		c026O	Oil-Cake	12672	oil-cake, sesame/gingelly/till
		c026O	Oil-Cake	12673	oil-cake, groundnut
		c026O	Oil-Cake	12674	oil-cake, linseed
		c026O	Oil-Cake	12675	oil-cake, maize
		c026O	Oil-Cake	12676	oil-cake, mowrah seed
		c026O	Oil-Cake	12677	oil-cake, mustard
		c026O	Oil-Cake	12678	oil-cake, rapeseed
		c025O	Oil-Cake	12681	oil-cake, sunflower
		c026O	Oil-Cake	12682	oil-cake, castor
		c026O	Oil-Cake	12683	oil-cake, coconut
		c026O	Oil-Cake	12684	oil-cake, neem seed
		c026O	Oil-Cake	12689	oil-cake, others (incl. solvent extracted)

A 3.2 Data sources: Brief description. Access, advantages and limitations

USDA production and distribution database

USDA provides yearly data starting on 1964 on consumption, supply and trade of vegetable oils and oilseeds. Units are 1000 MT, and yearly figures are based on local marketing year (Starting on October/September). PSD does not provide data on prices, which constitutes a limitation from the point of view of our study. Data are freely available from USDA (USDA, US Department of Agriculture, n.d.)

Data are provided in the form of supply and distribution tables, which is an accounting method where supply and use for a specific commodity are balanced out over the marketing period, including both food and non-food uses as well as waste and stock variation.

These data differ from FAO estimates in that FAO is committed to using official national estimates whenever available, while USDA PSD relies on alternative sources whenever they have been shown to be more timely or accurate than official estimates (USDA, US Department of Agriculture, n.d.). In addition, USDA base all of their estimates on marketing years while FAO use calendar years. In particular, we use specific data on imports, consumption, domestic production of oil and oil meal, oilseed crush and total domestic supply to disaggregate the edible oils sector structure in the SAM, to complementing other data sources. In addition, USDA data provide a consistent picture of historical evolution of commodity production, and use.

NSS household consumer expenditure survey

NSS surveys are available for purchase from the Government of India (NSSO, Government of India, Accessed August 2014). NSS (Schedule 1) provides household level data on monthly expenditure and quantity on 334 food items, with varying levels of aggregation across food groups (NSSO, Government of India, 2012b). These data can be used to estimate nutritional outcomes (NSSO, Government of India, 2012a). We use average monthly value and quantity purchases of food items by nine different household groups (five rural, four urban defined by occupation. NSS round 66th data are used in the construction of the original IEG SAM.

NSS data present some limitations when it comes to estimating detailed consumption patterns, including individual-level changes in consumption, and intra-household distribution of food consumption and total calorie or fat consumption. In addition, NSS data have been found to under-estimate the consumption of processed foods and food out of the house (Tandon and Landes 2012).

Annual Survey of Industries

The Annual Survey of Industries collects yearly industrial statistics on a nationally representative sample of all industries, including units employing ten or more workers using power (or 20 or more for those not using power). This survey is carried out by the government of India Central Statistics Office. Micro-data from years 1974 to 2013/14 are available for purchase from the Government of India (CSO, Government of India, n.d.).

Social Accounting Matrix

The original IEG SAM (Pradhan et al., 2013) includes 78 productive sectors, five rural and 9 urban household categories, one government account, a direct tax and an aggregate indirect tax account.

This SAM based on the 2007/2008 Input Output tables provided by the Government of India, combined with data from National Sample Survey Organization (NSSO) household consumer expenditure data and NCAER income-expenditure survey.

The data are freely available and published as part of the IEG working paper series, and the authors facilitated an excel version of the dataset. This dataset is, with date January 2017, the most updated SAM available, being based on more up-to-date data on National Account Statistics, compared to potential alternatives, such as GTAP database.

Nutritive Value of Indian Foods

(C. Gopalan, B. v. Rama Sastri & S.C. Balasubramanian, 1989) provides estimates of nutritive content for a wide range on Indian food items. These data are used in combination with NSS household consumer expenditure data to produce official government reports on nutritional intake at the national level (NSSO, Government of India, 2012a). The database includes energy and macronutrients as well as a range of micronutrients and fatty acid profiles.

Central Statistical Organisation Input-Output tables

Input-Output tables for 2007/08 are downloadable for registered users from the Ministry of Statistics and Program Implementation website (old version). Input output tables include an absorption (inputs) matrix and a "make" (outputs) matrix, for 130 economic sectors. Sectors are coded based on National Industry Classification code 2004 (NIC04). They reflect monetary flows across economic sectors in the economy. Edible oil manufacturing activities are aggregated into one activity, both in the Input Output tables and in the NIC04 sector classification. Partially hydrogenated vegetable oils constitute a separate sector.

FAOSTAT trade in crops and livestock products data: Data are freely available from FAOSTAT online database (FAO, n.d.), and provides yearly data on quantity and value in USD of imports and exports of the main food commodities. Prices reflect wholesale producer prices.

Government of India Import and export data bank: Provides annual total export and import quantities and values for the main commodities, with values in current INR, reflecting wholesale producer prices. Data are freely available online (Department of Commerce, GOI, n.d.). We use these data source to obtain prices for imports and exports of edible oil commodities, based on HS commodity codes (Cybex, n.d.) (8 digit level)

Index-Mundi monthly commodity prices: Index Mundi provides monthly commodity price averages in current USD and current INR. Figures are based on world-wide exchanges at wholesale producer prices. Index-Mundi aggregates data from a number of specialized commodity trading sites, offering freely accessible aggregate data and visualizations. We use these data to approximate producer, import and export prices when other data sources are not available.

GTAP database. This is a freely available data base containing fully documented information on bilateral trade, transport and protection linkages and consolidated Social Accounting Matrices representing monetary flows within and across the world economies (Global Trade Analysis Project, Purdue University, n.d.). We use information on the tax structure of the Indian economy to disaggregate the tax accounts in the IEG Social Accounting Matrix.

A 3.3 Additional tables and figures

Table A3-4 Data sources and use summary table.

Data source	**Data Use**
Social Accounting Matrix of India, Institute of Economic Growth, 2007/08 (Pradhan et al., 2013)	Benchmark dataset for CGE model
GTAP 9.1 SAM https://www.gtap.agecon.purdue.edu/databases/v9/	Disaggregation of Indirect tax account in IEG SAM, using shares based on GTAP SAM
CSO Input-Output tables for 2007/2008 http://www.mospi.gov.in/	Disaggregation of edible oils sector into "Hydrogenated fats and oils" and "Edible oils"
Annual Survey of Industries, Government of India, 2007/2008. http://www.csoisw.gov.in/cms/En/1023-annual-survey-of-industries.aspx	Disaggregation of edible oil input structure into processed food and PHVO sectors
National Sample Survey Organization Household Consumption expenditure survey round 66th round https://data.gov.in/catalog/household-consumer-expenditure-national-sample-survey	Household edible oil consumption patterns

Government of India Import Export data bank (8 digit precision) http://commerce.nic.in/eidb/icomq.asp	Disaggregation of import and export structure, wholesale unit rates for oils
USDA production, supply and distribution database https://apps.fas.usda.gov/psdonline/app/index.html#/app/home	Disaggregating consumption of soybean, palm oil and remaining edible oils. Oilseed crush quantity shares, in order to disaggregate input and factor use. Domestic production quantities.
FAOSTAT, Import, export, production, and availability data http://www.fao.org/faostat/en/	Disaggregation of import, export data: Double-checking and complementing data from Government of India for oil cake exports
Nutritive value of Indian foods database (Gopalan 1989, reprinted 2011)	Nutritional value coefficients for all food items in NSSO, aggregated to match SAM categories.
USDA food composition database https://ndb.nal.usda.gov/ndb/	Completing data from Gopalan (1989, 2011) for specific food items
Other additional databases used for background information, to check specific data or assumptions and complement other data sources: Expert interviews, newspaper articles (NY times), specialized commodity trading web pages (Zauba, IndexMundi), cost of cultivation database 2007/08, Malaysia Palm Oil board data on prices of FFB, palm kernel, IndexMundi for historical international price series, http://www.indexmundi.com/Commodities/ http://www.gmwatch.org/	Information on consumption patterns out of the house, sector structure, role of palm oil in the industry for PHVO and processed foods, oilseed values, proportion of value attributable to the sale of oil meal for the sector as a whole and for specific edible oils. * Values provided by NSSO consumer expenditure survey, used to disaggregate household consumption, are consumer prices. All other prices are wholesale FOB/CIF producer prices.

http://india.blogs.nytimes.com/ http://eands.dacnet.nic.in/Cost_of_Cultivation.htm https://www.zauba.com/	

Table A3-5 SAM sectors and correspondence

SAM commodities (Food-commodities marked with an F)	I-O Tables 2007-08	NSSO 2009-10
Paddy (F)	1	101-106
Wheat (F)	2	107-114
Jowar (F)	3	115
Bajara (F)	4	116
Maize (F)	5	117
Gram and Pulses (F)	6, 7	140-152
Sugarcane	8	172
Groundnut (F)	9	271
Coconut (F)	10	254, 255, 270
Other Oil Seeds	11	
Jute	12	
Cotton	13	
Tea	14	
Coffee	15	293
Rubber	16	
Tobacco	17	322
Fruits (F)	18	250-253, 256-268, 272-277
Vegetables (F)	19	210-242
Other Crops (F)	20	118-122, 139, 280-288, 310-312 330, 471
Animal Husbandry and Livestock (F)	21,22,23,24	160, 163-165, 174, 200, 202-206 343, 352
Forestry and Logging	25	341, 350

Fishing (F)	26	201
Mining	27-37	340, 347, 511
Sugar and Khandsari (F)	38, 39	170, 171, 173
PHVO (F)	40	190
Local edible oils/other (F)	41	191-194
Palm oil (F)	41	194
Soybean (F)	41	194
Oil Cake	41	
Tea and Coffee Processing	42	290-292
Processed Foods (F)	43	161, 162, 166, 167, 189, 298-308
Beverages (F)	44	294- 297,331-335
Tobacco Products	45	320, 321, 323-327
Textile	46,47,48,49,50,51	372, 386, 443, 466, 554, 555
Textile Products	52,53, 54	360-371, 373, 374, 380-385, 387
Furniture and Fixture Wooden	55	550-552, 557
Wood and Wooden Products except Furniture	56	556
Paper, paper products and newsprint	57	400-402
Printing, publishing and allied activities	58	400-402
Leather and Leather Products	59,60	390-392, 395
Rubber Products	61	393, 394, 603
Plastic Products	62	465
Petroleum Products	63	344, 345, 348, 353, 354, 508, 510
Coal Tar Products	64	
Chemicals	65, 66, 68, 69, 70, 71, 72, 73	346, 351, 410, 420, 450-453, 455-457, 467, 468, 470, 472
Fertilizers	67	
Cement	75	0
Non Metallic Mineral Products	74, 76	0
Metals	77,78,79, 80	0

Metal Products	81,82	0
Non Electrical Machinery	83, 84, 85, 86, 87	0
Electrical Machinery	88, 89, 90, 91, 92, 93, 94	0
Transport Equipment	95, 96, 97, 98, 99, 100	0
Other Manufacturing	101-105	0
Construction	106	0
Electricity	107	0
Water Supply	108	0
Transport	41,42,43	110-112
Supporting and Auxiliary Transport Services	41	113
Storage and Warehousing	41	114
Communication	44	115
Trade	40	116
Hotel and Restaurants	40	117
Banking and Insurance	145	118,119
Ownership of Dwellings	50	120
Education and Research	49	121
Medical and Health Services	49	122
Business Services	147	123
Real Estate Activities	147	126
Other Services	147	124, 125, 127-129
Public Administration	147	130

Table A3-6 Correspondence between SAM edible oil commodities and HS commodity codes, as used by the Government of India Export and Import Data Bank

All edible oils		15	Animal Or Vegetable Fats And Oils And Their Cleavage Products; Pre. Edible Fats; Animal Or Vegetable Waxex.
c025V	PHVO/vanaspati	1516	
		151610	Animal Fats And Oils And Their Fractions
		151620	Vegtbl Fats And Oils And Their Fractns
c026L	Mustard and Rapeseed oil	1514	Rape Colza/Mustard Oil And Its Fractns W/N Refined, But Not Chemiclly Modified
		151410	*Rape Colza/Mustard Crude Oil
		151411	Crude Low Eruc Acid Rape Colza Oil And Its Fractions
		151419	Low Eruc Acid Rape Colza Oil And Its Fractnsother Than Crude
		151490	*Refind Rape Colza/Mustard Oil
		151491	Othr Crude Colza Mustered Rape Seed Oils
		151499	Other Rape, Colza, Mustered Oils Other Than Crude
c026L	Groundnut oil		
		150810	Ground Nut Oil Crude
		150890	Othr Refnd Grnd Nut Oil And Its Fractions
c026L	Coconut oil		
		151311	Coconut (Copra) Crude Oil And Fractions
		151319	Coconut (Copra) Refined Oil And Fractions
c026P	Palm and Palm kernel oil	1511	
		151110	Crude Palm Oil And Its Fractns
		151190	Refined Palm Oil And Its Fractions
		15132110	Crude Palm Kernel Oil
		15132910	Refined Palm Kernel Oil And Its Fractns

c026S	Soybean oil	1507	
		150710	Soya Bean Crude Oil W/N Degummed
		150790	Other Soya Bean Oil And Its Fractions
c026L	Residual (Cottonseed oil)		
		151221	Cotn Sd Oil Crud W/N Gosypl Has Been Remvd
		151229	Othr Cotton Seed Oil And Its Fractions
c026L	Residual (other)	151211	Crude Oil Of Sunflower And Safflower Seed
		151219	Other Sunflwr And Safflwr Oil And Their Frctns
	Oil Cake	23040020	Oil Cake Of Soyabean,Solvent Extracted (Defatted) Variety
		2305	Oil Cake And Othr Solid Residus,Obtnd From Grndnut Oil Extrctn W/N Grnd/Pllts Form
		230670	*Oil Cake/Solid Resdus Of Maize(Corn)Germs
		23069017	Oil Cake And Meal Of Castor Seeds Expeller Variety
		23069090	Other Oil Cake/Solid Resdus

Source: Government of India. Department of Commerce, Export and Import data bank. http://commerce.nic.in/eidb/searchq.asp?fl=Icomq.asp

Table A3-7 Nutritional Coefficients

Energy in Kcal. Nutrients in grams per unit

SAM label	Description	NSS Item code	Food Item	Itemcode	Kcal	Carb	Prot	Fat	SFA	MUFA	PUFA	Trans	Units
c0001	Paddy	101	rice – PDS	101	3460	767	75	10	2.647059	2.352941	3	0	kg
c0001	Paddy	102	rice – other sources	102	3460	767	75	10	2.647059	2.352941	3	0	kg
c0001	Paddy	103	chira	103	3460	773	66	12	3.176471	2.823529	3.6	0	kg
c0001	Paddy	104	khoi, lawa	104	3250	736	75	1	0.264706	0.235294	0.3	0	kg
c0001	Paddy	105	muri	105	3250	736	75	1	0.264706	0.235294	0.3	0	kg
c0001	Paddy	106	other rice products	106	3460	767	75	10	2.647059	2.352941	3	0	kg
c0002	Wheat	107	wheat/ atta – PDS	107	3410	694	121	17	2.931034	1.758621	7.444828	0	kg
c0002	Wheat	108	wheat/ atta – other sources	108	3410	694	121	17	2.931034	1.758621	7.444828	0	kg
c0002	Wheat	110	maida	110	3480	739	110	9	1.551724	0.931034	3.941379	0	kg
c0002	Wheat	111	suji, rawa	111	3480	478	104	8	1.37931	0.827586	3.503448	0	kg
c0002	Wheat	112	sewai, noodles	112	3520	783	87	4	0.689655	0.413793	1.751724	0	kg
c0002	Wheat	113	bread (bakery)	113	2450	519	78	7	1.206897	0.724138	3.065517	0	kg
c0002	Wheat	114	other wheat products	114	3460	712	118	15	2.586207	1.551724	6.568966	0	kg
c0003	Jowar	115	jowar & its products	115	3490	726	104	19	3.281818	5.757576	8.924242	0	kg
c0004	Bajara	116	bajra & its products	116	3610	675	116	50	11.27273	10.90909	21.18182	0	kg
c0005	Maize	117	maize & products	117	3420	662	111	36	6.75	8.25	16.875	0	kg
c0019	Other Crops	118	barley & its products	118	3360	696	115	13	2.747727	1.684091	6.322727	0	kg
c0019	Other Crops	120	small millets & their products	120	2615	0	97	34	2.808696	5.913043	18.23188	0	kg
c0019	Other Crops	121	ragi & its products	121	3280	720	73	1.5	0.32	0.7	0.35	0	kg
c0019	Other Crops	122	other cereals	122	2615	0	97	34	6.778491	5.186168	11.76834	0	kg
c0019	Other Crops	139	cereal substitutes: tapioca, etc.	139	2090	0	28	3	0.645945	0.494207	1.121445	0	kg
c0006	Gram and Pulses	140	arhar, tur	140	3350	576	223	17	2.55	3.4	8.16	0	kg
c0006	Gram and Pulses	141	gram: split	141	3720	598	208	56	4.626087	9.73913	30.02899	0	kg
c0006	Gram and Pulses	142	gram: whole	142	3600	609	171	53	4.378261	9.217391	28.42029	0	kg
c0006	Gram and Pulses	143	moong	143	3480	599	245	12	3.176471	0.352941	5.647059	0	kg
c0006	Gram and Pulses	144	masur	144	3430	590	251	7	1.05	1.4	3.36	0	kg
c0006	Gram and Pulses	145	urd	145	3470	596	240	14	2.470588	1.647059	6.588235	0	kg
c0006	Gram and Pulses	146	peas	146	3150	565	197	11	1.361905	2.095238	4.97619	0	kg
c0006	Gram and Pulses	147	khesari	147	3450	566	282	6	0.9	1.2	2.88	0	kg
c0006	Gram and Pulses	148	other pulses	148	3400	0	220	12	1.522161	1.996293	6.062136	0	kg
c0006	Gram and Pulses	150	gram products	150	3600	609	171	6.9	0.57	1.2	3.7	0	kg
c0006	Gram and Pulses	151	besan	151	3400	0	220	12	1.8	2.4	5.76	0	kg
c0006	Gram and Pulses	152	other pulse products	152	3400	0	220	12	1.522161	1.996293	6.062136	0	kg
c0020	Animal Husbandry a	160	milk: liquid (litre)	160	1000	39.80583	40	42.71845	24.36388	10.60776	2.54743	0	litres
c0029	Beverages	161	baby food	161	0	0	380	1	0.570336	0.248318	0.059633	0	kg
c0029	Beverages	162	milk: condensed/ powder	162	4960	380	258	267	152.2798	66.30092	15.92202	0	kg
c0020	Animal Husbandry a	163	curd	163	600	30	31	40	22.81346	9.932722	2.385321	0	kg
c0020	Animal Husbandry a	164	ghee	164	9000	0	0	1000	856.7901	345.679	30.8642	0	kg
c0020	Animal Husbandry a	165	butter	165	7290	0	0	810	694	280	25	0	kg
c0029	Beverages	166	ice-cream	166	7.05	0	0.424	1.169	1.001588	0.404099	0.03608	0	Re
c0029	Beverages	167	other milk products	167	35.71	2.498	1.169	2.338	2.097916	0.884476	0.157252	0	Re

c0024	Sugar and Khandsa	170	sugar - PDS	170	3980	994	1	0	0	0	0	0	kg
c0024	Sugar and Khandsa	171	sugar - other sources	171	3980	994	1	0	0	0	0	0	kg
c0007	Sugarcane	172	gur	172	3830	950	4	1	0	0	0	0	kg
c0024	Sugar and Khandsa	173	candy, misri	173	3980	994	1	0	0	0	0	0	kg
c0020	Animal Husbandry a	174	honey	174	3190	795	3	0	0	0	0	0	kg
c0028	Processed Foods	189	salt	189	0	0	0	0	0	0	0	0	kg
c025V	Vanaspati	190	Vanaspati	190	9000	0	0	1000					kg
c026L	Local/others	191	mustard oil	191	9000	0	0	1000	107	560	326	0	kg
c026L	Local/others	192	groundnut oil	192	9000	0	0	1000	209	493.2	299	0	kg
c026L	Local/others	193	coconut oil	193	9000	0	0	1000	895	78	20	0	kg
c026L	Local/others	194	edible oil: others/cottonseed	194	9000	0	0	1000	259	178	519	0	kg
c026P	Palm	194	edible oil: others/palm	194	9000	0	0	1000	493	370	93	0	kg
c026S	Soybean	194	edible oil: others/soybean	194	9000	0	0	1000	156.5	227.8	577.4	0	kg
c026L	Local/others	194	edible oil: others/sunflower	194	9000	0	0	1000	103	195	657	0	kg
c0020	Animal Husbandry a	200	eggs (no.)	200	63	5.53	4.18	4.18	1.375	1.61	0.841	0.017	numbers
c0022	Fishing	201	fish, prawn	201	890	8	191	10	2	1.714286	2.821429	0	kg
c0020	Animal Husbandry a	202	goat meat/mutton	202	1180	0	214	36	16.69179	14.47466	2.642381	0	kg
c0020	Animal Husbandry a	203	beef/ buffalo meat	203	1140	0	226	26	10.53604	11.25693	0.983364	0	kg
c0020	Animal Husbandry a	204	pork	204	1140	0	187	44	16.16581	19.68881	4.197615	0	kg
c0020	Animal Husbandry a	205	chicken	205	1090	0	259	6	1.634578	2.353635	1.379175	0	kg
c0020	Animal Husbandry a	206	others: birds, crab, oyster, tortois	206	900	0	180	10	3.271513	3.1892	1.673203	0	kg
c0018	Vegetables	210	potato	210	970	226	16	1	0.253333	0.25	0.233333	0	kg
c0018	Vegetables	211	onion	211	500	111	12	1	0.163158	0.142105	0.384211	0	kg
c0018	Vegetables	212	radish	212	170	34	7	1	0.32	0.17	0.48	0	kg
c0018	Vegetables	213	carrot	213	480	106	9	2	0.333333	0.066667	0.988889	0	kg
c0018	Vegetables	214	turnip	214	290	62	5	2	0.506667	0.5	0.466667	0	kg
c0018	Vegetables	215	beet (root??)	215	430	88	17	1	0.253333	0.25	0.233333	0	kg
c0018	Vegetables	216	sweet potato	216	1200	282	12	3	0.76	0.75	0.7	0	kg
c0018	Vegetables	217	arum	217	970	211	30	1	0.253333	0.25	0.233333	0	kg
c0018	Vegetables	218	pumpkin	218	250	46	14	1	0.253333	0.25	0.233333	0	kg
c0018	Vegetables	220	gourd	220	120	25	2	1	0.253333	0.25	0.233333	0	kg
c0018	Vegetables	221	bitter gourd	221	600	106	21	10	2.533333	2.5	2.333333	0	kg
c0018	Vegetables	222	cucumber	222	130	25	4	1	0.225	0.0625	0.475	0	kg
c0018	Vegetables	223	parwal, patal	223	200	22	20	3	0.675	0.1875	1.425	0	kg
c0018	Vegetables	224	jhinga, torai	224	170	34	5	1	0.225	0.0625	0.475	0	kg
c0018	Vegetables	225	snake gourd	225	180	33	5	3	0.675	0.1875	1.425	0	kg
c0018	Vegetables	226	papaya: green	226	270	57	7	2	0.45	0.125	0.95	0	kg
c0018	Vegetables	227	cauliflower	227	300	40	26	4	0.622222	0.284444	1.928889	0	kg
c0018	Vegetables	228	cabbage	228	270	46	18	1	0	0.316667	0.383333	0	kg
c0018	Vegetables	230	brinjal	230	240	40	14	3	0.6	1.714286	0.214286	0	kg
c0018	Vegetables	231	lady's finger	231	350	64	19	2	1.057143	0.257143	0.114286	0	kg
c0018	Vegetables	232	palak/other leafy vegetables	232	260	29	20	7	1.575	0.4375	3.325	0	kg
c0018	Vegetables	233	french beans, barbati	233	260	45	17	1	0.227273	0.045455	0.513636	0	kg
c0018	Vegetables	234	tomato	234	200	36	9	2	0.272727	0.290909	0.8	0	kg
c0018	Vegetables	235	peas	235	930	159	72	1	0.191304	0.1	0.434783	0	kg
c0018	Vegetables	236	chillis: green	236	290	30	29	6	0.63	0.33	3.27	0	kg
c0018	Vegetables	237	capsicum	237	240	43	13	3	0.675	0.1875	1.425	0	kg

c0018	Vegetables	238	plantain: green	238	640	140	14	2	0.45	0.125	0.95	0	kg
c0018	Vegetables	240	jackfruit: green	240	510	94	26	3	0.675	0.1875	1.425	0	kg
c0018	Vegetables	241	lemon (no.)	241	100	0	2	2	0.26	0.073333	0.593333	0	numbers
c0018	Vegetables	242	other vegetables - rural	242	45.66	9.71275	1.169	0.237	0.053325	0.014813	0.112575	0	Re
c0017	Fruits	250	banana (no.)	250	1160	272	12					0	numbers
c0017	Fruits	251	jackfruit	251	880	198	19	1	0	0	0	0	kg
c0017	Fruits	252	watermelon	252	200	36	2	2	0.213333	0.493333	0.666667	0	kg
c0017	Fruits	253	pineapple (no.)	253	460	108	4	10	0.75	1.083333	3.333333	0	numbers
c0009	Coconut	254	coconut (no.)	254	6620	184	68	424.32	376.2752	18.05482	4.637239	0	numbers
c0009	Coconut	255	coconut green (no.)	255	0	0	35	1.7	0	0	0	0	numbers
c0017	Fruits	256	guava	256	510	112	9	3	0.858947	0.274737	1.266316	0	kg
c0017	Fruits	257	singara	257	1150	233	47	3	0	0	0	0	kg
c0017	Fruits	258	orange, mausami (no.)	258	0	0	10	10	1.25	1.916667	2.083333	0	numbers
c0017	Fruits	260	papaya	260	320	72	6	1	0.311538	0.276923	0.223077	0	kg
c0017	Fruits	261	mango	261	740	169	6	0.38	0	0	0	0	kg
c0017	Fruits	262	kharbooza	262	0	0	3	2	0	0	0	0	kg
c0017	Fruits	263	pears/naspati	263	520	119	6	2	0.314286	1.2	1.342857	0	kg
c0017	Fruits	264	berries	264	530	110	18	2	0.169697	0.284848	0.884848	0	kg
c0017	Fruits	265	leechi	265	610	136	11	2	0	0	0	0	kg
c0017	Fruits	266	apple	266	590	134	2	5	0.823529	0.205882	1.5	0	kg
c0017	Fruits	267	grapes	267	710	165	5	3	1.0125	0.13125	0.9	0	kg
c0017	Fruits	268	other fresh fruits rural	268	5.81	1.151375	0.237	0.0285	0.004479	0.0171	0.019136	0	Re
c0009	Coconut	270	coconut: copra	270	0	184	68	623		0.513644	0.096308	0	kg
c0008	Groundnut	271	groundnut	271	5670	261	253	401	88.22	210.525	102.255	0	kg
c0017	Fruits	272	dates	272	3170	758	25	4	0.328205	0.369231	0.194872	0	kg
c0017	Fruits	273	cashewnut	273	5960	223	212	469	103.18	246.225	119.595	0	kg
c0017	Fruits	274	walnut	274	6870	110	156	645	60.59301	88.35738	466.6037	0	kg
c0017	Fruits	275	other nuts	275	4100	242	108	300	66	157.5	76.5	0	kg
c0017	Fruits	276	raisin, kishmish, monacca, etc.	276	3080	746	18	3	0.378261	0.332609	0.241304	0	kg
c0017	Fruits	277	other dry fruits	277	3060	733.25	16	7	1.54	3.675	1.785	0	Kg
c0019	Other Crops	280	garlic (gm)	280	1.45	0.298	0.063	0.001	0.000149	0.000112	0.000551	0	gm
c0019	Other Crops	281	ginger (gm)	281	0.67	0.123	0.023	0.009	0.001345	0.001006	0.004955	0	gm
c0019	Other Crops	282	turmeric (gm)	282	3.49	0.694	0.063	0.051	0.00762	0.0057	0.02808	0	gm
c0019	Other Crops	283	black pepper (gm)	283	3.04	0.492	0.115	0.068	0.01016	0.0076	0.03744	0	gm
c0019	Other Crops	284	dry chillies (gm)	284	2.46	0.316	0.159	0.062	0.009264	0.006929	0.034136	0	gm

c0019	Other Crops	285	tamarind (gm)	285	2.83	0.674	0.031	0.001	0.000149	0.000112	0.000551	0	gm
c0019	Other Crops	286	curry powder (gm)	286	0.8	0.075	0.08	0.02	0.002988	0.002235	0.011012	0	gm
c0019	Other Crops	287	oilseeds (gm)	287	4.5	1.114	0.002	0.004	0.000598	0.000447	0.002202	0	gm
c0019	Other Crops	288	other spices (gm)	288	3.6	0.3325	0.14	0.19	0.028388	0.021235	0.104612	0	gm
c0027	Tea and Coffee Prc	290	tea : cups (no.)	290	27	6.36	0.3	0.04	0.022813	0.009933	0.002385	0	numbers
c0027	Tea and Coffee Prc	291	tea : leaf (gm)	291	0	0	0	0	0	0	0	0	gm
c0027	Tea and Coffee Prc	292	coffee : cups (no.)	292	40	9.02	0.8	0.08	0.045627	0.019865	0.004771	0	numbers
c0027	Tea and Coffee Prc	293	coffee: powder (gm)	293	0	0	0	0	0	0	0	0	gm
c0029	Beverages	294	mineral water (litre)	294	0	0	0	0	0	0	0	0	
c0029	Beverages	295	cold beverages: bottled/canned (	295	320	78	2	0	0	0	0	0	litres
c0029	Beverages	296	fruit juice and shake (litre)	296	250	38.5	15	4	0	0	0	0	litres
c0029	Beverages	297	other beverages: cocoa, chocolat	297	11.7	1.7675	0.1	0.47	0.268058	0.116709	0.028028	0	Re
c0028	Processed Foods	298	biscuits	298	33	7.33	0.47	0.2					Re
c0028	Processed Foods	300	cake, pastry	300	1131	163.75	65	24					kg
c0028	Processed Foods	301	prepared sweets	301	22.85	2.88	0.2	1.17					Re
c0028	Processed Foods	302	cooked meals received as assista	302	1200	230	25	20					numbers
c0028	Processed Foods	303	cooked meals purchased (no.)	303	1200	230	25	20					numbers
c0028	Processed Foods	304	salted refreshments	304	29.86	4.0325	0.8	1.17					Re
c0028	Processed Foods	305	pickles (gm)	305	0.04	0.00225	0.001	0.003					gm
c0028	Processed Foods	306	sauce (gm)	306	0.006	0.0012	0.0003	0					gm
c0028	Processed Foods	307	jam, jelly (gm)	307	0.025	0.00615	0.0001	0					gm
c0028	Processed Foods	308	other processed food	308	29.86	4.0325	0.8	1.17					Re
c0030	Tobacco Products	310	pan: leaf (no.)	310	2.2	0.3	0.16	0					numbers
c0031	Tobacco Products	311	pan: finished (no.)	311	3.7	0.5675	0.2	0					numbers
c0032	Tobacco Products	312	ingredients for pan (gm)	312	6.55	0.1	0.21	0.59					gm
c0030	Tobacco Products	320	bidi (no.)	320	0	0	0	0					numbers
c0030	Tobacco Products	321	cigarettes (no.)	321	0	0	0	0					numbers

Table A3-8 Shares for household disaggregation

Code	Commodity	RH1	RH2	RH3	RH4	RH5	UH1	UH2	UH3	UH4
c0001	Paddy	13.21%	17.83%	9.43%	24.27%	6.99%	11.18%	11.48%	3.60%	2.00%
c0002	Wheat	11.70%	11.84%	9.81%	27.43%	6.42%	14.75%	12.95%	3.14%	1.98%
c0003	Jowar	7.39%	30.97%	7.86%	28.98%	4.23%	7.98%	6.64%	5.05%	0.91%
c0004	Bajara	11.03%	17.79%	14.01%	40.44%	4.40%	5.38%	3.47%	3.20%	0.29%
c0005	Maize	6.90%	14.90%	15.79%	52.00%	5.87%	2.07%	1.39%	0.87%	0.21%
c0006	Gram and Pul	10.56%	14.80%	8.82%	24.91%	6.83%	13.82%	14.12%	3.82%	2.32%
c0007	Sugarcane	10.43%	14.09%	8.96%	34.97%	6.25%	11.40%	10.08%	2.48%	1.32%
c0008	Groundnut	9.18%	14.97%	6.98%	26.17%	7.05%	13.79%	16.17%	3.56%	2.14%
c0009	Coconut	9.78%	13.87%	11.36%	17.19%	9.23%	13.57%	15.96%	5.78%	3.25%
c0010	Other Oil See	9.78%	13.87%	11.36%	17.19%	9.23%	13.57%	15.96%	5.78%	3.25%
c0011	Jute									
c0012	Cotton									
c0013	Tea									
c0014	Coffee	6.26%	9.75%	7.03%	12.82%	6.86%	21.02%	26.21%	4.34%	5.70%
c0015	Rubber									
c0016	Tobacco	13.93%	22.51%	11.82%	33.19%	4.80%	5.63%	5.24%	2.19%	0.69%
c0017	Fruits	8.92%	7.52%	5.63%	18.24%	7.83%	21.09%	23.26%	2.58%	4.92%
c0018	Vegetables	11.31%	15.75%	9.32%	23.56%	6.87%	13.56%	13.83%	3.52%	2.30%
c0019	Other Crops	11.01%	16.77%	10.00%	23.60%	6.71%	12.60%	12.91%	4.13%	2.27%
c0020	Animal Husba	9.93%	10.01%	7.73%	28.07%	7.16%	16.18%	15.40%	3.00%	2.53%
c0021	Forestry and I	13.19%	23.77%	13.90%	32.36%	6.60%	4.29%	1.84%	3.51%	0.54%
c0022	Fishing	14.77%	14.72%	11.26%	18.39%	9.73%	10.85%	13.23%	3.71%	3.33%
c0023	Mining	15.63%	7.75%	12.77%	11.30%	6.33%	20.65%	13.16%	10.13%	2.27%
c0024	Sugar and Kha	11.01%	13.47%	9.69%	27.41%	7.05%	13.51%	12.34%	3.51%	2.02%
c025V	Vanaspati	12.54%	11.05%	11.23%	28.59%	7.27%	13.74%	11.04%	2.74%	1.80%
c026L	Local Edible o	11.99%	14.73%	9.54%	25.28%	7.01%	13.26%	12.77%	3.33%	2.10%
c026P	Palm Oil	8.09%	17.58%	8.44%	20.88%	5.38%	15.77%	16.83%	4.78%	2.25%
c026S	Soybean	8.09%	17.58%	8.44%	20.88%	5.38%	15.77%	16.83%	4.78%	2.25%
c026O	Oil Cake									
c0027	Tea and Coffe	10.43%	13.12%	9.95%	19.18%	7.43%	14.80%	17.99%	4.30%	2.80%
c0028	Processed Fo	8.37%	10.86%	8.78%	15.43%	11.71%	13.24%	19.42%	3.54%	8.65%
c0029	Beverages	10.63%	15.03%	10.91%	17.54%	5.66%	15.31%	17.35%	4.80%	2.77%
c0030	Tobacco Proc	11.03%	17.39%	12.95%	24.53%	5.01%	12.21%	11.09%	4.54%	1.24%
c0031	Textile	10.58%	8.98%	6.83%	30.24%	7.94%	14.46%	16.48%	1.62%	2.88%
c0032	Textile Produ	10.66%	10.80%	7.32%	23.19%	7.55%	15.65%	18.30%	2.77%	3.77%
c0033	Furniture and	5.91%	3.93%	3.98%	19.11%	6.09%	10.18%	48.76%	0.92%	1.12%
c0034	Wood and W	4.95%	10.33%	1.61%	10.57%	9.35%	22.85%	11.96%	27.82%	0.56%
c0035	Paper, paper	9.85%	4.97%	4.17%	14.43%	14.11%	20.16%	23.45%	1.76%	7.10%
c0036	Printing, publi	9.85%	4.97%	4.17%	14.43%	14.11%	20.16%	23.45%	1.76%	7.10%

c0037	Leather and L	9.75%	6.79%	5.56%	19.48%	8.56%	20.08%	23.14%	2.38%	4.25%
c0038	Rubber Produ	11.88%	13.13%	10.52%	27.72%	7.39%	12.33%	11.51%	3.11%	2.40%
c0039	Plastic Produ	11.27%	12.24%	6.74%	24.13%	7.89%	16.24%	16.06%	3.17%	2.26%
c0040	Petroleum Pr	8.81%	4.13%	4.15%	16.57%	7.77%	24.91%	27.04%	2.80%	3.82%
c0041	Coal Tar Products									
c0042	Chemicals	10.27%	12.75%	8.69%	22.05%	8.05%	14.72%	15.65%	3.78%	4.05%
c0043	Fertilizers									
c0044	Cement									
c0045	Non Metallic	11.14%	10.27%	11.35%	30.72%	7.93%	12.65%	11.46%	2.17%	2.32%
c0046	Metals									
c0047	Metal Produc	11.36%	11.52%	7.08%	23.24%	8.96%	15.04%	17.20%	2.84%	2.75%
c0048	Non Electrica	13.44%	2.51%	3.06%	7.97%	3.10%	28.40%	34.46%	2.23%	4.84%
c0049	Electrical Ma	6.75%	6.09%	5.32%	16.65%	6.48%	17.08%	35.05%	3.33%	3.25%
c0050	Transport Equ	16.20%	3.48%	2.04%	16.00%	6.77%	19.24%	34.71%	0.66%	0.89%
c0051	Other Manufa	10.32%	9.32%	9.35%	21.93%	11.47%	11.84%	20.44%	2.16%	3.17%
c0052	Construction	7.24%	10.33%	7.72%	24.81%	10.41%	12.11%	18.84%	2.72%	5.83%
c0053	Electricity	7.47%	7.54%	5.29%	14.98%	6.15%	25.39%	24.93%	3.36%	4.88%
c0054	Water Supply	4.46%	5.89%	3.20%	8.27%	3.69%	30.09%	32.31%	5.05%	7.05%
c0055	Transport	8.78%	10.10%	8.63%	18.33%	8.20%	15.43%	23.01%	3.35%	4.17%
c0056	Supporting ar	6.70%	10.20%	7.54%	21.08%	7.96%	15.93%	24.21%	1.68%	4.69%
c0057	Storage and Warehousing									
c0058	Communicati	8.71%	5.34%	5.27%	18.17%	8.09%	21.88%	25.11%	2.40%	5.03%
c0059	Trade	9.11%	0.12%	3.13%	5.90%	18.85%	20.07%	27.56%	0.33%	14.94%
c0060	Hotel and Re	9.11%	0.12%	3.13%	5.90%	18.85%	20.07%	27.56%	0.33%	14.94%
c0061	Banking and I	8.26%	10.59%	6.99%	17.18%	10.01%	14.44%	20.09%	3.18%	9.25%
c0062	Ownership of	0.47%	0.15%	0.54%	0.04%	1.27%	41.41%	41.23%	4.88%	10.00%
c0063	Education an	8.14%	3.81%	3.22%	15.72%	7.89%	24.40%	30.35%	1.53%	4.96%
c0064	Medical and I	10.85%	10.25%	7.67%	18.09%	9.32%	14.78%	17.95%	4.69%	6.40%
c0065	Business Serv	0.47%	0.15%	0.54%	0.04%	1.27%	41.41%	41.23%	4.88%	10.00%
c0066	Real Estate A	0.47%	0.15%	0.54%	0.04%	1.27%	41.41%	41.23%	4.88%	10.00%
c0067	Other Service	8.42%	9.05%	6.22%	18.36%	6.23%	21.31%	22.37%	2.92%	5.13%
c0068	Public Administration									

Table A3-9 Adjusted nutritional weights. Nutritional weights per INR in baseline

Code	Commodity	Kcal	Carb	Prot	Fat	SFA	MUFA	PUFA
c0001	Paddy	244.68	54.25	5.30	0.70	0.19	0.17	0.21
c0002	Wheat	250.92	50.83	8.86	1.23	0.21	0.13	0.54
c0003	Jowar	292.61	60.87	8.72	1.59	0.28	0.48	0.75
c0004	Bajara	340.19	63.61	10.93	4.71	1.06	1.03	2.00
c0005	Maize	301.89	58.44	9.80	3.18	0.60	0.73	1.49
c0006	Gram and Pulses	61.82	9.24	4.03	0.36	0.05	0.06	0.18
c0007	Sugarcane	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c0008	Groundnut	106.60	4.91	4.76	7.54	1.66	3.96	1.92
c0009	Coconut	19.13	0.53	0.20	1.80	0.06	0.00	0.00
c0017	Fruits	13.46	2.83	0.17	0.13	0.02	0.04	0.05
c0018	Vegetables	36.97	7.74	1.15	0.17	0.04	0.03	0.06
c0019	Other Crops	14.78	2.37	0.32	0.02	0.00	0.00	0.01
c0020	Animal Husbandry and L	43.24	1.59	1.93	1.93	1.71	0.73	0.13
c0022	Fishing	11.93	0.11	2.56	0.13	0.03	0.02	0.04
c0024	Sugar and Khandsari	125.02	31.22	0.03	0.00	0.00	0.00	0.00
c0027	Tea and Coffee Process	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c0028	Processed Foods	12.77	2.07	0.26	2.35	0.00	0.00	0.00
c0029	Beverages	46.22	10.72	0.30	0.27	0.19	0.08	0.02
c025V	Vanaspati	158.41	0.00	0.00	17.60	0.00	0.00	0.00
C026L	Local edible oils/other	141.24	0.00	0.00	15.75	2.93	7.11	5.50
c026P	Palm oil	178.09	0.00	0.00	20.15	9.93	7.45	1.87
c026S	Soybean oil	160.56	0.00	0.00	18.16	2.84	4.14	10.49

Code	*Local edible oils/other	Shares	Kcal	Carb	Prot	Fat	SFA	MUFA	PUFA
c026L	Mustard/Rapeseed	0.62	134.21	0.00	0.00	14.91	1.60	8.35	4.86
c026L	Groundnut	0.18	132.79	0.00	0.00	14.75	3.08	7.28	4.41
c026L	Coconut	0.04	153.04	0.00	0.00	17.00	15.22	1.33	0.34
c026L	Rest: Cottonseed	0.16	174.83	0.00	0.00	19.78	5.12	3.52	10.26

Sources: Gopalan (1989), USDA nutrient composition tables. Consumption shares from NSS, USDA ps&d.
Nutritional weight per INR. Energy in Kcal. Rest in g
Consumption shares derived from NSS, USDA ps&d. nutritional content from Gopalan (1989), USDA nutrient composition tal

Appendix 4: Simulation results summary tables

Table A4-1 Changes in palm oil tariffs. Scenario (A), 20% reduction (tariff removal), Scenario (B) 25% increase with respect to baseline (ASEAN limit)

Results summary table 1.Scenarios (A), (B). Changes in palm oil tariffs: 20% reduction (tariff removal); 25% increase with respect to baseline (ASEAN limit)

	Nutritional Outcomes												Economic impacts			
	SFA [1]		UFA [1]		Trans [1]		Fat [2]		Processed food [2]		Edible oils [2]		Expenditure oils		Household income	
Tariff change	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Rural																
Self-employed in non-agriculture	0.21%	-0.20%	-0.16%	0.16%	-0.04%	0.04%	0.37%	-0.30%	0.09%	-0.10%	0.89%	-0.59%	-0.05%	0.05%	0.04%	-0.05%
agricultural labour	0.28%	-0.28%	-0.24%	0.23%	-0.04%	0.04%	0.59%	-0.49%	0.12%	-0.13%	1.41%	-0.86%	-0.02%	0.02%	0.04%	-0.05%
other labour	0.24%	-0.24%	-0.19%	0.18%	-0.05%	0.05%	0.44%	-0.37%	0.10%	-0.12%	0.87%	-0.72%	-0.03%	0.03%	0.05%	-0.06%
self-employed in agriculture	0.21%	-0.20%	-0.17%	0.17%	-0.04%	0.04%	0.39%	-0.32%	0.09%	-0.10%	1.20%	-0.67%	-0.05%	0.05%	0.04%	-0.05%
other	0.22%	-0.22%	-0.15%	0.15%	-0.07%	0.07%	0.34%	-0.28%	0.09%	-0.10%	0.45%	-0.62%	-0.05%	0.05%	0.05%	-0.06%
Urban																
self-employed	0.25%	-0.25%	-0.20%	0.20%	-0.05%	0.05%	0.48%	-0.39%	0.08%	-0.09%	1.17%	-0.79%	-0.05%	0.06%	0.05%	-0.06%
regular wage	0.27%	-0.27%	-0.20%	0.20%	-0.06%	0.07%	0.49%	-0.39%	0.08%	-0.09%	0.86%	-0.81%	-0.05%	0.06%	0.05%	-0.06%
casual labour	0.30%	-0.29%	-0.24%	0.24%	-0.05%	0.05%	0.59%	-0.48%	0.10%	-0.12%	1.23%	-0.89%	-0.03%	0.03%	0.05%	-0.06%
other	0.26%	-0.27%	-0.15%	0.15%	-0.12%	0.12%	0.34%	-0.28%	0.08%	-0.09%	0.28%	-0.73%	-0.05%	0.06%	0.05%	-0.06%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	-0.14%	0.15%	0.02%	-0.03%	0.10%	-0.12%	-0.63%	0.71%	-0.40%	0.45%	-0.04%	0.04%	-16.21%	20.21%	-0.07%	0.07%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Reference elasticity parameters: EFP, EVP, EHD= 0.7

Table A4-2 Results summary. Scenarios (C), (C + S2), 60% increase in palm oil tariffs (Historical levels); 60% increase and revenue-neutral subside on soybean

Results summary table 2. Scenarios (C), (C+S2). 60% increase increase in palm oil tariffs (Historical levels); 60% increase and revenue-neutral subsidy on local/other oils

	Nutritional Outcomes												**Economic impacts**			
	SFA [1]		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**C**	**C+S2**	**C**	**C+S2**	**C**	**C+S2**	**C**	**C+S2**	**C**	**C+S2**	**C**	**C+S2**	**C**	**C+S2**	**C**	**C+S2**
Rural																
Self-employed in non-agriculture	-0.43%	-0.55%	0.33%	0.49%	0.09%	0.06%	-0.56%	0.22%	-0.22%	-0.13%	-1.32%	0.51%	0.12%	0.24%	-0.13%	-0.05%
agricultural labour	-0.58%	-0.69%	0.48%	0.61%	0.09%	0.08%	-0.90%	-0.13%	-0.30%	-0.17%	-2.10%	-0.21%	0.04%	0.20%	-0.13%	-0.04%
other labour	-0.49%	-0.61%	0.38%	0.53%	0.11%	0.08%	-0.68%	0.06%	-0.27%	-0.15%	-1.32%	0.18%	0.07%	0.22%	-0.14%	-0.05%
self-employed in agriculture	-0.42%	-0.54%	0.34%	0.49%	0.08%	0.05%	-0.59%	0.13%	-0.23%	-0.12%	-1.78%	0.28%	0.11%	0.25%	-0.12%	-0.03%
other	-0.47%	-0.59%	0.32%	0.46%	0.15%	0.13%	-0.53%	0.08%	-0.22%	-0.16%	-0.66%	0.32%	0.12%	0.22%	-0.14%	-0.05%
Urban																
self-employed	-0.53%	-0.65%	0.42%	0.56%	0.11%	0.09%	-0.70%	-0.11%	-0.21%	-0.15%	-1.68%	-0.20%	0.13%	0.22%	-0.13%	-0.05%
regular wage	-0.57%	-0.68%	0.43%	0.56%	0.14%	0.12%	-0.71%	-0.17%	-0.21%	-0.16%	-1.23%	-0.32%	0.13%	0.22%	-0.13%	-0.05%
casual labour	-0.61%	-0.73%	0.50%	0.63%	0.12%	0.10%	-0.88%	-0.25%	-0.27%	-0.18%	-1.79%	-0.44%	0.07%	0.20%	-0.14%	-0.05%
other	-0.57%	-0.69%	0.31%	0.45%	0.26%	0.24%	-0.52%	-0.10%	-0.21%	-0.17%	-0.40%	-0.08%	0.13%	0.20%	-0.13%	-0.05%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.00%	-0.07%	-0.04%	-0.27%	-0.21%	1.60%	1.55%	1.00%	2.22%	0.07%	-6.44%	48.41%	48.52%	0.14%	-0.03%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Reference elasticity parameters: EFP, EVP, EHD= 0.7

Table A4-3 Results summary. Scenarios (C), (C + S1), 60% increase in palm oil tariffs (Historical levels); 60% increase and revenue-neutral subside on soybean

Results summary table 3. Scenarios (C), (C+S1). 60% increase increase in palm oil tariffs (Historical levels); 60% increase and revenue-neutral subsidy on soybean oil

	Nutritional Outcomes												Economic impacts			
	SFA [1]		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**	**C**	**C+S1**
Rural																
Self-employed in non-agriculture	-0.43%	-0.58%	0.33%	0.51%	0.09%	0.07%	-0.56%	0.24%	-0.22%	-0.16%	-1.32%	0.50%	0.12%	0.22%	-0.13%	-0.05%
agricultural labour	-0.58%	-0.80%	0.48%	0.74%	0.09%	0.06%	-0.90%	0.41%	-0.30%	-0.16%	-2.10%	0.77%	0.04%	0.22%	-0.13%	-0.05%
other labour	-0.49%	-0.67%	0.38%	0.60%	0.11%	0.08%	-0.68%	0.28%	-0.27%	-0.16%	-1.32%	0.61%	0.07%	0.21%	-0.14%	-0.06%
self-employed in agriculture	-0.42%	-0.59%	0.34%	0.54%	0.08%	0.05%	-0.59%	0.29%	-0.23%	-0.14%	-1.78%	0.60%	0.11%	0.24%	-0.12%	-0.04%
other	-0.47%	-0.63%	0.32%	0.50%	0.15%	0.13%	-0.53%	0.19%	-0.22%	-0.17%	-0.66%	0.54%	0.12%	0.21%	-0.14%	-0.05%
Urban																
self-employed	-0.53%	-0.77%	0.42%	0.69%	0.11%	0.07%	-0.70%	0.36%	-0.21%	-0.15%	-1.68%	0.76%	0.13%	0.23%	-0.13%	-0.05%
regular wage	-0.57%	-0.81%	0.43%	0.71%	0.14%	0.10%	-0.71%	0.35%	-0.21%	-0.15%	-1.23%	0.80%	0.13%	0.22%	-0.13%	-0.05%
casual labour	-0.61%	-0.88%	0.50%	0.80%	0.12%	0.08%	-0.88%	0.43%	-0.27%	-0.15%	-1.79%	0.85%	0.07%	0.22%	-0.14%	-0.06%
other	-0.57%	-0.74%	0.31%	0.52%	0.26%	0.23%	-0.52%	0.17%	-0.21%	-0.17%	-0.40%	0.69%	0.13%	0.21%	-0.13%	-0.05%
Economic Impacts																
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.00%	-0.07%	-0.05%	-0.27%	-0.21%	1.60%	1.51%	1.00%	1.50%	0.07%	0.04%	48.41%	48.52%	0.14%	-18.17%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Kcal. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Reference elasticity parameters: EFP, EVP, EHD= 0.7

Table A4-4 Sensitivity analysis Scenario (C): 60%increase in palm oil tariffs (Historical levels): Elasticity EFP, EVP=reference, EHD= High

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP, EHD= High

	Nutritional Outcomes												Economic impacts			
	SFA [1]		UFA [1]		Trans [1]		Fat [2]		Processed food [2]		Edible oils [2]		Expenditure oils		Household income	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-1.27%	0.33%	0.95%	0.09%	0.32%	-0.56%	-0.57%	-0.22%	-0.18%	-1.32%	-1.45%	0.12%	0.07%	-0.13%	-0.12%
agricultural labour	-0.58%	-1.72%	0.48%	1.39%	0.09%	0.32%	-0.90%	-0.86%	-0.30%	-0.25%	-2.10%	-1.80%	0.04%	0.00%	-0.13%	-0.12%
other labour	-0.49%	-1.48%	0.38%	1.09%	0.11%	0.39%	-0.68%	-0.67%	-0.27%	-0.22%	-1.32%	-1.75%	0.07%	0.03%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-1.27%	0.34%	0.98%	0.08%	0.29%	-0.59%	-0.57%	-0.23%	-0.17%	-1.78%	-1.62%	0.11%	0.08%	-0.12%	-0.10%
other	-0.47%	-1.45%	0.32%	0.91%	0.15%	0.54%	-0.53%	-0.53%	-0.22%	-0.19%	-0.66%	-1.52%	0.12%	0.06%	-0.14%	-0.13%
Urban																
self-employed	-0.53%	-1.63%	0.42%	1.24%	0.11%	0.39%	-0.70%	-0.67%	-0.21%	-0.17%	-1.68%	-1.80%	0.13%	0.08%	-0.13%	-0.13%
regular wage	-0.57%	-1.75%	0.43%	1.27%	0.14%	0.48%	-0.71%	-0.67%	-0.21%	-0.17%	-1.23%	-1.77%	0.13%	0.08%	-0.13%	-0.13%
casual labour	-0.61%	-1.86%	0.50%	1.47%	0.12%	0.40%	-0.88%	-0.82%	-0.27%	-0.22%	-1.79%	-1.87%	0.07%	0.03%	-0.14%	-0.14%
other	-0.57%	-1.83%	0.31%	0.95%	0.26%	0.87%	-0.52%	-0.51%	-0.21%	-0.17%	-0.40%	-1.64%	0.13%	0.08%	-0.13%	-0.14%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.07%	-0.07%	-0.11%	-0.27%	-0.21%	1.60%	6.54%	1.00%	3.84%	0.07%	0.42%	48.41%	47.76%	0.14%	0.59%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EVP, EHD= 2.4

Table A4-5 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP = low, EHD = high

Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP = low; EHD= High

	Nutritional Outcomes												Economic impacts			
	SFA [1]		UFA [1]		Trans [1]		Fat [2]		Processed food [2]		Edible oils [2]		Expenditure oils		Household income	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.83%	0.33%	0.72%	0.09%	0.11%	-0.56%	-0.58%	-0.22%	-0.23%	-1.32%	-1.48%	0.12%	0.14%	-0.13%	-0.13%
agricultural labour	-0.58%	-1.34%	0.48%	1.22%	0.09%	0.11%	-0.90%	-0.87%	-0.30%	-0.29%	-2.10%	-1.83%	0.04%	0.08%	-0.13%	-0.13%
other labour	-0.49%	-0.98%	0.38%	0.84%	0.11%	0.13%	-0.68%	-0.68%	-0.27%	-0.27%	-1.32%	-1.78%	0.07%	0.10%	-0.14%	-0.15%
self-employed in agriculture	-0.42%	-0.89%	0.34%	0.77%	0.08%	0.12%	-0.59%	-0.59%	-0.23%	-0.22%	-1.78%	-1.65%	0.11%	0.15%	-0.12%	-0.12%
other	-0.47%	-0.78%	0.32%	0.67%	0.15%	0.11%	-0.53%	-0.55%	-0.22%	-0.23%	-0.66%	-1.55%	0.12%	0.14%	-0.14%	-0.14%
Urban																
self-employed	-0.53%	-1.17%	0.42%	1.03%	0.11%	0.14%	-0.70%	-0.69%	-0.21%	-0.21%	-1.68%	-1.83%	0.13%	0.16%	-0.13%	-0.14%
regular wage	-0.57%	-1.20%	0.43%	1.08%	0.14%	0.12%	-0.71%	-0.69%	-0.21%	-0.21%	-1.23%	-1.79%	0.13%	0.16%	-0.13%	-0.14%
casual labour	-0.61%	-1.41%	0.50%	1.29%	0.12%	0.13%	-0.88%	-0.84%	-0.27%	-0.26%	-1.79%	-1.90%	0.07%	0.11%	-0.14%	-0.15%
other	-0.57%	-0.79%	0.31%	0.69%	0.26%	0.11%	-0.52%	-0.53%	-0.21%	-0.22%	-0.40%	-1.67%	0.13%	0.15%	-0.13%	-0.14%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.15%	-0.07%	-0.10%	-0.27%	-0.28%	1.60%	2.73%	1.00%	2.85%	0.07%	0.43%	48.41%	48.08%	0.14%	0.66%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EVP=0.1; EHD= 2.4

Table A4-6 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP = high, EHD = low

Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP = high; EHD= low

	Nutritional Outcomes												**Economic impacts**			
	SFA [1]		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.48%	0.33%	0.26%	0.09%	0.22%	-0.56%	-0.56%	-0.22%	-0.19%	-1.32%	-0.96%	0.12%	0.06%	-0.13%	-0.12%
agricultural labour	-0.58%	-0.42%	0.48%	0.21%	0.09%	0.21%	-0.90%	-0.94%	-0.30%	-0.27%	-2.10%	-1.52%	0.04%	-0.02%	-0.13%	-0.12%
other labour	-0.49%	-0.54%	0.38%	0.28%	0.11%	0.26%	-0.68%	-0.69%	-0.27%	-0.24%	-1.32%	-1.20%	0.07%	0.01%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-0.40%	0.34%	0.23%	0.08%	0.17%	-0.59%	-0.60%	-0.23%	-0.20%	-1.78%	-1.10%	0.11%	0.05%	-0.12%	-0.12%
other	-0.47%	-0.71%	0.32%	0.28%	0.15%	0.43%	-0.53%	-0.53%	-0.22%	-0.19%	-0.66%	-1.02%	0.12%	0.06%	-0.14%	-0.13%
Urban																
self-employed	-0.53%	-0.48%	0.42%	0.23%	0.11%	0.26%	-0.70%	-0.72%	-0.21%	-0.18%	-1.68%	-1.31%	0.13%	0.07%	-0.13%	-0.13%
regular wage	-0.57%	-0.58%	0.43%	0.22%	0.14%	0.36%	-0.71%	-0.73%	-0.21%	-0.18%	-1.23%	-1.39%	0.13%	0.07%	-0.13%	-0.13%
casual labour	-0.61%	-0.49%	0.50%	0.21%	0.12%	0.27%	-0.88%	-0.93%	-0.27%	-0.24%	-1.79%	-1.57%	0.07%	0.01%	-0.14%	-0.13%
other	-0.57%	-1.09%	0.31%	0.31%	0.26%	0.77%	-0.52%	-0.52%	-0.21%	-0.18%	-0.40%	-1.23%	0.13%	0.07%	-0.13%	-0.13%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.34%	-0.07%	-0.06%	-0.27%	-0.23%	1.60%	3.38%	1.00%	0.63%	0.07%	-0.13%	48.41%	48.43%	0.14%	-0.22%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EVP=2.4; EHD= 0.1

Table A4-7 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP, EHD = low

Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP, EHD low

	Nutritional Outcomes												**Economic impacts**			
Nutritional Outcomes	**SFA [1]**		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.03%	0.33%	0.02%	0.09%	0.01%	-0.56%	-0.57%	-0.22%	-0.24%	-1.32%	-0.97%	0.12%	0.13%	-0.13%	-0.13%
agricultural labour	-0.58%	-0.04%	0.48%	0.03%	0.09%	0.01%	-0.90%	-0.95%	-0.30%	-0.32%	-2.10%	-1.53%	0.04%	0.05%	-0.13%	-0.13%
other labour	-0.49%	-0.04%	0.38%	0.03%	0.11%	0.01%	-0.68%	-0.71%	-0.27%	-0.28%	-1.32%	-1.21%	0.07%	0.09%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-0.02%	0.34%	0.02%	0.08%	0.00%	-0.59%	-0.62%	-0.23%	-0.25%	-1.78%	-1.11%	0.11%	0.12%	-0.12%	-0.13%
other	-0.47%	-0.03%	0.32%	0.02%	0.15%	0.02%	-0.53%	-0.55%	-0.22%	-0.24%	-0.66%	-1.03%	0.12%	0.13%	-0.14%	-0.14%
Urban																
self-employed	-0.53%	-0.02%	0.42%	0.01%	0.11%	0.01%	-0.70%	-0.74%	-0.21%	-0.22%	-1.68%	-1.32%	0.13%	0.15%	-0.13%	-0.13%
regular wage	-0.57%	-0.03%	0.43%	0.01%	0.14%	0.02%	-0.71%	-0.75%	-0.21%	-0.22%	-1.23%	-1.40%	0.13%	0.15%	-0.13%	-0.13%
casual labour	-0.61%	-0.04%	0.50%	0.02%	0.12%	0.01%	-0.88%	-0.94%	-0.27%	-0.29%	-1.79%	-1.58%	0.07%	0.09%	-0.14%	-0.14%
other	-0.57%	-0.04%	0.31%	0.01%	0.26%	0.04%	-0.52%	-0.55%	-0.21%	-0.22%	-0.40%	-1.24%	0.13%	0.15%	-0.13%	-0.13%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.43%	-0.07%	-0.06%	-0.27%	-0.30%	1.60%	-0.33%	1.00%	-0.39%	0.07%	-0.15%	48.41%	48.61%	0.14%	-0.18%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EVP, EHD= 0.1

Table A4-8 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD = High, EVP = low

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD =high, EVP=low.

	Nutritional Outcomes												**Economic impacts**			
	SFA [1]		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-1.03%	0.33%	0.75%	0.09%	0.29%	-0.56%	-0.58%	-0.22%	-0.19%	-1.32%	-1.31%	0.12%	0.07%	-0.13%	-0.13%
agricultural labour	-0.58%	-1.54%	0.48%	1.24%	0.09%	0.30%	-0.90%	-0.86%	-0.30%	-0.25%	-2.10%	-1.71%	0.04%	0.01%	-0.13%	-0.13%
other labour	-0.49%	-1.23%	0.38%	0.87%	0.11%	0.35%	-0.68%	-0.68%	-0.27%	-0.23%	-1.32%	-1.61%	0.07%	0.03%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-1.05%	0.34%	0.80%	0.08%	0.25%	-0.59%	-0.58%	-0.23%	-0.17%	-1.78%	-1.48%	0.11%	0.08%	-0.12%	-0.11%
other	-0.47%	-1.19%	0.32%	0.69%	0.15%	0.50%	-0.53%	-0.54%	-0.22%	-0.19%	-0.66%	-1.39%	0.12%	0.07%	-0.14%	-0.14%
Urban																
self-employed	-0.53%	-1.41%	0.42%	1.06%	0.11%	0.35%	-0.70%	-0.68%	-0.21%	-0.17%	-1.68%	-1.68%	0.13%	0.08%	-0.13%	-0.14%
regular wage	-0.57%	-1.54%	0.43%	1.09%	0.14%	0.45%	-0.71%	-0.68%	-0.21%	-0.17%	-1.23%	-1.67%	0.13%	0.08%	-0.13%	-0.13%
casual labour	-0.61%	-1.67%	0.50%	1.30%	0.12%	0.37%	-0.88%	-0.83%	-0.27%	-0.22%	-1.79%	-1.78%	0.07%	0.03%	-0.14%	-0.14%
other	-0.57%	-1.52%	0.31%	0.69%	0.26%	0.83%	-0.52%	-0.51%	-0.21%	-0.18%	-0.40%	-1.54%	0.13%	0.08%	-0.13%	-0.14%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.10%	-0.07%	-0.11%	-0.27%	-0.22%	1.60%	5.71%	1.00%	3.51%	0.07%	0.40%	48.41%	47.86%	0.14%	0.60%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EHD= 2.4, EVP=0.1

Table A4-9 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP=reference, EHD=high.

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP=reference, EHD=high.

	Nutritional Outcomes												Economic impacts			
	SFA [1]		UFA [1]		Trans [1]		Fat [2]		Processed food [2]		Edible oils [2]		Expenditure oils		Household income	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.95%	0.33%	0.78%	0.09%	0.17%	-0.56%	-0.58%	-0.22%	-0.22%	-1.32%	-1.47%	0.12%	0.12%	-0.13%	-0.13%
agricultural labour	-0.58%	-1.44%	0.48%	1.27%	0.09%	0.17%	-0.90%	-0.87%	-0.30%	-0.28%	-2.10%	-1.82%	0.04%	0.06%	-0.13%	-0.13%
other labour	-0.49%	-1.12%	0.38%	0.92%	0.11%	0.20%	-0.68%	-0.68%	-0.27%	-0.25%	-1.32%	-1.78%	0.07%	0.08%	-0.14%	-0.15%
self-employed in agriculture	-0.42%	-1.00%	0.34%	0.83%	0.08%	0.16%	-0.59%	-0.58%	-0.23%	-0.20%	-1.78%	-1.65%	0.11%	0.13%	-0.12%	-0.11%
other	-0.47%	-0.96%	0.32%	0.74%	0.15%	0.22%	-0.53%	-0.54%	-0.22%	-0.22%	-0.66%	-1.54%	0.12%	0.12%	-0.14%	-0.14%
Urban																
self-employed	-0.53%	-1.29%	0.42%	1.09%	0.11%	0.20%	-0.70%	-0.68%	-0.21%	-0.20%	-1.68%	-1.82%	0.13%	0.14%	-0.13%	-0.14%
regular wage	-0.57%	-1.35%	0.43%	1.13%	0.14%	0.22%	-0.71%	-0.68%	-0.21%	-0.20%	-1.23%	-1.79%	0.13%	0.14%	-0.13%	-0.13%
casual labour	-0.61%	-1.54%	0.50%	1.34%	0.12%	0.20%	-0.88%	-0.84%	-0.27%	-0.25%	-1.79%	-1.89%	0.07%	0.09%	-0.14%	-0.14%
other	-0.57%	-1.07%	0.31%	0.76%	0.26%	0.31%	-0.52%	-0.52%	-0.21%	-0.21%	-0.40%	-1.66%	0.13%	0.13%	-0.13%	-0.14%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.13%	-0.07%	-0.11%	-0.27%	-0.26%	1.60%	3.81%	1.00%	3.14%	0.07%	0.43%	48.41%	48.00%	0.14%	0.64%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EVP= 0.7, EHD=2.4

Table A4-10 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD=reference, EVP=high.

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD=reference, EVP=high.

	Nutritional Outcomes												Economic impacts			
	SFA [1]		UFA [1]		Trans [1]		Fat [2]		Processed food [2]		Edible oils [2]		Expenditure oils		Household income	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.58%	0.33%	0.48%	0.09%	0.10%	-0.56%	-0.55%	-0.22%	-0.22%	-1.32%	-1.11%	0.12%	0.11%	-0.13%	-0.13%
agricultural labour	-0.58%	-0.69%	0.48%	0.59%	0.09%	0.10%	-0.90%	-0.90%	-0.30%	-0.30%	-2.10%	-1.59%	0.04%	0.04%	-0.13%	-0.13%
other labour	-0.49%	-0.66%	0.38%	0.53%	0.11%	0.12%	-0.68%	-0.67%	-0.27%	-0.26%	-1.32%	-1.36%	0.07%	0.07%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-0.57%	0.34%	0.48%	0.08%	0.09%	-0.59%	-0.58%	-0.23%	-0.22%	-1.78%	-1.25%	0.11%	0.11%	-0.12%	-0.12%
other	-0.47%	-0.63%	0.32%	0.47%	0.15%	0.16%	-0.53%	-0.52%	-0.22%	-0.22%	-0.66%	-1.17%	0.12%	0.11%	-0.14%	-0.13%
Urban																
self-employed	-0.53%	-0.67%	0.42%	0.55%	0.11%	0.12%	-0.70%	-0.69%	-0.21%	-0.21%	-1.68%	-1.44%	0.13%	0.13%	-0.13%	-0.13%
regular wage	-0.57%	-0.70%	0.43%	0.55%	0.14%	0.15%	-0.71%	-0.70%	-0.21%	-0.20%	-1.23%	-1.49%	0.13%	0.13%	-0.13%	-0.13%
casual labour	-0.61%	-0.73%	0.50%	0.61%	0.12%	0.12%	-0.88%	-0.88%	-0.27%	-0.27%	-1.79%	-1.64%	0.07%	0.07%	-0.14%	-0.14%
other	-0.57%	-0.75%	0.31%	0.48%	0.26%	0.27%	-0.52%	-0.52%	-0.21%	-0.21%	-0.40%	-1.34%	0.13%	0.13%	-0.13%	-0.13%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.29%	-0.07%	-0.08%	-0.27%	-0.27%	1.60%	1.83%	1.00%	1.24%	0.07%	0.11%	48.41%	48.37%	0.14%	0.17%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EHD= 0.7, EVP=2.4

Table A4-11 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); elasticity EVP, EHD=reference, EFP=high

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EVP, EHD=reference, EFP=high.

	Nutritional Outcomes												Economic impacts			
	SFA [1]		UFA [1]		Trans [1]		Fat [2]		Processed food [2]		Edible oils [2]		Expenditure oils		Household income	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.58%	0.33%	0.35%	0.09%	0.23%	-0.56%	-0.55%	-0.22%	-0.19%	-1.32%	-1.03%	0.12%	0.06%	-0.13%	-0.12%
agricultural labour	-0.58%	-0.73%	0.48%	0.50%	0.09%	0.23%	-0.90%	-0.89%	-0.30%	-0.27%	-2.10%	-1.53%	0.04%	-0.02%	-0.13%	-0.12%
other labour	-0.49%	-0.68%	0.38%	0.40%	0.11%	0.28%	-0.68%	-0.67%	-0.27%	-0.24%	-1.32%	-1.28%	0.07%	0.02%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-0.55%	0.34%	0.36%	0.08%	0.19%	-0.59%	-0.58%	-0.23%	-0.19%	-1.78%	-1.18%	0.11%	0.06%	-0.12%	-0.11%
other	-0.47%	-0.78%	0.32%	0.34%	0.15%	0.44%	-0.53%	-0.52%	-0.22%	-0.19%	-0.66%	-1.10%	0.12%	0.06%	-0.14%	-0.13%
Urban																
self-employed	-0.53%	-0.72%	0.42%	0.44%	0.11%	0.28%	-0.70%	-0.69%	-0.21%	-0.18%	-1.68%	-1.38%	0.13%	0.07%	-0.13%	-0.13%
regular wage	-0.57%	-0.83%	0.43%	0.45%	0.14%	0.38%	-0.71%	-0.70%	-0.21%	-0.18%	-1.23%	-1.43%	0.13%	0.08%	-0.13%	-0.13%
casual labour	-0.61%	-0.81%	0.50%	0.51%	0.12%	0.30%	-0.88%	-0.87%	-0.27%	-0.24%	-1.79%	-1.58%	0.07%	0.02%	-0.14%	-0.14%
other	-0.57%	-1.13%	0.31%	0.35%	0.26%	0.78%	-0.52%	-0.51%	-0.21%	-0.18%	-0.40%	-1.28%	0.13%	0.07%	-0.13%	-0.13%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.27%	-0.07%	-0.08%	-0.27%	-0.22%	1.60%	4.00%	1.00%	1.47%	0.07%	0.03%	48.41%	48.30%	0.14%	0.08%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EVP, EHD= 0.7, EFP=2.4

Table A4-12 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels) Elasticity EFP, EVP = reference, EHD = low

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EFP, EVP =reference, EHD =Low

	Nutritional Outcomes												Economic impacts			
	SFA [1]		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.15%	0.33%	0.09%	0.09%	0.06%	-0.56%	-0.57%	-0.22%	-0.23%	-1.32%	-0.97%	0.12%	0.11%	-0.13%	-0.13%
agricultural labour	-0.58%	-0.15%	0.48%	0.08%	0.09%	0.06%	-0.90%	-0.95%	-0.30%	-0.31%	-2.10%	-1.53%	0.04%	0.03%	-0.13%	-0.13%
other labour	-0.49%	-0.18%	0.38%	0.10%	0.11%	0.08%	-0.68%	-0.70%	-0.27%	-0.27%	-1.32%	-1.21%	0.07%	0.07%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-0.13%	0.34%	0.08%	0.08%	0.05%	-0.59%	-0.61%	-0.23%	-0.24%	-1.78%	-1.11%	0.11%	0.10%	-0.12%	-0.12%
other	-0.47%	-0.22%	0.32%	0.09%	0.15%	0.13%	-0.53%	-0.54%	-0.22%	-0.23%	-0.66%	-1.03%	0.12%	0.11%	-0.14%	-0.13%
Urban																
self-employed	-0.53%	-0.15%	0.42%	0.07%	0.11%	0.08%	-0.70%	-0.73%	-0.21%	-0.21%	-1.68%	-1.32%	0.13%	0.13%	-0.13%	-0.13%
regular wage	-0.57%	-0.18%	0.43%	0.07%	0.14%	0.11%	-0.71%	-0.75%	-0.21%	-0.21%	-1.23%	-1.40%	0.13%	0.13%	-0.13%	-0.13%
casual labour	-0.61%	-0.16%	0.50%	0.08%	0.12%	0.08%	-0.88%	-0.94%	-0.27%	-0.27%	-1.79%	-1.58%	0.07%	0.07%	-0.14%	-0.14%
other	-0.57%	-0.32%	0.31%	0.09%	0.26%	0.23%	-0.52%	-0.54%	-0.21%	-0.21%	-0.40%	-1.24%	0.13%	0.13%	-0.13%	-0.13%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.40%	-0.07%	-0.06%	-0.27%	-0.28%	1.60%	0.72%	1.00%	-0.09%	0.07%	-0.14%	48.41%	48.56%	0.14%	-0.19%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: Elasticity EFP, EVP =0.7, EHD =0.1.

Table A4-13 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD = reference, EVP = low

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EFP, EHD =reference, EVP =low.

	Nutritional Outcomes												**Economic impacts**			
	SFA [1]		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.35%	0.33%	0.27%	0.09%	0.09%	-0.56%	-0.56%	-0.22%	-0.22%	-1.32%	-1.06%	0.12%	0.12%	-0.13%	-0.13%
agricultural labour	-0.58%	-0.53%	0.48%	0.44%	0.09%	0.09%	-0.90%	-0.90%	-0.30%	-0.30%	-2.10%	-1.56%	0.04%	0.04%	-0.13%	-0.13%
other labour	-0.49%	-0.42%	0.38%	0.31%	0.11%	0.11%	-0.68%	-0.68%	-0.27%	-0.27%	-1.32%	-1.31%	0.07%	0.07%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-0.36%	0.34%	0.28%	0.08%	0.08%	-0.59%	-0.59%	-0.23%	-0.23%	-1.78%	-1.20%	0.11%	0.11%	-0.12%	-0.12%
other	-0.47%	-0.39%	0.32%	0.24%	0.15%	0.15%	-0.53%	-0.53%	-0.22%	-0.22%	-0.66%	-1.12%	0.12%	0.12%	-0.14%	-0.14%
Urban																
self-employed	-0.53%	-0.47%	0.42%	0.36%	0.11%	0.11%	-0.70%	-0.70%	-0.21%	-0.21%	-1.68%	-1.40%	0.13%	0.13%	-0.13%	-0.14%
regular wage	-0.57%	-0.51%	0.43%	0.37%	0.14%	0.14%	-0.71%	-0.71%	-0.21%	-0.21%	-1.23%	-1.45%	0.13%	0.13%	-0.13%	-0.13%
casual labour	-0.61%	-0.56%	0.50%	0.45%	0.12%	0.11%	-0.88%	-0.88%	-0.27%	-0.27%	-1.79%	-1.61%	0.07%	0.07%	-0.14%	-0.14%
other	-0.57%	-0.49%	0.31%	0.24%	0.26%	0.25%	-0.52%	-0.52%	-0.21%	-0.21%	-0.40%	-1.30%	0.13%	0.13%	-0.13%	-0.14%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.32%	-0.07%	-0.07%	-0.27%	-0.28%	1.60%	1.50%	1.00%	0.88%	0.07%	0.05%	48.41%	48.42%	0.14%	0.13%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EFP, EHD =0.7, EVP =0.1.

Table A4-14 Sensitivity analysis Scenario (C): 60% increase in palm oil tariffs (Historical levels); Elasticity EVP, EHD = reference, EFP = low

Sensitivity analysis Scenario (C): 60% increase increase in palm oil tariffs (Historical levels); Elasticity EVP, EHD =reference, EFP =low.

	Nutritional Outcomes												Economic impacts			
	SFA [1]		**UFA [1]**		**Trans [1]**		**Fat [2]**		**Processed food [2]**		**Edible oils [2]**		**Expenditure oils**		**Household income**	
Tariff change	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**	**Ref**	**Sensitivity**
Rural																
Self-employed in non-agriculture	-0.43%	-0.37%	0.33%	0.33%	0.09%	0.04%	-0.56%	-0.56%	-0.22%	-0.23%	-1.32%	-1.09%	0.12%	0.14%	-0.13%	-0.13%
agricultural labour	-0.58%	-0.52%	0.48%	0.48%	0.09%	0.04%	-0.90%	-0.91%	-0.30%	-0.31%	-2.10%	-1.58%	0.04%	0.06%	-0.13%	-0.13%
other labour	-0.49%	-0.43%	0.38%	0.38%	0.11%	0.05%	-0.68%	-0.68%	-0.27%	-0.28%	-1.32%	-1.34%	0.07%	0.09%	-0.14%	-0.14%
self-employed in agriculture	-0.42%	-0.38%	0.34%	0.34%	0.08%	0.04%	-0.59%	-0.59%	-0.23%	-0.24%	-1.78%	-1.24%	0.11%	0.13%	-0.12%	-0.12%
other	-0.47%	-0.36%	0.32%	0.31%	0.15%	0.04%	-0.53%	-0.53%	-0.22%	-0.23%	-0.66%	-1.15%	0.12%	0.14%	-0.14%	-0.14%
Urban																
self-employed	-0.53%	-0.47%	0.42%	0.42%	0.11%	0.05%	-0.70%	-0.70%	-0.21%	-0.22%	-1.68%	-1.43%	0.13%	0.15%	-0.13%	-0.14%
regular wage	-0.57%	-0.47%	0.43%	0.42%	0.14%	0.05%	-0.71%	-0.71%	-0.21%	-0.22%	-1.23%	-1.48%	0.13%	0.15%	-0.13%	-0.13%
casual labour	-0.61%	-0.54%	0.50%	0.50%	0.12%	0.05%	-0.88%	-0.89%	-0.27%	-0.28%	-1.79%	-1.63%	0.07%	0.09%	-0.14%	-0.14%
other	-0.57%	-0.37%	0.31%	0.31%	0.26%	0.06%	-0.52%	-0.53%	-0.21%	-0.22%	-0.40%	-1.33%	0.13%	0.15%	-0.13%	-0.14%
	Economic Impacts															
	Government revenues		**Absorption**		**Processed Food sector value added**		**PHFO value added**		**Oilseed sector value added**		**Price Local**		**Price Palm**		**Price Soybean**	
	0.31%	0.33%	-0.07%	-0.07%	-0.27%	-0.29%	1.60%	0.62%	1.00%	0.82%	0.07%	0.09%	48.41%	48.45%	0.14%	0.17%

[1] Fatty acid contribution (% of Total). Change with respect to baseline

[2] Total intake. Percentage change with respect to baseline

All other variables in monetary units. Percentage changes with respect to baseline

Elasticity parameters: EVP, EHD =0.7, EFP =0.1.

Appendix 5 Specification and calibration of the nested demand model

The key concepts and expressions characterizing our demand system have been described in Chapter 9. Here, we provide more detail on some of the specifications and relationships between different expressions, as well as providing a description of the calibration, using the indirect utility function. We use simplified notation, where P represent consumer prices, Q are quantities consumed and all equations are understood to represent demand for household h.

We have implemented a nested demand model, representing a process of two-stage budgeting as depicted in Figure 9-3.

g = commodity groups

G = specific commodity group where I want to nest a CES equation. This is done only for edible oils.

c = commodities

We will start from the second stage, and then link this to the first-stage budget allocation.

The second stage maximization problem is, due to weak separability assumptions, independent of the decisions in the first stage, and only depends on the budget available for group G

$$\text{Max}_{Q_c}\ u_G = \alpha_G\left(\sum_c \delta_c Q_c^{-\rho_G}\right)^{\frac{1}{-\rho_G}} \tag{A6-1}$$

$$\text{Subject to: } E_G = \sum_c P_c Q_c \tag{A6-2}$$

Give the first order condition:

$$P_c = E_G * \left(\frac{\delta_c Q_c^{-\rho-1}}{\sum_{c'} \delta_c Q_c^{-\rho}}\right) \tag{A6-3}$$

Where u_G is a CES sub-utility function for commodity group G, $\delta_c \mid \sum_{c \in G} \delta_c = 1$ are distribution parameters, E_G is the expenditure on group G and ρ_G is the CES exponent

$$\rho_G = \frac{1 - \sigma_G}{\sigma_G} \tag{A6-4}$$

Where σ_G is the elasticity of substitution.

Due to homotheticity in the second stage, expenditure for group E_G can be expressed as the product of an exact price index, and the value of the indirect utility function in the optimum. P_G can be interpreted as the index price of a unit of utility. P_G (Equation A6-5) is the price of a unit of utility from consumption in group G. See (Aasness and Holtsmark 1993) for an example of use in a CGE model, and (Gorman 1959) for theoretical proof of the conditions for separability and aggregation in demand. (Deaton and Muellbauer 1980) provide an overview of the topic in the context of two-stage budgeting and utility trees.

$$E_G = P_G V_G \tag{A6-5}$$

$$\mathrm{P_G} = \left(\frac{1}{\alpha_G}\right)\left[\sum_{c' \in C|g} \delta_c^{\sigma_G} PQ_c^{(1-\sigma_G)}\right]^{\frac{1}{(1-\sigma_G)}} \tag{A6-6}$$

From this expression can be deduced the CES demand equations:

$$Q_c = \delta_c \left(\frac{P_G}{P_c}\right)^{\sigma_G} \left(\frac{E_G}{P_G}\right) \tag{A6-7}$$

Parameter Calibration

The parameters are calibrated as follows

Distribution parameter for commodity c within group G:

$$\delta_c = (P0_c\, Q0_c^{1/\varepsilon_G}) / \sum\nolimits_{c' \epsilon G} (P0_{c'} Q0_{c'}^{1/\varepsilon_G}) \tag{A6-8}$$

Shift multiplicative parameter for the demand functions in the second stage

$$\alpha_G = \frac{V_G}{(\sum_{c' \in C|g} \delta_c Q0_c^{-\rho_G})^{-\frac{1}{\rho_G}}} \tag{A6-9}$$

Where V_G is derived in calibration from expression (A6-5).

Quantity demanded of group G (first-stage) in the absence of household production:

$$Q_G = \gamma_G + \beta_G \left[E - \sum\nolimits_{c\ not\ in\ G} (P_c \gamma_c) - P_G \gamma_G \right] / P_G \tag{A6-10}$$

Minimum expenditure for group G

$$M_G = \sum_{c \in C|g} P_c \gamma_c \tag{A6-11}$$

Where γ_c is the minimum consumption of commodity c, estimated from baseline data.

Minimum consumption for group G

$$\gamma_G = \frac{M_G}{P_G} \tag{A6-12}$$

Where:

Total expenditure on consumer goods

$$E = \sum_c P_c Q_c \tag{A6-13}$$

Marginal budget share for commodity c.

$$\beta_c = \frac{P_c Q_c}{E} \varepsilon_c \tag{A6-14}$$

ε_c = elasticity of demand for commodity c. Exogenous parameter, used as part of the scenario design and subject to sensitivity analysis.

Marginal budget share for group, based on current budget shares in baseline SAM data

$$\beta_G = \sum_{c \in C|g} \beta_c \tag{A6-15}$$

In single-commodity groups the two-stage demand collapses to a one level function, where g can be replaced by c, and quantity demanded is given by expression A6-16.

$$Q_{c\ not\ in\ G} = \gamma_c + \beta_c \frac{(E - \sum_{c\ not\ in\ G}(P_c \gamma_c) - P_G \gamma_G)}{P_c} \tag{A6-16}$$