REPRODUCTION WITHIN DIFFERENT POPULATION POLICY ENVIRONMENTS IN RURAL CHINA: 1979-2000

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Yan Che in January 2011

Dedication

To my parents

Shoutai Che

&

Xiaoling Wang

To my wife

Xiaofang Wu

Declaration

I, Yan Che, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

This study uses data from National Family Planning and Reproductive Health Survey undertaken in 2001, systematic reviews of provincial policy fertility in 1990s, information on the nature of family planning (FP) services at grassroots institutions and a new measure of women's son preference, to advance knowledge of determinants of reproduction in rural China.

The main statistical methods in this study include latent class analysis, life table, parity progression ratio, multilevel logistic regression and multilevel Poisson regression. The analysis is performed within groups of provinces according to their population policy (1-child, 1.5-child and 2-child).

The results showed that fertility rate was closely related to China's population policy: the stricter the policy, the lower the fertility rate. By the end of the last century, fertility rates for the three types of provinces were close to respective policy fertility, indicating a success of China's population policy. However, strict population policy increased risks of abortion and imbalance in sex ratio at birth (SRB), particularly the rising sex ratio of second births in 1.5-child provinces. Variations in availability of specific FP methods by local services did not play a leading role in reducing fertility level, risk of abortion and imbalanced SRB. Son preference at province or individual level had strong impacts on progression to second birth, risk of abortion, and SRB, but the effects vary between types of provinces. Effects of other individual characteristics, i.e., couples' age, women's education, sex of existing child, on reproduction are also explored and discussed in this study.

It can be concluded that strict implementation of population policy was the dominant influence on fertility levels but it also raised risk of abortion and imbalance in SRB in rural China. For these and other reasons, China needs to relax its 1-child and 1.5-child policies immediately.

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Acronyms

AIC	Akaike's information criterion
BIC	Bayesian Information Criterion
CCCPC	Central Committee of the Communist Party of China
CPC	Communist Party of China
DIC	Deviance Information Criterion
EM	Expectation-Maximization procedure
FP	Family Planning
FPSC	Family Planning Service Centre
FS	Female Sterilisation
GIS	Geographic Information Systems
ICPD	International Conference on Population and Development
IGLS	Iterative Generalised Least Squares
IUD	Intrauterine Device
LCA	Latent Class Analysis
LCM	Latent Class Model
MCMC	Monte Carlo Markov Chain
ML	Maximum Likelihood
MOH	Ministry of Health
MQL	Marginal Quasi-Likelihood
MS	Male Sterilisation
NFPRHS	National Family Planning and Reproductive Health Survey
NPFPC	National Population and Family Planning Commission
NR	Newton-Raphson procedure
PPS	Probability Proportional to Size
PQL	Predictive (or Penalized) Quasi-Likelihood
PRC	The People's Republic of China
RH	Reproductive Health
RIGLS	Reweighted IGLS
SFPC	State Family Planning Commission
SRB	Sex Ratio at Birth
TFR	Total Fertility Rate
TFR_{ppr}	Total Fertility Rate based Parity Progression Ratios

Chapter 1: Introduction, Background and Literature Review

1.1 Introduction and background

The section contains a brief history of population policy in China and a description of family planning (FP) services.

China has long been the most populous country in the world. It was estimated that China had 10 million people in 2000 BC, which accounted for about 37% of global population. This proportion declined to 30% by 400 BC, and further to about 26% in the 17th century. In the first year (*1950*) after the founding of the People's Republic of China (PRC), official estimates indicated that China's population was 550 million and accounted for 24% of world population (*Xiao and Zhou 1998*). As a consequence of a consistently high birth rate and a rapidly declining death rate during early years of PRC (disrupted by the "great leap" famine for a short period), China's population increased very fast, from 670 million in 1959 to 800 million in 1969, to 890 million in 1973, to 1134 million in 1990 and to 1266 million in 2000 (*Qu 2008; IOSC 1995; NBS 2002*). As early as 1957, a Chinese economist, demographer and the former president of Peking University, Ma Yinchu, warned that a growing population was dangerous for China's development. However, his view was not accepted until 1970s when China formulated and implemented a national population policy. This policy underwent several modifications and each modification had a tremendous impact on China's population development.

1.1.1 Population policy evolution of PRC, particularly after 1970

Initially, China's post-1949 leaders, particularly the founder of PRC, Mao Zedong, were ideologically disposed to view a large population as an asset. But the liabilities of a large, rapidly growing population soon raised great concerns of another leader, the late Premier Zhou Enlai. In the "The Basic Tasks of China's First Five-year Construction Plan", Zhou Enlai pointed out that "*our people are fond of more children, however, to supply for the rapid population growth is our (China's) big burden*" (*Zhou 1953*).

Endorsed by Premier Zhou, the State Council instructed the Ministry of Health to support birth control by providing contraceptives. It also ratified provisions concerning contraception and induced abortions in 1953, and the State Council further issued "Instructions on Conscientious Advocacy of Family Planning" in 1962. Special administrative organizations were also established in 1964 to oversee scientific research, production, and supply of contraceptives and to provide couples of childbearing age with free contraceptives (*Qian 1983*). These efforts, however, had little impact on fertility due mainly to the interruptions of the Great Leap Forward (1958-1961) and Cultural Revolution (mainly between 1966 and 1969). The population increased from 601 million in 1954 to 807 million in 1969 (*Yao & Yin 1994*).

From the early 1970s, Chinese leaders became increasingly aware that the over-rapid growth of population was unfavourable to economic and social development, and their interest in birth control revived. In 1971, Premier Zhou Enlai reiterated the importance of population control and supported its incorporation into the 4th Five-Year Plan (1971-1975) for the development of the national economy in 1971 (*Qian 1983*). The Planned Reproduction Group of the State Council of the Central Government was created in July 1973, which was responsible for formulating national population policy and its implementation. Four months later, the Group arranged a national meeting to discuss population control. It was during this meeting that the slogan "*wan* (later), *xi* (birth spacing), *shao* (fewer)" was proposed and introduced throughout the country (*Attane 2002; Peng 1991; Yang 2003*). The basic concepts of *wan*, *xi* and *shao* are that every couple is exhorted to marry late (male ≥25 years old, female ≥23 years old), to space births by at least 3 years, and to have few children. Promotion of FP was one of the main mechanisms of population control. Nevertheless, at that time, FP was voluntary and the final decision to adopt contraceptive methods was left to the couples themselves. However, even though the total fertility rate (TFR) in China declined from 4.45 in 1973 to 2.84 in 1977, the population size increased from 8.9 billion to 9.5 billion during this short period (*NBS 2002*). It, therefore, was not surprising that the population policy tightened in the following years. In 1978, population control was incorporated into the Constitution and was regarded as a basic national policy. Moreover, the propaganda of the population policy shifted from "*one's not too few, two will do, and three are too many for you*" to "*one best, two most, and space at least 3 years*" in late 1978 (*Feng*

1998). Based on this policy, every couple was limited to two children with few exemptions.

Nevertheless, these measures were still regarded to be inadequate to meet the official target of 1.2 billion population by 2000. Consequently, a more stringent rule – the one-child-per-couple policy (one-child policy) – was introduced in 1979 (*Attane 2002; Hesketh, Li and Zhu 2005; Kane and Choi 1999; Peng 1991*). The one-child policy was endorsed by Deng Xiaoping, the chief architect of China's reform and opening to the outside world. On 30 March 1980, he pointed out that, "*to accomplish the goal of the four modernizations in China, it was imperative to take into consideration the basic features of the Chinese environment, that is, the vast scale of the country, its weak foundation, its massive population and the low ratio of cultivated land; and these considerations demonstrated the objective need for the development of population to be coordinated with the development of the economy, society, resources and environment*" (*IOSC 1995, p2*). The Central Committee of the Communist Party of China (CCCPC) issued an open letter to all members of the Party and Communist Youth League in September 1980, exhorting them to have only one child (*CCCPC 1982*). Owing to the dominant roles of the Party and the Youth League in Chinese social life, the open letter had a tremendous influence on the implementation of one-child policy even today.

However, the one-child policy was unevenly enforced. It was strictly enacted in urban areas, while in rural areas some couples were permitted to have a second child under particular conditions. Even so, only 5 per cent of rural couples met the rules to have a second child (*Peng 1997*). Therefore, the one-child policy encountered very strong resistance in rural areas. The reasons are that, in rural China, the centuries-old tradition of preserving family lineage was strong; there was continuing need for security in old age; the rural household contract responsibility system required more labour for a family after economic liberalization in 1979; and the perception that girls are of little use in either respect because they marry and leave home in rural areas.

From 1984 on, the rigorous policy was modified and implemented along more pragmatic lines to make it easier to carry out. The sign of this transition is the Central Document 7 that was issued by the CCCPC on 13 April 1984. The overall objective of Document 7 was to establish a FP strategy that was realistic, fair and reasonable to the people, easy for cadres to implement, yet capable of achieving the Party's goal of holding the population at 1.2 billion by the end of 2000 (*Greenhalgh 1986*). Under the slogan "*open a small hole (permit two births on conditions) to close up a large one (forbid three or more births and those without permission)*", Document 7 allowed second children among rural couples with "*practical difficulties*", as long as second births were carried out according to plan and did not jeopardize achievement of the 1.2 billion goal. As for the size of the small hole, in 1984, a central-level committee suggested that initially about 10 per cent of rural couples should be allowed two children and that the percentage should gradually be permitted to rise (*Greenhalgh 1986*). After promulgation of Document 7, provincial FP regulations were revised to incorporate many of the changes spelled out in the document. The major modification is that most rural couples were allowed a second child, subject to province-specific conditions (*Attane 2002; Gu et al. 2007b; Peng 1991*). Examination of regulations from 30 provinces (excluding Tibet) identified a total of 22 unique exemptions for allowing a second or a third child. Typically, rural couples with only one daughter and individuals who are only children themselves were allowed to have a second child; miners who work underground, fishermen, farmers in mountainous or poor areas, couples deemed to have economic difficulties, persons who belonged to an ethnic minority and couples whose first child had died or was physically handicapped could have a second child (*Gu et al. 2007b*). For urban couples with a nonagricultural household registration status, one child per couple remained the rule (*Attane 2002; Gu et al. 2007b; Peng 1991*).

After modification of the population policy in the mid-1980s, the policy stressed stability. The Standing Committee of Central Government emphasized on 31 March 1988 that, "*for the Governmental cadres, employees, and urban residents, each couple is permitted to have one child except few with special permission; in rural areas, couples who have practical difficulties, including those who have single daughter, after getting permission, can have a second birth several years later after the first birth; no matter what condition, a third birth is forbidden; FP should also be promoted among ethnic minorities, The concrete policies are worked out by the minority autonomous areas and the relevant provinces and autonomous regions according to specific local conditions. The above policies must be carried out from now for quite a long period. The policy should keep stable in favour of population control" (Yang, Liang and Zhang 2001, p169).* The importance of policy stability was reiterated by Premier Li Peng (1993) at the third conference on FP of CPC and the State Council on 21 March 1993. He said that "*among a number of experiences on population control, one of which is that the current population policy should keep stable. This policy must not swing*". Similar statements were seen on many other occasions, official documents and top leaders' speeches during the late 1980s and in 1990s (*Yang 2003*). After years of implementing the modified population policy, the policy was formalised by the Population and Family Planning Law of PRC which has been enacted since 1 September 2002 (*PFPL 2001*).

1.1.2 Family Planning among Ethnic Minorities

China is a united multi-ethnic nation of 56 ethnic groups. According to the fourth national census taken in 1990, the Han people made up 91.96% of the country's total population, and the other 55 ethnic groups, 8.04% (*NBS 1990*). As the majority of the population is of the Han ethnic group, China's other ethnic groups are customarily referred to as the national minorities. Most of these minorities live in southern China, Tibet or the western Province of Xinjiang or near the borders of Burma, Laos, Vietnam, India, Russia, Mongolia, North Korea and the former Soviet republics of Kazakhstan, Kyrgyzstan and Tajikistan. A number of areas associated with one or more ethnic minorities are designated as autonomous regions, such as Inner Mongolia Autonomous Region, founded on May 1, 1947; Xinjiang Uygur Autonomous Region, founded on October 1, 1955; Guangxi Zhuang Autonomous Region, founded on March 5, 1958; Ningxia Hui Autonomous Region, founded on October 25, 1958; and Tibet Autonomous Region, founded on September 9, 1965. In addition to the five provincial level autonomous regions, China currently has 30 autonomous prefectures and 120 autonomous counties (or in some cases called "banners"), in addition to more than 1,300 ethnic townships within the five autonomous regions and other provinces (*Wikipedia 2010a*). These areas are recognized in the PRC's Constitution and are nominally given a number of rights not accorded to other administrative divisions.

Since 1949, different population policies have been carried out for the ethnic minorities and the Han group. Between 1949 and 1970, ethnic minorities were excluded from national FP campaigns. Some groups, such as those living in Inner Mongolia, Tibet, Xinjiang and Jinyuan, were even encouraged to have more births (*Yang 2003*). During the 1970s, while a strict population policy was enforced among Han Chinese, FP programmes among ethnic minorities were initiated. For instance, Ningxia Hui Autonomous Region, Xinjiang Uygur Autonomous Region and Inner Mongolia created the Region's FP Offices in 1972, 1975 and 1979, respectively, which were responsible for local FP programme implementation. According to local regulations, the Han Chinese who live in autonomous areas, prefectures or counties/banners were subject to strict population policy, while there was no birth limitation for the ethnic minorities in these autonomous areas. However, FP education was advocated among all ethnic groups and minority couples could get contraceptive methods on demand (*Yang 2003*). Owing to these differences of population policy between Han and ethnic minorities, the total fertility rate had been higher among the minorities than those of Han between 1971 and 1980 (Table 1.1).

Table 1.1: Total fertility rates of Han Chinese and ethnic minorities between 1971 and 1980

year	Han Chinese	Ethnic minorities
1971	5.29	6.03
1972	4.78	5.85
1973	4.34	5.89
1974	3.94	6.01
1975	3.54	5.52
1976	3.03	5.14
1977	2.67	4.46
1978	2.58	4.15
1979	2.60	4.49
1980	2.12	4.01

Source: Wang HM 1999

Since the early 1980s the Chinese government has advocated FP for ethnic minorities, except for those who lived in sparsely populated minority areas. In 1984, The CCCPC approved the Circular on the Report Regarding the FP Work submitted by SFPC, which instructed that "*there should be appropriate FP policy for national minorities. It can be that every couple can be approved to have two children, a few couples can have three children on particular conditions, but no couple can be approved to have four children. The concrete policies are worked out by the minority autonomous areas and the relevant provinces according to specific local conditions, and carried out after getting approval from the standing committee of the people's congress or people's government* *at the next higher level*" (*Yang 2003, p 146*). In spite of this Circular, among ethnic minorities with extremely small populations, couples may have as many children as they want.

Taking the Tibet as an example, in 1985 the People's Government of the Tibet began to advocate FP among Tibetan cadres, workers and staff, encouraging each couple to voluntarily space two births at reasonable intervals. Among the broad masses of farmers and herdsmen, the government has mainly educated them in child-bearing knowledge, advocated healthier birth and child-rearing practices, improved health care for women and children, and provided contraceptives and birth control technical services to those who volunteer to practice birth control. No policy restrictions have ever been imposed on the number of births in the agricultural and pastoral areas. (*IOSC 1995*).

1.1.3 Family planning network and responsibility

Before introducing China's FP network, I would like to briefly introduce China's administrative system. This is helpful to understand China's FP network and responsibility for policy setting and implementation.

The State Council is the supreme administrative organ in China, under which there are five levels of local government: province, prefecture, county, township and village. With the village being the grassroots (usually a hundred or so families), local government advances through the township, county, prefecture, and the province as the geographical area of jurisdiction increases. However, villages usually do not have much importance in political representative power and thus the township is the basic level of political division.

The functions of central and local governments are very similar in content. The difference between the local and central level is that the central government manages the administrative affairs of the country centrally and makes the macro decisions while the local governments manage local administration. However, the branches of local governments must carry out the laws and regulations of central government, complete the tasks given by it and accept its professional guidance. At the same time. local governments at different levels enjoy considerable political autonomy. They can exercise their functions and powers independently under the guidance of the higher-level government. Each level of local government is responsible for overseeing the work carried out by lower levels of the administrative strata and has the power to alter or annul inappropriate decisions of their subordinate governments (*ESCAP 2009*).

As of December 31, 2005, there are 31 provinces, 333 prefectures, 2,862 counties, 41,636 townships, and several hundred thousand village-level units in mainland China (Wikipedia 2009). Provinces range from a few million to nearly 100 million people. The mean size of a county is about 630,000 people but size varies between several thousand (e.g. 6,384 at Zada county in Tibet) and nearly 2 million (e.g. 1.8 million at Linquan county in Anhui province). The population of a township is approximately 19,000 and the population of a village averages close to 1,200. The population in townships and villages also varies from place to place (*Banister & Harbaugh 1994*).

China's State Family Planning Commission (SFPC) (renamed National Population and Family Planning Commission (NPFPC) in 2003) was formed in 1981. Before that date, it had very different forms and names but the routine work were under the jurisdiction of Ministry of Health (MOH) (*Li 2001*). SFPC takes responsibility for supervising 30 provincial FP committees (excluding Tibet where the FP office is affiliated to the Bureau of Public Health) and formulates national guidelines and regulations concerning births, population targets, monitoring and evaluation systems, and standards of care. Based on the national guidelines, provinces formulate their own regulations and the national FP programme is managed as a top-down process working from nation to province to prefecture to county to township and finally to the village level (*Kaufman et al. 1992a; Kaufman et al. 2006; Li 2001; Xie 2000*). All levels of government are required to provide adequate funding to local FP bureaus to carry out the FP program (*Kaufman et al. 1992a*).

The national population policy formulated by the central government issues basic principles for the local governments to follow. There is considerable freedom for provinces to formulate their own population policy. With regard to the number of children per couple, China's Population and Family Planning Law (*PFPL 2001*) announces that "*the State shall maintain its current fertility policy encouraging late marriage and childbearing and advocating one child per couple; arrangements for a second child, if requested, being subject to law and regulation. Specific measures shall be enacted by the People's Congress or its standing committee in each province,* *autonomous region, and municipality*" (article 18). Nevertheless, the definition of late marriage [1] and decisions of whom and under what conditions can have a second child are subject to each province. The prefectures and counties usually have little freedom to formulate their own fertility regulation policies. A few exemptions were seen in minority autonomous regions. For instance, Puer Hanizu Yizu Autonomous County formulated its own fertility regulations, which were approved by the standing committee of Yunan province (*PHYA 2005*). Township governments carry out decisions and orders issued by the higher governmental authorities and do not have power to formulate their own fertility regulations.

There are two main FP branches at each of the provincial and subordinate governments: the FP committee who takes general responsibility for implementation of local population policy, and FP service institution or FP service centre (FPSC) that is mainly responsible for local FP clinical services. The clinical service institutions/centres are non-profit units. They usually receive full funding from local governments in developed areas; while in poor areas, part of the funding comes from the central government as well as higher-level provincial government, part from the local government. However, occasionally, the local government cannot provide adequate funding in time and or in amount in the poor areas. It is not uncommon that FPSCs in the poor areas provide some clinic services other than FP to ensure their financial viability.

By the end of 1990, the number of clinical institutions at the county level and FPSCs in towns and townships below the county level totalled 2,203 and 25,345 respectively, accounting for 92 per cent and 47 per cent respectively of the targeted total service institutions and FPSCs to be established (*Banister & Harbaugh 1994*). The number of FPSCs in towns and townships was considered inadequate in early 1990s. An editorial of the People's Daily [2] in 1991 urged that "*it is necessary to resolve to form a family planning work team at the grass-roots level characterized by a good state of mind and a correct work style and with professional knowledge and management ability; to speed up the establishment of FP networks covering counties, townships, and villages; and to strengthen the numbers of FP personnel of various villages and work groups so that there are always some people at the grassroots level in charge of the various tasks related to FP.*" (*Banister & Harbaugh 1994, p70*).

The main tasks of FPSCs at townships are providing four types of FP surgical and clinical operations, namely IUD insertion and removal, abortion and sterilization. The FPSCs also provide technical advice and some gynaecological and prenatal health care. The main tasks of village FP service rooms are providing condoms, pills and other short-term contraceptives, ideological guidance, and some clinical advice. Although no nationwide research had been conducted to examine the overall quality of FP services at grassroots level throughout the country, the National Family Planning and Reproductive Health Surveys (NFPRHS) that were carried out in 1997 and in 2001, respectively, provided insights into the nature and quality of FP services at township and village levels (*Liu and Chang 2001; Zhou 2004*). Data from the 1997 NFPRHS showed that in only 43 per cent of female sterilizations, 49 per cent of IUD insertions, 50 per cent of abortions, and 47 per cent of other operations did clients receive counselling by service providers at the township FPSCs prior to the procedures, while the prevalence of follow-up checks and consultations after operations were 52, 41, 60 and 45 per cent, respectively (*Liu and Chang 2001*). Slightly more than a half (52 per cent) of FP personnel at village level graduated from middle school; 33 per cent graduated from high school; only one per cent graduated from college or above (*Zhou 2004*). More than a half of villages provided condoms (87 per cent), daily oral pills (80 per cent) and once-a-month pills[3] (65 per cent). Forty to forty-eight per cent of villages provided spermcides (48%) and visiting pills[4] (40%). Only 5 per cent of villages provided emergency pills (*Zhou 2004*). Data from the 2001 NFPRHS indicated that, among married women, only 7 per cent obtained contraceptives at villages (in rural areas) or work units (in urban areas), and 20 per cent at FPSCs. Surprisingly, about 50 per cent of women accessed contraceptive methods at township or county hospitals (*Zhou 2004*).

In addition to formulating the population policy, the CCCPC and the State Council introduced the FP responsibility system in the early 1990s. The system requires that heads of Party organizations and governments in all provinces, autonomous regions and municipalities take full responsibility for implementing their local population plans, integrating population plans with their social and economic development plans, and giving priority to the FP programme. Government at all levels is to implement and improve the responsibility system of population target management, and leaders of Party committees and governments at all levels are personally responsible for the accomplishment of their population plans. Failure to meet the population-control targets may incur some kind of penalty, such as the withholding of a bonus, demotion or dismissal. There is little doubt that the responsibility system of population-target management has strengthened leadership in implementing the policy (*Xie 2000*).

1.2 Literature review

This section provides a literature review of the key themes to be addressed in the thesis: sex ratio at birth (SRB), abortion and fertility.

1.2.1 Sex ratio at birth

An old Chinese saying goes "*the greater the number of offspring brings greater happiness for a family*". Traditionally, Chinese favour a large family. A stereotyped view of the Chinese family was that of a large extended family, with several generations and immediate families all living under one roof, being a self sufficient and self-help institution for its members, providing care of children and the elderly.

While Chinese traditionally preferred large families, they also valued sons far more than daughters. Sons are valued in China because they provide labour, economic security, and emotional care for their parents in old age, continue the male line, and perform ancestral worship rites whereas, following marriage, daughters leave to become members of their in-laws' family. Another reason is that sons bestow strength and prestige on their families and descent groups (particularly in rural areas), thereby helping them compete for economic and political resources (*Murphy 2003; Xie 1994*). Son preference is the fundamental reason for high SRB, not just in China but also in countries from East Asia through South Asia to the Middle East and North Africa (*Hesketh and Xiang 2006*).

Nevertheless, the reported SRB in China was normal (close to 106 males per 100 females) in most years in the 1960s and 1970s (*Johansson and Nygren 1991; Sun 2003; Zeng et al. 1993*). The ratio increased after 1980: 108.5 in 1981, 110.9 in 1986, 113.8 in 1989, 115.6 in 1995 and 117.8 in 2000 (*Zeng et al. 1993; Sun 2003*). It is widely accepted that this trend was due mainly to the culture of son preference, together with China's compulsory family planning programme and 'one-child-policy' because female births would be prevented to allow for the desired number of sons within the regulations (*Chu 2001; Hesketh and Xing 2006; Lai-wan, Blyth and Hoi-Yan 2006*).

Son preference is stronger in rural than in urban areas in China. A study conducted in Beijing in 2002 indicated that 65 per cent young adults aged 20 to 29 wanted only one child. Sixty-three per cent of all respondents had no sex preference, while 14.7 per cent of them wanted only one son and 16.4 per cent wanted only one daughter (*Li 2003*). Another study conducted in Nanjing, the capital city of Jiangsu province, in 2002, reported similar outcomes: 70 per cent of young adults wanted only one child, 65 per cent had no sex preference, 20 per cent wanted a son, and 15 per cent wanted a daughter (*Yin, Shuai and Wen 2005*). On the contrary, Li's study in rural area of Hunan province in 2002 indicated that 72 per cent of respondents preferred two children, 46 per cent had son preference, 22 per cent preferred daughter, and 32 per cent had no sex preference (*Li, Xu and Shen 2003*). A study conducted in rural area of Sichuan province reported that 75 per cent of women wanted two children, 83 per cent of them want one son and one daughter. Under the one-child rule, 32 per cent wanted a son and only 9 per cent wanted a daughter (*Chen and Zhang 2003*).

Because of the urban-rural difference in son preference, SRB was higher in rural than in urban: 111.6 vs. 108.5 in 1989 (*Gu and Xu 1994*) and 119.3 vs. 113.0 in 2000 (*Sun 2007*) for the country as a whole. The differences of SRBs between provinces and changes over time are displayed in Table 1.2. Most provinces had a normal SRB in 1982. Ten years later, most provinces had abnormal SRBs and the situation was worse in more recent years. A number of Chinese studies reported that a high SRB was also associated with high parity/birth order, poor education, Han nationality, and couples who had a daughter but no son (*Gu and Xu 1994; Lofstedt, Shusheng and Johansson 2004; Zeng et al. 1993*).

Table 1.2: Sex ratios at birth (SRB) at province-level between 1982 and 2005

SRB	Year of survey			
	1982	1992	2000	2005
- 107	Tibet, Beijing, Tianjin, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Jiangxi, Hubei, Hunan, Sichuan, Guizhou, Yunnan, Gansu, Qinghai, Ningxia, Xinjiang, (19)	Beijing, Guizhou, Heilongjiang, Shanghai, Tibet, Yunnan, Qinghai, Ningxia, Xinjiang (9)	Guizhou, Tibet, Xinjiang (3)	Tibet, Xinjiang, Ningxia (3)
108-109	Hebei, Shanxi, Zhejiang, Fujian, Shandong, Shaanxi (6)	Shanxi, Gansu Inner Mongolia, Jilin, Fujian, Hubei, (6)	Inner Mongolia, Heilongjiang, Yunnan, Ningxia (4)	Heilongjiang (1)
110-120	Anhui, Henan, Guangdong, Guangxi (4)	Tianjin, Hebei, Liaoning, Jiangsu, Zhejiang, Anhui, Jiangxi, Hunan, Shandong, Henan, Guangdong, Guangxi, Hainan, Sichuan, Shaanxi (15)	Beijing, Tianjin, Hebei, Shanxi, Liaoning, Jilin, Shanghai, Jiangsu, Zhejiang, Fujian, Jiangxi, Shandong, Henan, Chongqing, Sichuan, Gansu, Qinghai (17)	Yunnan, Henan, Liaoning, Tianjin, Chongqing, Jilin, Zhejiang, Beijing, Shandong, Gansu, Inner Mongolia, Sichuan, Shanxi, Qinghai, Hebei, Shanghai, Guangdong, Guangxi (18)
121+	-		Anhui, Hubei, Hunan, Guangxi, Guangdong, Hainan, Shanxi (7)	Hubei, Anhui, Shaanxi, Jiangxi, Guizhou, Jiangsu, Hainan, Fujian, Hunan (9)

Note: The most recent administrative changes have included the elevation of Hainan (1988) and Chongqing (1997) to provincial level status. Thus there were a total of 29 provinces (no Hainan and Chongqing) in China in 1982, and 30 provinces (no Chongqing) in 1992.

Source: Liu 2007

Three factors were regarded as the main reasons for the deficit of daughters in China: 1) underreporting of female births, 2) excess female infant mortality, and 3) prenatal sex determination and sex-selective abortion of female foetuses (*Chu 2001; Wu, Viisainen and Hemminki 2006*). Imbalance in SRB may reflect sex selective abortion and/or underreporting of female births. In the early 1990s, some researchers argued that underreporting was the main cause of the high SRB in China (*Zeng et al. 1993*). However, studies in more recent years indicated that the selective abortions of female foetuses contributed most (*Chu 2001; Wang et al. 2001; Wu, Viisainen and Hemminki 2006*). The under-reporting of female live births and neglect or poorer care of female newborn infants played a secondary role (*Wu, Viisainen and Hemminki 2006*).

Increasingly available ultrasound B-machines throughout China offered indirect support for the viewpoint that selective abortion played the main role. China manufactured its first ultrasound B-machine in 1979. Since 1982, both Chinese-manufactured and imported ultrasound B-machines have been introduced on a large scale. In 1987, over 13,000 such machines were being used in hospitals, on average about six for each county. In 1991, China's largest ultrasound B-machine manufacturer had the capacity to produce 5,000 machines annually, the equivalent of two for each county. Now almost all county and township hospitals and family planning service centres in China are equipped with high-quality ultrasound B-machines operated by skilled technicians and such equipment is also available in many private clinics (*Tang 2007*). It has been forbidden to use ultrasound B-machine to detect fetal sex in China since 1986. However, the official ban is not strictly implemented in many rural areas and private clinics. In a small scale study, Chu (*2001*) provided direct evidence that ultrasound B-scans were widely used by rural women for prenatal sex termination. High SRBs were also reported in India, South Korea, Singapore, and Taiwan where there are no strict population policies (*Hesketh and Xing 2006; Lane 2004; Sun 2001*).

Since the overall SRB of China has been increasing during last three decades, a number of commentators predict that this situation will lead to increased levels of antisocial behaviour and violence, for instance, and will ultimately present a threat to long-term stability and the sustainable development of Chinese society (*Cai and Lavely 2003; Banister 2004; Hudson and Den Boer 2004*). By late 1990s, some demographers and government officers had argued that it was time for China to relax the strict population policy. However, their advice was not accepted by the central government, which may reflect a concern the fertility rate might be rebound following any relaxation. Alternatively, the Chinese government adopted and carried out a series of policies, laws and strategic actions to improve girl-child survival, increase women's status, and promote sex equality in order to address the issue of abnormally high SRB. For instance, a pilot 'Care for Girls' campaign was launched in Caohu city in 2000. The main activities of the campaign included: establishing specialized organizations, training, punishing those found to be committing non-medical sex-selective abortions and infanticide, advocating for regulations and laws addressing sex equality, holding group discussions for mothers-in-law, helping women to participate in socio-economic activities by providing economic support, encouraging active male participation in the improvement of women's status, enhancing the social-security system, and popularizing 'uxorilocal' marriage (in which husbands marry into wives' birth families) (*Li SZ 2007*). The pilot campaign decreased the SRB of Caohu city from 125 in 1999 to 114 in 2002. Based on the experience of Chaohu, NPFPC expended the 'Care for Girls' campaign to 24 counties in 24 provinces between 2003 and 2005 (*Li SZ 2007*). During the experimental period, the SRB in the 24 pilot counties declined from 133.8 in 2000 to 119.6 in 2005 (*Li SZ 2007*). This latter figure, however, is still significantly above normal. Since the fundamental causes of high SRB are strong son preference together with strict population policy, it is unrealistic to expect that the high SRB will return to normal through the 'Care for Girls' campaign, which is aimed to reduce the strength of son preference, without consideration of the population policy. Hence the campaign suggests that further research is needed to bridge the gap between population policy and decline of SRB in China's complex social and economical context.

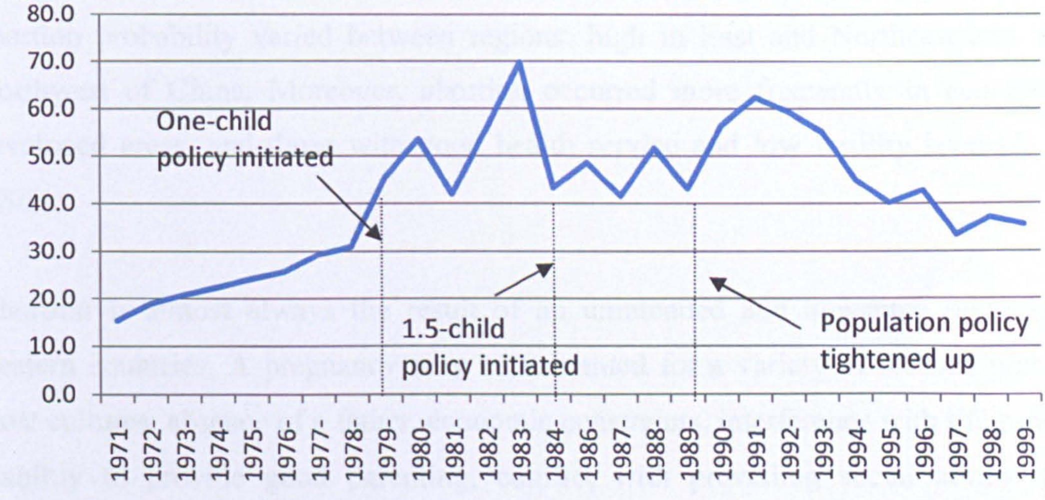
1.2.2 Abortion

Although the Maoist regime was at first pronatalist, the 1953 census figures led the Government to reverse its position: it introduced and supported the use of contraception and abortion to control population growth (but not consistently until 1971) (*DESD 1992*). An abortion can be performed on request with the consent of the family and spouse in China. Moreover, the government provides the services free of charge and allows the women 14 days of paid sick leave for a first-trimester abortion or 30 days if the pregnancy is terminated after the first trimester (*DESD 1992*).

Although the Chinese government has always claimed that abortion is not a contraceptive but a backup method, it does play a central role in the population policy. Reliance on abortion for population control has varied over time and by region due to variations in the degree of enforcement of Government's policy. In 1974, the planned birth model was introduced, birth quotas were set and a persuasion-education model of communication was implemented. Before 1979, birth quotas were set at two births per couple; after that date, the one-child policy was introduced. The strict population policy increased the role that abortion played in population control. In 1983, a nationwide campaign was carried out, including mandatory sterilization for couples with 2 or more children, abortion for unplanned pregnancies and IUD insertions for women with one child. Between 1984 and 1986, however, policy implementation became more lenient and abortion and sterilization campaigns were practically eliminated. The relaxation of controls was believed to have resulted in a rise in population growth rates, between 1985 and 1987, which in turn led to a subsequent renewal and strengthening of policy enforcement (*DESD 1992*).

Under China's health service regulation, almost all abortions are performed in the public health sector. Moreover, the public hospitals need special approval from their local health authority to provide abortion service. Such permission is usually not given to private health facilities. The public hospitals are required routinely to report the number of abortions and relevant complications to local health bureau. All these figures are further aggregated by the MOH every year. Based on data published by MOH, the abortion trend during 1971 and 2000 roughly reflects changes of China's population policy performance during this period (Figure 1.1). Before 1979, the ratio of induced abortion was below 31 per 100 live births. After the date, it increased and reached a peak of 69.8 per 100 live births in 1983, but decreased and remained at relatively low levels during 1984-88, which was due mainly to the leniency of population policy. However, it rose in 1989 and reached a second peak of 62.4 per 100 live births in 1991 when the one-child policy was tightened up again. During more recent years, the ratio has decreased in a general trend with a few small waves (*Qiao and Suchindran 2006*).

Figure 1.1: Ratios of induced abortion (/100 live births) in China between 1971 - 1999



Source: *Qiao and Suchindran 2006*

An estimated 42 million abortions were induced worldwide in 2003. However, China alone accounts for a fifth of these abortions (*Sedgh et al 2007*). Table 1.3 shows abortion rates in China and some selected Asian and western countries between 1975 and 1996. In England & Wales and United States, the rates are relatively constant during these years. In the Asian countries, the rate gradually declined with time. The abortion rates in China and South Korea are higher than other countries. Son preference is also stronger in these two counties than in others.

Table 1.3: Trends in the rate of legal induced abortion per 1,000 women 15–44, by selected country

Country \ Year	1975	1980	1982	1984	1986	1988	1990	1992	1993	1995	1996
China	27.5	44.8	54.9	36.6	44.4	46.2	-	35.6	27.9	26.1	-
South Korea	63.9	64.0	-	50.2	-	-	36.5	-	33.7	-	19.6
Japan	25.2	22.5	22.5	21.4	19.8	18.2	17.0	15.4	14.6	13.4	-
Singapore	23.5	28.4	28.6	32.2	32.9	28.0	22.5	20.0	19.2	16.4	15.9
England & Wales	11.2	12.8	12.2	12.8	13.5	15.3	15.8	14.8	14.7	14.4	15.6
United States	21.7	29.3	28.8	28.1	27.4	27.3	27.4	25.9	25.4	22.9	22.9

Source: AGI 2009

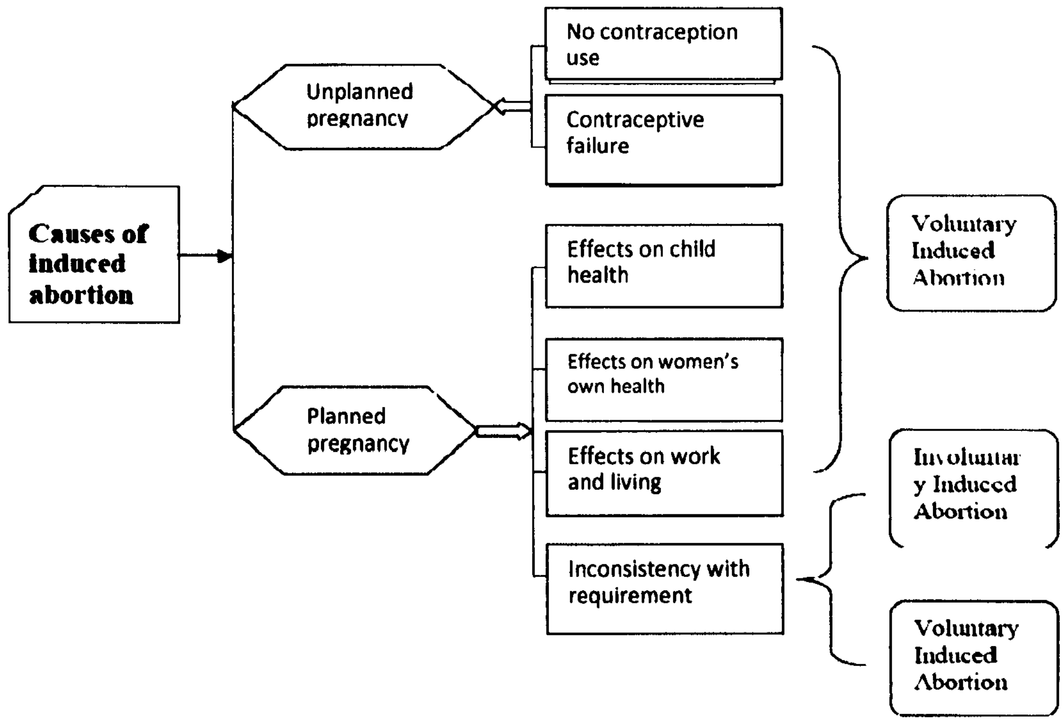
The abortion probability was reported to be higher in urban than in rural areas in China (*Kang et al. 1991; Qiao and Suchindran 2006; Pang, Sun and Zheng 2004*). Moreover, professionals, better-educated women and women who belong to Han nationality were more like to have an abortion than their respective counterparts (*Kang et al. 1991; Pang, Sun and Zheng 2004; Qiao and Suchindran 2006*). The likelihood of abortion is also affected by women's parity, number of live births, and sex of live births. Women who had high parity, more children or already had a son were more likely to have an abortion

(*Pang, Sun and Zheng 2004; Qiao and Suchindran 2006*). It is documented that abortion probability varied between regions: high in East and Northeast and low in Northwest of China. Moreover, abortion occurred more frequently in economically developed areas, and those with good health service and low fertility level (*Li et al. 2005*).

Abortion is almost always the result of an unintended and unwanted pregnancy in western countries. A pregnancy may be unwanted for a variety of reasons present in most cultures: absence of a father, economic constraints, interference with life prospects, inability to provide good parenting, conflict with prevailing social norms, health concerns and a lack of social support (*Faúndes 2010*). The most important reasons given by women for having an abortion in the US are: not ready for a (another) child/time is wrong (25%), cannot afford a child now (23%); have completed childbearing/have other people depending on me (19%), do not want to be a single mother or was having relationship problems (8%), feel too young (7 %), would interfere with education or career plans (4%), health concerns (4%), and effects on the health of the fetus (3%) (*Finer et al. 2005*). In China, a national survey shows that the most frequent reasons of abortions are unplanned pregnancy (40%), inconsistency with the requirements of population policy (36%), effects on working and living conditions (11%), and effects on child health (3%) (*Qiao and Suchindran's 2006*). Despite the fact that abortion reasons in the US and in China are classified in different ways, American women exclusively attribute their abortions to personal reasons, while 36 per cent of their Chinese counterparts cite to the restriction of population policy as the reason. A substantial number of studies also concluded that abortion in China was strongly associated with population policy, either through compulsory abortion due to unapproved pregnancy or selective abortion due to son preference within the regulated circumstances (*Chu 2001; Qiao and Suchindran 2006; Lofstedt, Shusheng and Johansson 2004; Murphy 2003; Pang et al. 2004; Wu, Viisaine and Hemminki 2006*).

Nevertheless, unplanned pregnancy was the main cause in urban areas (46%) in China, which was followed by inconsistency with policy requirements (26%). Conversely, inconsistency with policy requirements was the main cause in rural areas (42%), and unplanned pregnancy (36 per cent) was in second place (*Qiao and Suchindran's 2006*). Figure 1.2 shows the classification of the reasons for induced abortions given by Qiao and Suchindran (*2006*). Unplanned pregnancies may result from no contraception use or contraceptive failure. However, planned pregnancies may also end in abortion, due to inconsistency with policy requirement, effects on child health, effects on women's own health or effects on work and living.

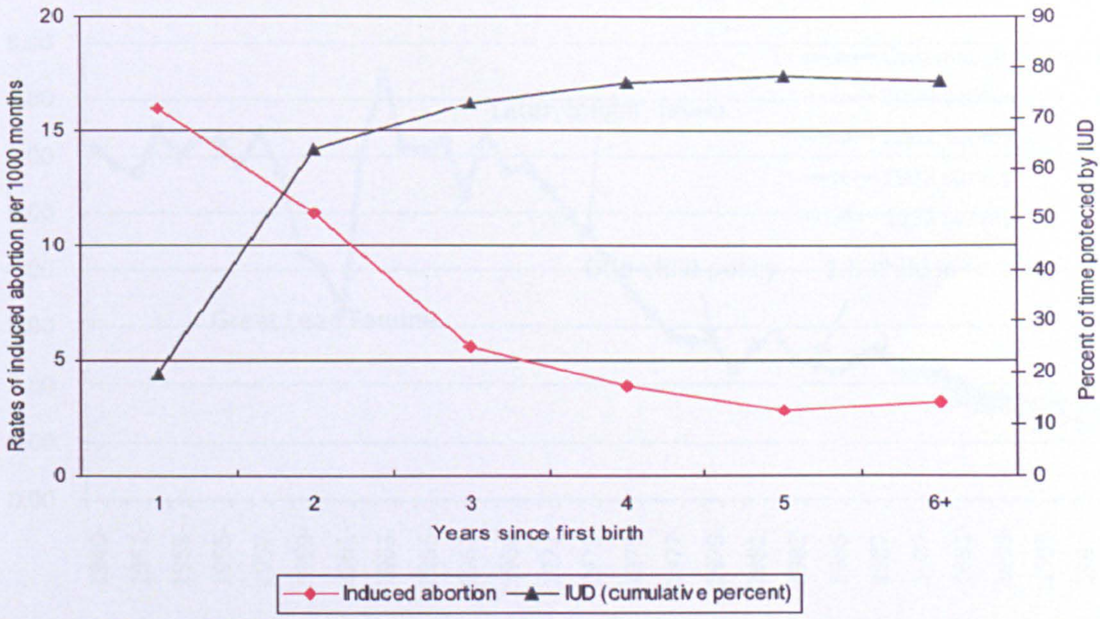
Figure 1.2: The classification of the causes of induced abortions



A number of small scale studies conducted in local areas reported that contraceptive failure and no contraceptive use were the leading causes of abortion in urban areas; each accounted for more than a half of abortions alone in different studies (*Chen et al. 1996; Lou et al. 2000; Tong et al. 2002*). A study conducted in rural areas in four provinces reported that 53 per cent of abortions were due to contraceptive failure and 35 per cent were due to lack of contraceptive use (*Li et al. 2004*). These studies indicated that unplanned pregnancy is becoming the leading cause of induced abortion in China in more recent years.

Figure 1.3 shows an interesting abortion pattern after a first birth in Shanghai (*Che and Cleland 2001*). The induced abortion rate declined with the increasing of IUD use after childbirth. This study indicated that the abortion rate in urban China was strongly affected by adoption of effective contraceptive method.

Figure 1.3: IUD use and abortion rate in Shanghai, China



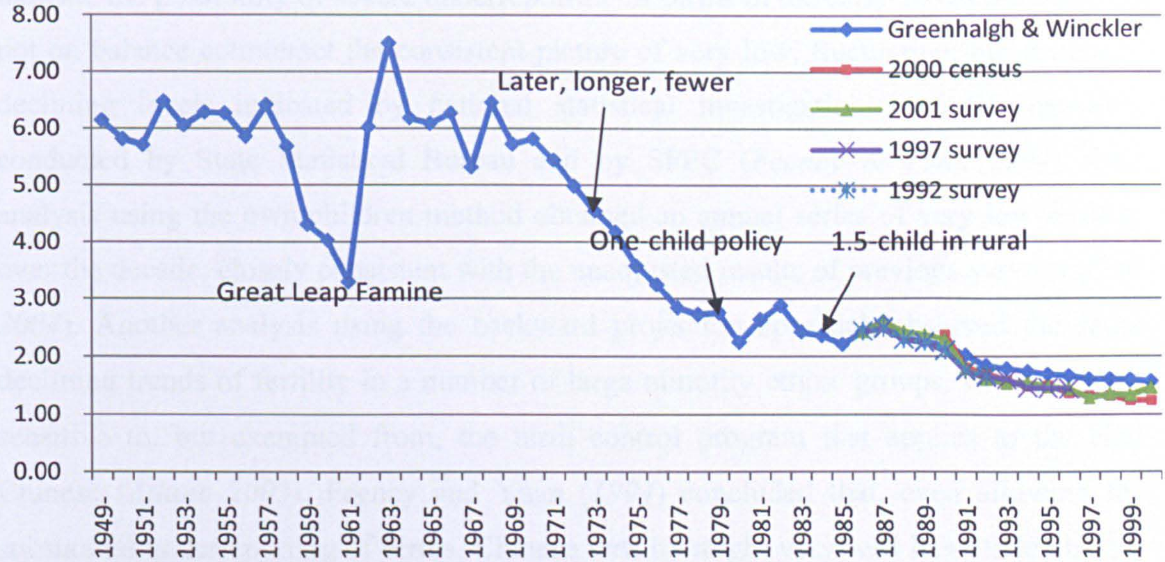
Source: Che and Cleland 2001

1.2.3 Fertility and progression to second birth

Fertility level and determinants

Figure 1.4 shows the trend of China's total fertility rate (TFR) from different sources between 1949 and 2000. It is widely accepted that China's TFR has been below replacement level since the early 1990s (*Cai 2008; Retherford et al. 2005; Feeney and Yuan 1994; Pan J 2004; Wang 2004; Zeng 1996*). However, there is considerable controversy with regard to how far it is below the replacement during the recent decade (*Cai 2008; Guo and Chen 2007; Lavely 2001; Retherford et al. 2005; Scharping 2007; Wang 2004; Zhang and Zhao 2006*). The Chinese government insisted on a total fertility of 1.8 in 1990s, but researchers suspected that this estimate was based on political considerations (*Cai 2008*). The most recent assessments have approached a consensus that China's national TFR during 1990s had declined to around 1.5 (*Cai 2008; Retherford et al. 2005; Zhang and Zhao 2006*). One analysis estimated that China's TFR for 2001 – 2005 was around 1.4 (*Gu et al. 2007a*).

Figure 1.4: Trend of China's Total Fertility Rate between 1949 and 2000



Sources: *Greenhalgh & Winckler 2005; Pan J 2004; Yu and Yuan 2004; Feeny and Yuan 1994b; Yan 2006; NPFPC, http://www.npfpc.gov.cn/en/endata_1.htm*

Since there are many concerns about underreporting of births in national surveys and censuses the above estimates were all upwardly adjusted. A few papers and articles in the years following the 1990 census explored the birth underreporting issue. Findings of these studies include: 1) most underreporting of births occurred in rural areas, as many peasants were determined to have more children, at least until they had one son; 2) consequently, those "unplanned" or "out-of-plan" births, e.g. female births, second and higher order births, were more likely to be underreported; 3) in most cases, those "missing" children in previous enumerations could be expected to show up in later ones, when they grew up to certain ages, i.e. aged 6-7, as they started to use education and other social services, and 4) accordingly, the closer to the enumeration time point, the more likely the "unplanned" births were to be unreported (*Zhang 2004*). Nevertheless, an extensive review failed to find convincing evidence to support the claim of up to 20-30% concealment of births in surveys and censuses as the official estimates indicated (*Zhang 2003)*. For instance, some detailed examinations suggested that the internal consistency of data was good both in a 1992 survey and in the 1995 sample census. Recognizing the problem in data collection, some intensive post-enumeration surveys after completion of large-scale sample surveys were conducted. The available results indicated that the extent of directly detected underreporting was not as serious as generally suspected, e.g. 6.47 per cent in the 1997 NFPRHS (*SFPC 2000*). Thus, contrary to general belief, not all "unplanned" or "out-of-plan" births went unreported in every source of population statistics. Several thorough analyses of the census data indicate the possibility of severe underreporting of births in the early 1990s but these do not on balance counteract the consistent picture of very low, fluctuating, but generally declining levels indicated by national statistical investigations and the censuses conducted by State Statistical Bureau and by SFPC (*Feeney & Yuan 1994*). One analysis using the own-children method obtained an annual series of very low fertility over the decade, closely consistent with the unadjusted results of previous surveys (*Guo 2004*). Another analysis using the backward projection approach observed the same declining trends of fertility in a number of large minority ethnic groups, which are not sensitive to, but exempted from, the birth control program that applies to the Han Chinese (*Attane 2003*). Feeney and Yuan (*1994*) concluded that, even allowing for substantial underreporting of births, Chinese fertility might very well have fallen below replacement level during early 1990s. Guo (*2003*) reached a similar conclusion that, even if the raw statistics were adjusted to allow for 20 per cent underreporting of birth, China's TFR was still below 1.8. Given the rapid socio-economic development and the strengthening in the birth control programme, it is possible that China's fertility could drop as fast as shown in the unadjusted data.

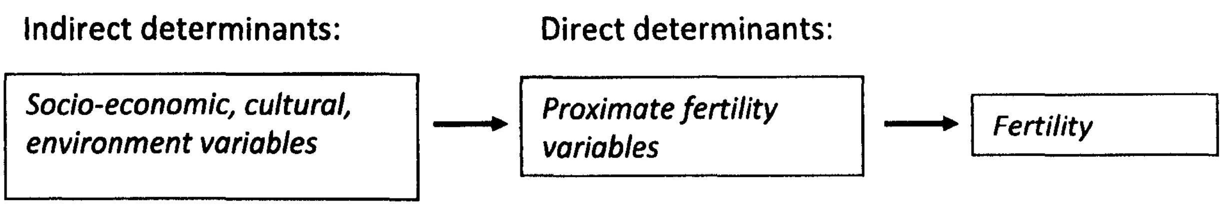
The conventional TFR is only one of several statistics that may be used to measure the level and change in fertility. An alternative measure is total fertility based on period parity progression ratios (PPRs). Each PPR is calculated by the period life table method from duration-in-parity-specific probabilities of progressing to the next parity for a particular calendar year, where duration is measured in years up to a maximum of ten, at which point the life table is terminated. It is assumed that the probability of progression after a birth interval of ten years is small enough to be ignored without introducing appreciable error in the estimate of the PPR. An exception is progression from a woman's own birth to her first marriage, in which case the life table is truncated at 35 years, the assumption being that a negligible proportion of first marriages occur after age 35. This approach has advantage of allowing us to look at trends and make comparisons separately for births of different orders. Table 1.4 shows TFR based on PPRs (TFR_{ppr}) which were derived from three surveys in 1990s by different authors. It is noted that TFR_{pprs} were generally higher than traditional TFRs that were based on age-specific fertility rates. Nevertheless, they were still lower than the official estimates in 1990s.

Table 1.4: Trends of total fertility rates based on period parity progression ratios, 1986 - 1999

Year	1992 survey	1997 NFPRHS	2001 NFPRHS
1986	2.40	2.43	
1987	2.48	2.47	
1988	2.27	2.28	
1989	2.24	2.23	
1990	2.09	2.09	
1991	1.75	1.73	1.93
1992		1.63	1.97
1993		1.59	1.73
1994		1.45	1.75
1995		1.44	1.67
1996		1.43	1.78
1997			1.43
1998			1.37
1999			1.58

Sources: Feeney & Yuan 1994; Guo 2000; Ding 2003

There are a large number of theories of fertility transition (*Peng 1991; Zhang and Du 2006*). The proximate determinants framework was first defined by Davis and Blake (*Davis and Blake 1956*). Bongaarts and Potter modified the model in the late 1970s and early 1980s, greatly simplifying the task of constructing models of human reproduction (*Bongaarts 1978, 2003*). The following simple diagram summarizes the relationships among the determinants of fertility (*Bongaarts 1978*):



The proximate determinants of fertility are the biological and behavioural factors through which the indirect determinants – social, economic, psychological, and environmental variables – affect fertility. The distinguishing feature of a proximate determinant is its direct connection with fertility, that changes in a determinant, such as contraceptive use, necessarily induces a change in fertility. This is not necessarily true for an indirect determinant of fertility such as income or education. Consequently, fertility differences among populations and trends in fertility over time can always be traced to variations in one or more of the proximate fertility variables (*Bongaarts 1978*). The eight important proximate variables reported by Bongaarts (*1978*) include proportion married, contraception, induced abortion, lactational infecundability, frequency of intercourse, sterility, spontaneous intrauterine mortality and duration of the fertile period.

However, in China, maybe uniquely in the world, population policy plays direct role in fertility change – it stipulates how many children one couple can have. Based on current population policy, all couples can have one child, a substantial proportion of couples are allowed to have two and very few can have three. Thus, the progress to second birth is the key determinant of overall fertility in China. Almost all researchers agree that China's population policy is the most important determinant of fertility decline (*Attane 2002; Gu et al. 2007; Hesketh, Lu and Xing 2005; Peng 1991; Potts 2006; Xie 1993*). It not only limited the number of children that a couple could have but also extensively influenced Chinese marriage age, contraceptive use and induced abortion over the last three decades.

As in many other countries, socio-economic development also contributed to China's fertility decline (*Hesketh, Lu and Xing 2005*; *Peng 1991; Xie 1993; Zhang and Du 2006*). The developed areas had lower fertility than less developed areas. Moreover, the better-educated women, professionals, cadres and Han nationality were reported to have lower fertility than their respective counterparts (*Gu 2004; Peng 1991*). TFR in rural areas was higher than in urban areas and varied between provinces (*Gu 2007a; 2007b; Peng 1991*)

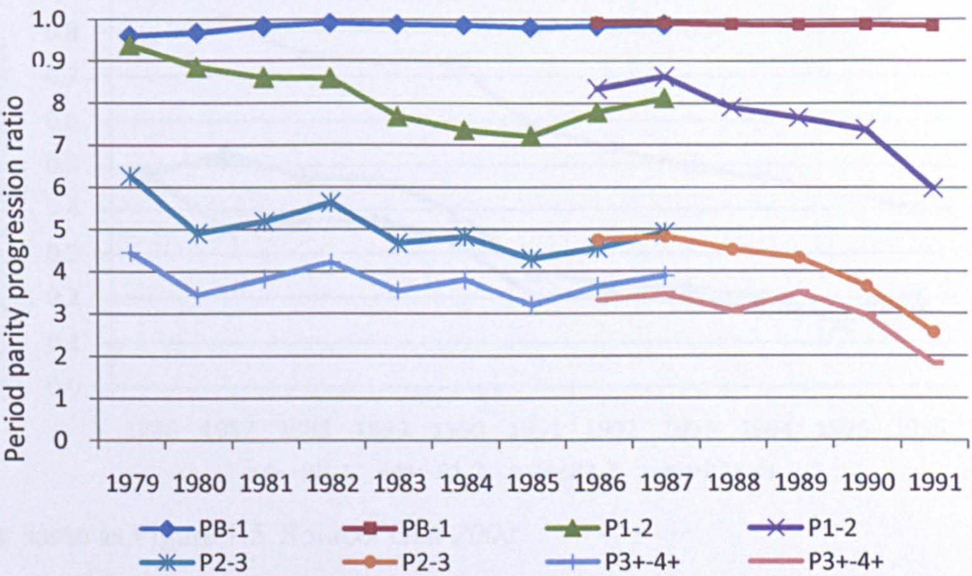
Progression to second birth and associated determinants

Despite the one-child policy, second births are common China, particularly in rural areas, though the progression to second birth has declined since the 1970s. Guo and Choe's study indicated that, in Beijing, the progression to second birth within 5 years declined from 75.8 per cent in 1967-71 to 16.5 per cent in 1982-87 (*Guo & Choe, 1991*). The decline in Liaoning was from 91.6 per cent to 11.0 per cent. Over time the ratio of second births became smaller and the birth interval became wider. Only 13.1 per cent in 1982-87 in Beijing progressed from a second to a third birth; 12.1 per cent had a third birth in Liaoning. This study also showed that declines were slower in Gansu, Guangdong, and Guizhou provinces (*Guo & Choe, 1991*). Ahn reported that, based on the China's In-Depth Fertility Survey Phase I in 1985, the parity progression ratio to the second birth by the 7th year since the previous birth was 59 per cent in Shanghai (a more-developed area), and 91 per cent in Hebei and Shaanxi provinces (less-developed areas). For Hebei and Shaanxi, the parity progression ratio to the second or the third birth was about 10 per cent higher in rural areas than in urban areas. However, the parity progression ratio to second birth was higher for couples with daughters in rural areas by 15-25 per cent. In Hebei and Shaanxi, the chances of a second birth were 9-16 per cent higher before the policy for couples, with a daughter, and 38 per cent higher after the policy. Urban residence had negative effects on progression to second and third births. Child mortality had positive effects on second birth likelihood (*Ahn 1994*). With regard to the progression to second birth, there were significant interregional differences which appeared to follow patterns of socioeconomic development and achievements in FP (*Huang & Xie 1991*).

An exceptional outcome was observed by Feeney in rural areas between 1984 and 1987. The progression from first to second birth increased from 63 per cent to 76 per cent (*Feeney 1994*). His explanation is that this phenomenon was due to the relaxation of marriage age controls in 1980s and the relaxation of controls in the one-child policy in 1984. Survey data for 1991 show 60 per cent of women progressing to a second birth and 75 per cent progressing to a second birth in rural areas (*Feeney & Yuan 1994*).

During more recent years, several studies computed birth probabilities specific for parity and age in single years and from these birth probabilities, PPR for progression to first birth, first to second birth, and second to third birth, and third and higher order to fourth and higher order birth were computed (*Ding 2003; Feeney and Yuan 1994; Guo 2000; Retherford et al. 2005*). Figure 1.5 shows PPRs from the surveys of 1988 and 1992 (*Feeney and Yuan 1994*). Progression to first birth has been high and unchanging since early 1980s, with negligible discrepancy between the two series. The survey of 1988 shows slightly lower levels of progression from first to second birth for 1986 and 1987 than those of 1992. This might be explained by, and perhaps taken as evidence for, underreporting of young second children in the 1988 survey. The two surveys yield nearly identical levels of progression from second to third birth for the years of overlap, however, and the 1988 survey shows higher levels of progression from third and higher order to fourth and higher order births than the 1992 survey. It is notable that there is no change in progression to first birth. Despite later childbearing rules, there would be minimal incentive to underreport first births. Progression from second to third and from third and higher order to fourth and higher order births declines sharply during 1989-1991. Progression from first to second birth changes very little between 1989 and 1990, but drops very sharply between 1990 and 1991.

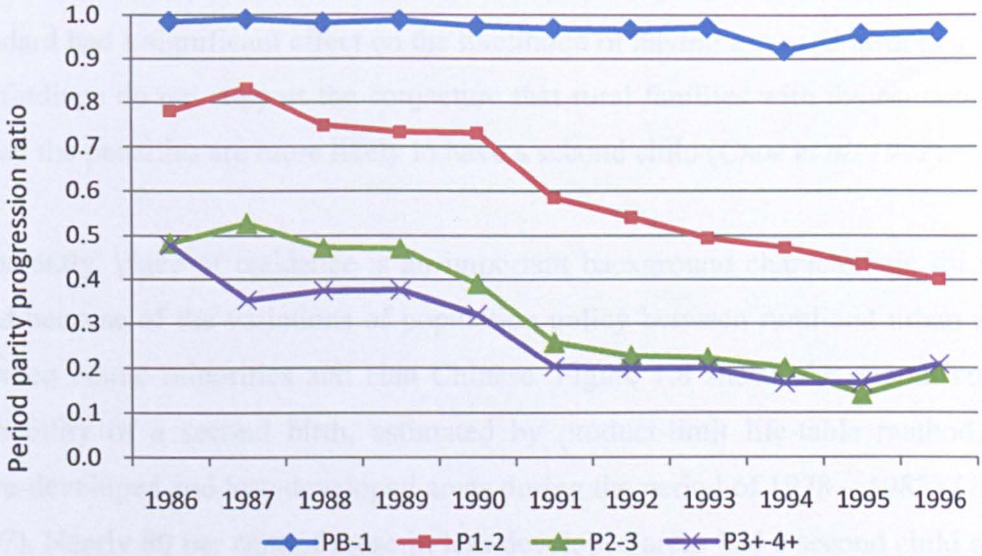
Figure 1.5: Period parity progression ratios for China, 1979-1991



Notes: Period parity progression ratios computed from birth probabilities specific for single year of age and birth order. $P_{B\text{-}1}$: progression from woman's own birth to first birth; $P_{1\text{-}2}$: progression from first to second birth; $P_{2\text{-}3}$: progression from second to third birth; $P_{3^+\text{-}4^+}$: progression from third or higher order to fourth or higher order birth.
Source: Feeney and Yuan 1994.

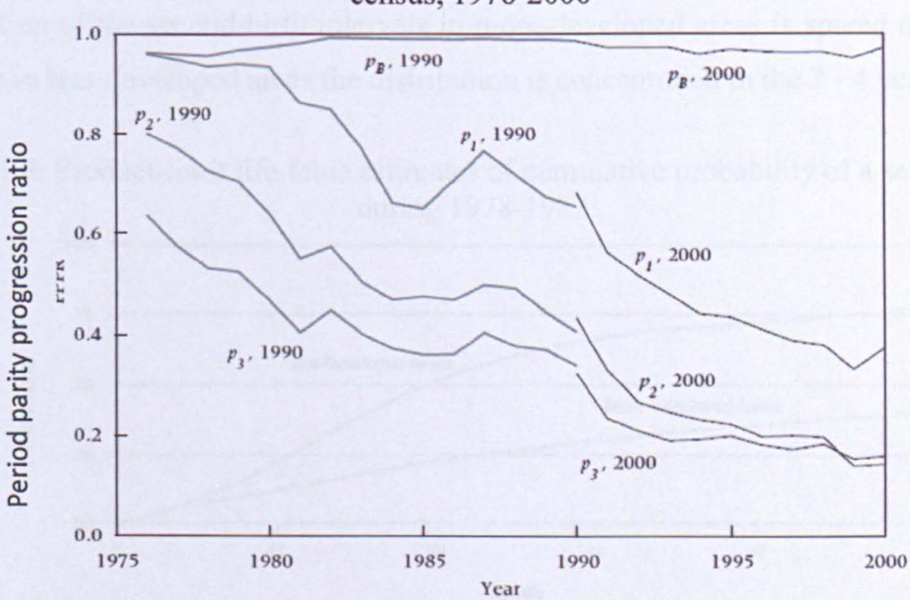
Figure 1.6 and Figure 1.7 show trends of PPRs derived from 1997 NFPRHS by Guo (*2000*) and from 1990 and 2000 censuses by Retherford and co-workers (*2005*), respectively. Similar to the Feeney and Yuan's result, progression from woman's own birth to her first birth is close to one. The progressions from first to second birth and from second to third followed a very similar trajectory and have declined sharply since 1990. Both studies indicate that a substantial proportion of couples had a second birth but only small proportion of them had three or more children during their life courses in 1990s. The various PPR trends derived from the 1990 and 2000 census overlap for the year 1990, which are rather close. However, the outcomes also indicate some underreporting of children ever born in the two censuses. This tends to bias downward the estimates of the progression from first to second birth and higher-order PPRs. Retherford et al (*2005*) explained that underreporting of children ever born biases downward the estimates of TFR_{ppr}. But the close overlaps in the trends for the year 1990 suggest that this bias is small.

Figure 1.6: Trends in period parity progression ratios derived from the 1997 National Family Planning and Reproductive Health Survey, 1986 - 1996



Notes: same as Figure 1.5. Source: *Guo 2000*

Figure 1.7: Trends in period parity progression ratios derived from the 1990 and 2000 census, 1976-2000

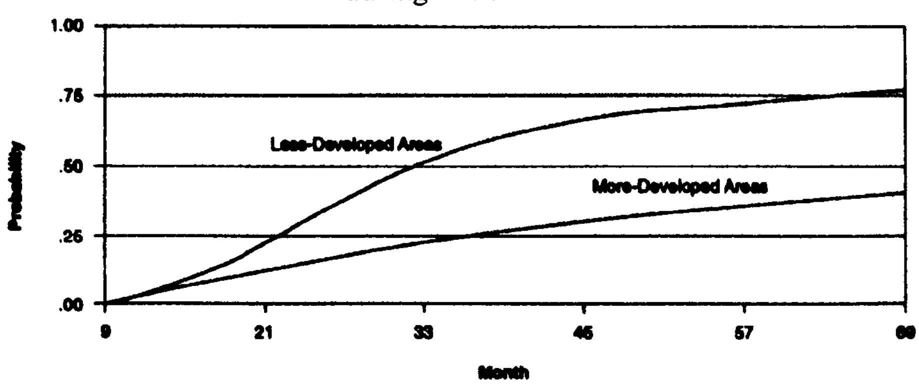


Source: *Retherford et al. 2005*

Couples who have a second birth generally desire to have a son. The Chinese government recognises the difficulty of implementing the one-child policy in rural areas, and permits rural couples with one daughter to have a second child. Sex of the first birth is thus a strong predictor of a second birth. Women whose first child was a daughter were significantly more likely to have a son rather than a daughter as their second child (*Choe, et al. 1992; Qian 1995; Li & Choe 1997*). The death of the previous child was also identified as a significant covariate for predicting a second birth, particularly in areas where few women have more than one child (*Choe et al. 1992*). While living standard had a significant effect on the likelihood of having a second birth in some areas, the findings do not support the conjecture that rural families with the economic means to pay the penalties are more likely to have a second child (*Choe et al. 1992*).

Apparently, place of residence is an important background characteristic for a second child because of the variations of population policy between rural and urban areas and between ethnic minorities and Han Chinese. Figure 1.8 shows the overall cumulative probability of a second birth, estimated by product-limit life-table method, in both more-developed and less-developed areas during the period of 1978 – 1982 (*Li & Choe, 1997*). Nearly 80 per cent of those in less-developed areas had a second child compared with about 40 per cent in more-developed areas. Li and Choe (*1997*) also reported that living in a town has a significant effect on the probability of a second birth in less-developed areas, but only a borderline significant effect in more-developed areas. The distribution of the second-birth intervals in more-developed areas is spread out evenly, whereas in less-developed areas the distribution is concentrated in the 2 - 4 year range.

Figure 1.8: Product-limit life-table estimates of cumulative probability of a second birth during 1978-1982



Months since first birth

Source: *Li & Choe, 1997*

Women's education was found to have significant effects on the probability of a second birth; higher education is associated with a lower probability of a second birth (*Li & Choe, 1997*). The probability of a second birth decreases as age at first birth increases.

In more-developed areas, very young or very old age at the first child's birth is associated with a shorter second birth interval, whereas these ages are associated with a longer interval in less-developed areas (*Li & Choe, 1997*). Han Chinese, peasants, first birth prior to 1979 and level of education are also known to have independent effects on the transition to a second birth (Choe et al. 1997).

From the above literature review, it can be concluded that population policy is the dominant influence on reproductive behaviours in China during last three decades, but it varies considerably between geographic regions, between rural and urban areas, and between ethnic minorities and Han Chinese; variations in son preference are also important with regard to influence on reproductive behaviours; however, little is known about the influence of FP clinical services on SRB, abortion and fertility. Reviewing the literature points to certain gaps in the body of knowledge in relation to population policy and nature of FP services, and also suggests a rationale for conducting this study.

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1 Late marriage will be bestowed some extra bonus, such as longer wedding vacation.

2 People's Daily [人民日报] is the most popular official news paper in China. The editorial was published on 29 April 1991.

3 Once-a-month pill is a type of oral contraceptive pills that was developed in the late 1960s in China. It is a combined pill that contains both estrogen (quinestrol) and progestogen. After oral intake, quinestrol is stored in fat tissue from where it is slowly released and metabolized to ethinylestradiol. The progestogen component is short-acting and produces a progestogen peak followed by a decline which induces a menstruation-like withdrawal bleeding, typically starting on Day 3 after taking the pill. The recommendation for use of the pill is to take the first pill on the fifth day of menses, the second pill on the twentieth day after the first one, and thereafter one pill at monthly interval (*Fang et al. 2007*).

4 Visiting pill is one type of oral contraceptive pills. It can start at any day during a menstrual cycle, one pill a day continuing 14 days, then stopping and waiting for menses. Women may follow the same procedure from the first day of next menstrual cycle. Such a way prevents women from pregnancy for the whole cycle. It is convenient to use particularly for couples who do not cohabite but visit home for a short period, such as army soldiers. However, some types of visiting pills have been removed from the national FP programme due to less effectiveness and potential risk to women's health.

Chapter 2: Rationale, Aims and Conceptual Framework

2.1 Rationale

The fertility rate in contemporary China has been far below replacement level since mid-1990s. Consequently, China became an ageing country during a very short period and the sex ratio at birth (SRB) increased far above normal during the last 30 years. It is agreed that these consequences have their origin in China's population policy.

The effect of population policy on ageing is obvious. However, the effect of the policy on high SRB is mainly based in theory. To what extent and in what manner policy affects SRB are not very clear. This is because few studies examined in detail the link between SRB and population policy. Nevertheless, the primary cause of lack of evidence may be that it is the difficult to measure population policy. As mentioned early, China's population policy has many rules and these rules vary between provinces, between rural and urban areas, and between Han Chinese and ethnic groups. Demographic and fertility data for populations under particular rules are usually not available.

In 2007, Gu and colleagues obtained so called "policy fertilities" of China's 30 provinces. This numerical indicator is defined as the average number of children in a population that would be born to a woman over her lifetime if all women strictly follow the population policy. This indicator is calculated by multiplying the proportion of provincial population under different population policies by the total number of people in each province based on China's 1990 census. The policy fertility portrayed differences of the population policy between provinces and provided an opportunity to evaluate the effects of population policy on SRB as well as other reproductive outcomes in China. Thus far, no study has made use of this new data set to investigate linkage of population policy with Chinese reproductive behaviours.

China's population policy has been implemented primarily through the FP programme. Although in many provinces and for many years, women have been asked to use IUD after the first birth and to use sterilisation after the second birth, China has modified the strategy for FP programme since 1994 International Conference on Population and Development (ICPD). The country has widened its focus from FP to reproductive health, from population control to client-centred services, from contraceptive methods to informed choice and from administrative targets to providing quality of care services. Although it is generally believed that the overall quality of FP services in China has improved, it is still uncertain whether the quality or nature of

FP services affects reproductive outcomes throughout the country. A national survey of FP service institutions is the best way to measure the quality of FP services across the country. The 2001 National FP and Reproductive Health Survey (NFPRHS) provided the most recent data in this area. (The latest survey on FP and reproductive health in China was conducted in August 2006, but it did not collect data on FP services centres in rural areas). No previous studies have explored the effects of characteristics of FP services at township and village levels on reproductive outcomes.

Son preference is a traditional Chinese value, which is particularly strong in rural areas. Although son preference is agreed to be the fundamental cause of SRB imbalance, achieved largely through sex-selective abortion, such a conclusion is mainly based on qualitative data. Since son preference is against social norms advocated by the government, it is difficult to gather reliable information on couple's son preference by asking "D*o you have son preference?*" or "D*o you prefer a son more than a daughter?*" In this study, an indirect indicator, which calculates the difference between women's ideal number of boys and girls, is used to measure women's son preference. In such a way, sex sensitivity is largely eliminated and thus social desirability bias in reporting son preference can be reduced. Moreover, son preference can be measured at provincial level by aggregating data of individual woman's son preference. Similar analysis is rarely seen in previous Chinese studies.

In summary, this thesis brings several new data sets – policy fertility derived by Gu and co-workers in 2007, nature of FP services at grassroots institutions and a new measure of son preference derived from 2001 NFPRHS - to advance knowledge on the effects of population policy, nature of FP service and culture of son preference on reproductive behaviours in China. Among reproductive behaviours, SRB, abortion and the progression to 2^{nd} birth are of particular interest in this thesis.

2.2 Aims, objectives and hypothesis

The broad aim of this study is to assess the effects of different population policies, level of development, local FP services and individual characteristics on SRB, women's abortion and progression to second birth in rural China.

This research will focus on rural areas because the lenient population policy (1.5-child and 2-child policies) mainly applies in rural areas. The data on FP services at grassroots institutions are only available in rural areas in the 2001 NFPRHS.

In order to reach the broad aim mentioned above, this study will start with preliminary analyses of the aggregate variables at township and provincial levels, which provide information to conduct further analyses of the effects of the aggregate variables on women's reproductive outcomes. The final part is the main aim of this study, which contains three objectives and each objective focuses on one type of China's population policies. Results of the three objectives will be compared in order to identify specific effects of each policy on reproduction. Below I provide some detailed information on aims and main hypothesis for each aim.

Aim 1: To assess the extent to which population policy (using the quantitative indicator 'policy fertility') correlates with regional GDP per capita, proportion of rural population, proportion of minorities and son preference at provincial level.

Hypotheses:

Low policy fertility will be associated with high GDP per capita, low proportion of rural population and ethnic minorities at provincial level, and less strong son preference at provincial level. The reasons are: the population policy is normally different between urban and rural areas, and between ethnic minority and Han nationality. Rural areas carry out less stringent population policy than urban areas, and ethnic minorities carry out a more lenient policy than Han Chinese. The developed areas are expected to have more urban population but fewer ethnic minorities. Nevertheless, it expected that appreciable variation in policy fertility will remain, a reflection of a degree of provincial autonomy in setting policies.

Aim 2: To examine the link between characteristics of FP services at grassroots institutions and policy fertility and socio-economic development indicators at provincial level

Hypotheses:

Good FP services at townships' family planning service centres (FPSCs) as well in villages will be associated with low policy fertility and high GDP per capita at the provincial level. The reasons are: China's population policy has been implemented primarily through the FP programme. Strict population policy requires the local government to give more support to the local FP services, and to stress the long-term contraceptive methods, such as IUD and sterilization. Therefore, FP service capacities would be enhanced in these areas. Similarly, FP service institutions will receive more financial support in the developed provinces than the less developed provinces, which will result in enhancement of FP services at FPSCs.

Aim 3: Within specific types of population policy, assess the effects of development, characteristics of FP services at grassroots institutions and individual characteristics on fertility, abortion and SRB.

The indicator of policy fertility at provincial level obtained by Gu and colleagues (2007b) ranged from 1.06 to 2.37 (detailed information will be given in Chapter 3). In this study, it is grouped into three classes: 1 –1.3 (actually ranging from 1.06 to 1.27), corresponding to provinces with a predominately 1-child policy; 1.3 – 1.9 (actually ranging from 1.38 to 1.67), corresponding to provinces with a predominately 1.5-child policy; ≥2.0, for provinces with policies permitting two or more children. Although policy fertility of Tibet is not available, Tibet is classified into the group with policy fertility ≥2.0 because the autonomous region has imposed no specific requirements in FP. This study, hence, has three specific objectives under the three aims.

Objective 1: To assess the fertility level, progression to the second birth, abortion rate before and after the first and second birth and SRB of the first and second birth under 1-child policy.

Hypotheses:

Among provinces dominated by 1-child policy, fertility level and progression to second birth will be low, abortion rates before and after first and second birth will be high, and SRBs of the first and second birth will be above normal; Good FP services at grassroots institutions will be associated with low abortion rates. The reasons are: the strict population policy prevents most second births among these provinces. Couples who have son preference will be more likely to have selective abortions for a son. Consequently, the abortion rate before the first birth and SRB of the first and second birth will be high. The abortion rate after first and second birth will also be high because, among these provinces, women may have longer exposure to unprotected sex than their counterparts among other provinces. IUD and condom will be popular among these provinces but not sterilisation. Use of less effective contraceptives also contributes to the high abortion rate. Some women may be asked to have an abortion for an unapproved pregnancy. However, good FP services at FPSCs and villages will reduce the risk of abortion caused by unwanted pregnancy. An effect of couple's education on fertility level of the second birth can be almost ignored because opportunities for the second birth are limited. Moreover, better-educated women may be less likely to have an abortion and the SRB among them will be lower than their counterparts because their son preference is less strong.

Objective 2: To assess the fertility level and progression to the second birth, abortion rate before and after first and second birth and SRB of first, second and third birth under 1.5-child policy.

Hypotheses:

Among provinces dominated by 1.5-policy, the overall fertility level will be higher than that among provinces dominated by 1-child policy. Progression ratio to second birth will vary by the sex of the first birth, which will be higher among women who had a daughter than among those who had a son. This consequence is mainly caused by the 1.5-child policy, which allows a second birth for women with only a daughter. The SRB may be normal or close to normal for the first birth, but will be high for the second and third birth because women who had only daughters would seek selective abortions for a son. Thus the abortion rate after the first birth will be higher among women who had only a daughter than those who had a son. After the first child, women will be less likely to use permanent contraceptive methods; but after the second birth, sterilisation will become popular because many women may be asked to use sterilisation, particularly those who have had a son. Owing to the high prevalence of sterilisation, the abortion rate after the second birth will be low. However, it is difficult to formulate hypothesis on the associations between FP services and level of second births and abortions. This is because good FP services should be helpful to reduce the second births and abortions on the one hand, but, on the other hand, the existence of good FP services might be a programmatic response to high local demand for second births, particularly in provinces where population control is a high priority. Local governments have to enhance local FP services and management to townships where the second birth rate is high. It is expected that fertility level of the second birth will be higher among less-educated women than their better-educated counterparts because less-educated women have stronger son preference.

Objective 3: To assess the fertility level, progression to the second birth, abortion rate before and after the first and second birth and SRB of first and second birth under 2-child policy; to explore the differences of fertility, abortion and SRB between Han Chinese and ethnic minorities.

Hypotheses:

The overall fertility level and progression from first to second birth will be higher among these provinces than the others due mainly to the lenient population policy. Abortion rate will be low because more births are permitted. SRB of the first birth will be within the normal range but SRB may increase with birth order due to desire for a son. The fertility level is expected to be higher among ethnic minorities than Han Chinese because minorities are subject to a more lenient population policy than the Han. Both abortion rate and SRB among Han people are expected to be higher than the minorities because of the differences of population policies and son preference between them. Similarly as above, expected associations of capacity of FP services at grassroots institutions with level of second births, abortions and SRB are difficult to predict because either could be the cause of the other. Differences in fertility level by women's education are expected to be large because better-educated women will prefer small family sizes and less-educated women may have as many as children that the fertility regulations allow.

2.3 Conceptual framework

Figure 2.1 represents the conceptual framework of this study. The framework considers explanatory indicators from individuals, surrounding socio-economic and political environment, institutional determinants and their interactions. Individual indicators are in the context of broader institutional, cultural, socio-economic and political settings.

As shown in the conceptual framework, the outcome indicators are measurements at the individual level. However, their relationships are not parallel. Fertility and SRB are directly affected by abortion. SRB may increase by birth order. Contraception and son preference are women's important characteristics. Contraception will directly affect fertility level and abortion prevalence, while son preference will directly affect abortion and affect fertility and SRB through abortion and contraceptive adoption. Abortion and contraception affect each other: abortion may be a cause of contraceptive adoption and contraceptive use can reduce risk of abortion.

All the outcome indicators will be affected by couples' characteristics (i.e. age, education, income, etc.) and surrounding environment. Political environment, particularly the population policy, has been demonstrated to have a profound impact on women's reproductive behaviour and regional fertility levels. It also affects how well localities provide FP services, including types and quality of the FP services. Social, cultural and economic environments are independent factors that affect women's reproductive behaviour and subsequent outcomes. They also affect policy formulation (i.e. China's population policy was modified in 1984 due to resistance in rural area where son preference is very strong). Economic development is one of the key factors of quality of FP services.

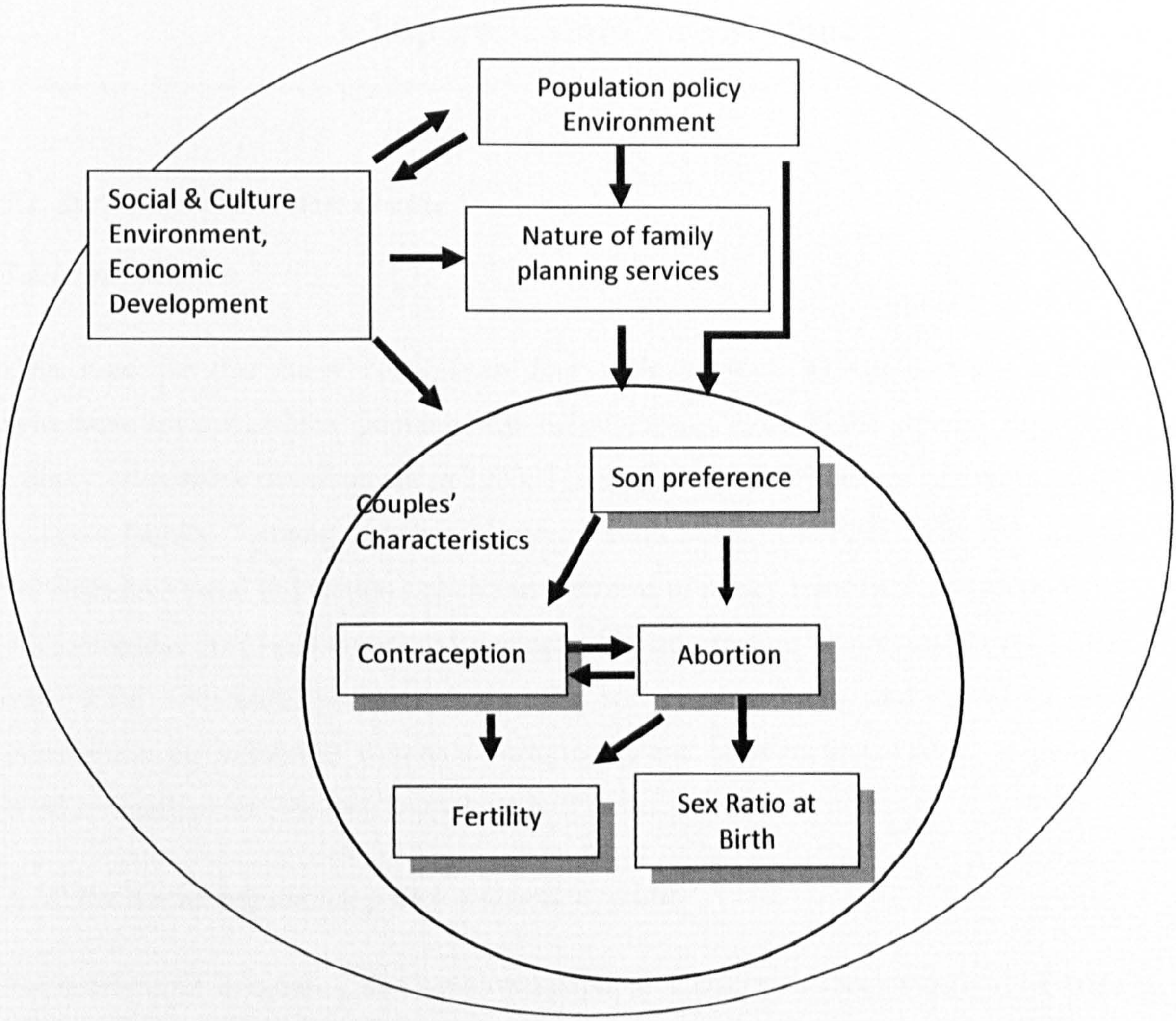


Figure 2.1: Conceptual framework

Chapter 3: Data and Methods

3.1 Data sources and data quality

3.1.1 Introduction

Data used for this study come from four main sources: 1) Gu and co-workers' systematic review of local population policies across China; 2) the strategy report on China's sustainable development in 2000; 3) data from the 2000 census, and 4) the 2001 National Family Planning and Reproductive Health Survey (NFPRH). The first source provides provincial population policies in the form of policy fertilities. The second and third provides socio-economic and demographic information at province level in the mid-1990s. The fourth provides data on FP services in villages and townships, and information on individual women's background and reproduction. Data at province-level are merged into the data from 2001 NFPRHS.

3.1.2 Provincial population policy and policy fertility

For nearly three decades, China's national population policy has been mostly referred to as a one-child policy. However, although population control remains basic state policy, the central government has refrained from implementing a set of uniform policies across the country (*Greenhalgh 1986, 1993; Short and Zhai 1998; Scharping 2004*). Modifications to the state policy of population control have been left to each province, under the general principle of slowing down population growth and encouraging only one child per couple (*Gu et al. 2007b*). Considering all the modifications, China's population policy can be grouped into four categories in general: 1) one-child policy (one child per couple); 2) 1.5 children policy (those whose first child is a girl may have a second child); 3) two-children policy (two children per couple); and 4) three-children policy (three children per couple).

Provinces in China range from a few million to nearly 100 million people, and each province has a high degree of geographic, economic, and demographic heterogeneity. Due to the variations of population policy between different groups of people and their disproportional distribution between and within provinces, it is inevitable that the fertility level will vary between provinces. In 1990, in order to formulate the national and provincial Eighth Five-Year Population Plan, the State Family Planning Committee (SFPC) introduced the quantitative indicator "policy fertility" to summarize the fertility levels required by local fertility policies and local family planning (FP) officials were asked to report the policy fertility (*Gu et al. 2007b*). However, the reliability of the reported policy fertility of each province is unknown. To attain accurate policy fertility at provincial or national level is difficult because of the localised nature of China's population policy. To remedy this problem, a pioneering study was conducted by Gu and colleagues. They collected local population policies from 420 prefecture-level units [1] across China and conducted a systematic review. Based on such information, they further calculated accurate national and provincial policy fertilities (*Gu et al. 2007b*).

Firstly, the population policy of each prefecture was classified into four categories as mentioned above. Then the authors estimated the number of people in each prefecture falling under different categories of the policy. This is done by multiplying the proportion of prefecture population under each category by the total number of people in each prefecture based on China's 1990 census. For each prefecture, the policy fertility level is the weighted average of fertility under different policies. This formula is shown as follows:

$$\text{Policy fertility} = 1\times k_1 + 1.483\times k_{1.5} + 2\times k_2 + 3\times k_3 \qquad (3.1)$$

where, k is the proportion of the population under 1-child, 1.5-child, 2-child and 3-child policy. For policy fertility in areas with a policy that allows couples whose first birth is female to have a second child, the sex ratio at birth (SRB) is also considered. The SRB is assumed to be at the normal level of 107, which is the SRB among the first births in China's 2000 census, the proportion of first births that are female is 0.483. This implies an average completed fertility for the population under this policy of 1.483 (*Gu et al. 2007b*).

By aggregating populations under different policies of all prefectures within a province or throughout the whole country, the provincial and national average policy fertilities were obtained. The national policy fertility level was estimated to be 1.47 and those of all provinces (excluding Tibet, where the state has imposed no specific requirements in family planning, *IOSC 1995*) are shown in Table 3.1 (*Gu et al. 2007b*). The explanation of policy fertility is similar to that of total fertility rate, namely the average number of children in a population that would be born to a woman over her lifetime if all women strictly follow the local population policy. Up until to today, the policy fertilities obtained by Gu and colleagues are the most precise indicators that measure differences of population policy between provinces.

Table 3.1: Policy fertilities at province level in China

Province	Policy fertility	Province	Policy fertility	Province	Policy fertility
Shanghai	1.06	Shandong	1.45	Guangxi	1.53
Jiangsu	1.06	Jiangxi	1.46	Gansu	1.56
Beijing	1.09	Hubei	1.47	Hebei	1.59
Tianjin	1.17	Zhejiang	1.47	Inner Mongolia	1.60
Sichuan	1.19	Hunan	1.48	Guizhou	1.67
Chongqing	1.27	Anhui	1.48	Yunnan	2.01
Liaoning	1.38	Fujian	1.48	Qinghai	2.10
Heilongjiang	1.39	Shanxi	1.49	Ningxia	2.12
Guangdong	1.41	Henan	1.51	Hainan	2.14
Jilin	1.45	Shaanxi	1.51	Xinjiang	2.37

Note: not including Tibet. Source: *Gu et al. 2007b*

3.1.3 Socio-economic and demographic data at province level

Table 3.2 shows five indicators at provincial level. The average annual incomes in rural areas and GDP per capita at province level during mid-1990s were obtained from the strategic report concerning China's sustainable development published by Chinese Academy of Sciences in 2000 (*WGCSDS 2000*). The proportion of population in rural areas and proportion of minority ethnic groups came from the 2000 census (*NSB 2010*). However, the strength of son preference at province level is calculated by aggregating up characteristics of the 39,585 women in the 2001 NFPRHS to their respective provinces. It is defined as the ratio of total ideal number of sons plus number of children no matter the sex over total ideal number of girls plus number of children no matter the sex. Aggregation of individuals in this way is a recognised method of constructing community-level data (*Casterline 1987*), and several studies have relied partially or wholly on this method (*Lesthaeghe et al. 1985; McNay, Arokiasamy and Cassen 2003*). However, I acknowledge that the method is vulnerable to whatever degree of sampling error that may be present in the survey. But this deficiency does not really matter because: the sample of the 2001 NFPRHS is designed to be not just nationally representative but also regionally representative [2]; the data will be further recoded into 3 categories, corresponding to no son preference, weak son preference and strong son preference.

Table 3.2: Socioeconomic and demographic information at province level

Provinces	Rural popul. %	Ethnic minority %	Strength of son preference	Average annual income in rural (RMB Yuan)	GDP per capita (RMB Yuan)
Beijing	22.46	4.3	0.94	3,661.7	14,597.5
Tianjin	28.01	2.7	0.88	3,243.7	13,015.7
Hebei	73.94	4.4	1.01	2,286.0	6,057.9
Shanxi	65.09	0.3	1.06	1,738.3	4,712.3
Inner Mongolia	57.32	20.8	0.95	1,780.2	4,705.6
Liaoning	45.76	16.1	0.95	2,301.5	8,434.2
Jilin	40.32	9.2	0.89	2,186.3	5,505.8
Heilongjiang	48.46	4.9	0.91	2,308.3	7,220.6
Shanghai	11.69	0.6	0.85	5,277.0	23,062.5
Jiangsu	58.51	0.4	0.95	3,269.9	9,345.8
Zhejiang	51.33	0.9	0.98	3,684.2	10,458.3
Anhui	72.19	0.7	1.03	1,808.8	4,357.7
Fujian	58.43	1.7	1.11	2,785.7	9,141.9
Jiangxi	72.33	0.3	1.12	2,107.3	4,133.0
Shandong	62.00	0.7	1.01	2,292.1	7,569.7
Henan	77.00	1.3	1.04	1,733.9	5,387.1
Hubei	59.78	4.4	1.00	2,102.2	5,874.8
Hunan	70.25	10.1	1.04	2,037.1	4,629.5
Guangdong	45.00	1.5	1.22	3,467.7	10,375.1
Guangxi	71.85	38.4	1.17	1,875.3	4,349.7
Hainan	59.89	17.4	1.11	1,916.9	5,516.3
Sichuan	66.91	5.0	0.98	1,680.7	3,938.5
Guizhou	73.31	37.8	1.05	1,298.5	2,199.1
Yunnan	76.13	33.4	1.04	1,375.5	4,016.2
Tibet	76.64	93.9	1.16	1,194.5	3,104.0
Chongqing	81.07	6.5	0.98	1,643.2	4,438.2
Shaanxi	67.74	0.5	1.05	1,273.3	3,714.4
Gansu	75.99	8.8	1.09	1,185.1	3,132.9
Qinghai	65.04	46.0	0.99	1,320.6	4,073.6
Ningxia	67.57	34.6	1.12	1,512.5	3,979.6
Xinjiang	66.18	59.4	1.04	1,504.4	6,112.6

Note: Strength of son preference = (no. of ideal boys + no. of children no matter what sex) / (no. of ideal girls + no. of children no matter what sex) ×100, using data from 2001 NFPRHS. Source: *NSB 2010b; WGCSDS 2000; 2001 NFPRHS*

3.1.4 Data on township FP centres, villages and individual women at reproductive age

In order to review the trend of population dynamics as well as the contraceptive practice of Chinese couples of childbearing age, their reproductive health status and the needs for family planning services, and to provide a scientific basis for improving family planning management and enhancing reproductive health services, the National Population and Family Planning Commission (NPFPC) organized and undertook NFPRHS in 1997 and in 2001, respectively (*Pan G 2004*).

This study will use the data of the 2001 NFPRHS. The survey was conducted across all 31 provinces, autonomous regions, and municipalities in mainland of China from July to September 2001. A three-stage stratified probability proportional to size (PPS) cluster sample was drawn to be regionally and nationally representative of women aged 15 to 49 living in China. In the first stage, a number of counties (and equivalent urban districts) were sampled at each province based on PPS. Three hundred and thirty-seven counties and districts were selected at the first stage. In the second stage, using township (in rural) / street (in urban) as the sample unit, three to four townships and streets were selected (based on PPS) at each of the above countries and districts. A total of 1041 townships and streets (including 830 townships) were finally included in the survey. In the third stage, one rural village or urban community was randomly selected from each of the above township or street. All eligible women at the village and community were invited to answer a structured questionnaire.

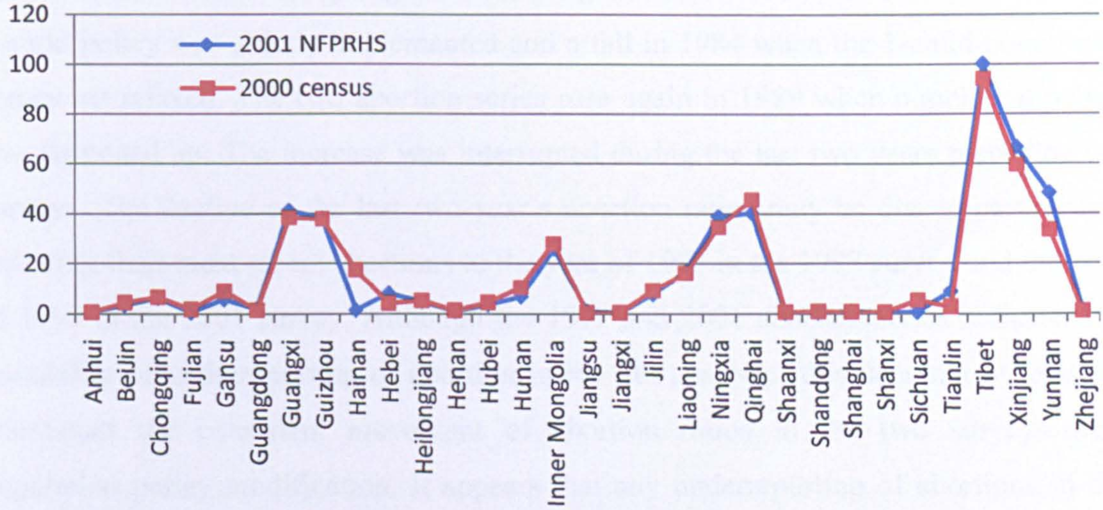
The survey included three components: township family planning service centre (FPSC) survey, village survey and survey of individual women who were of reproductive age. In China, every township is usually required to set up one FPSC. However, among the 830 sampled townships, 776 (93.5%) had and 54 did not have a FPSC. Information on the FPSC's basic infrastructure, service equipment, personnel number and qualification, contraceptive method mix and other health services provided in 2000, and population size and areas of the township were collected. From the 830 villages, the types and number of the public facilities, village doctors, midwives, number and qualification of FP personnel, contraceptive and other health services provision, and environmental deterioration, etc were collected (instruments shown in Appendix I). The individual women's interviews were carried out in the women's own home by trained local health workers and covered a range of reproductive health topics, including demographic information, history of pregnancy and pregnancy outcomes, current contraceptive use and experienced side effects, contraceptive knowledge, knowledge of STDs/HIV/AIDs and current reproductive health status, etc. A total of 39,585 women were interviewed, and 74.5% of them (29,512) were from rural villages. The response rate of the individual survey was 98.27%.

3.1.5 Quality of data from 2001 NFPRHS

In general, the quality of the data is high. As demonstrated by the former vice minister of NPFPC, Pan Guiyu, "*Using a scientific methodology and an appropriate sample, the survey [i.e. 2001 NFPRHS] yielded high-quality data which is significant value to understanding and analyzing the marital, fertility, contraceptive and reproductive health conditions and needs of Chinese women, the implementation of the population and family planning program, and the status of family planning management and service capacity-building*" (*Pan G 2004*).

To ensure the quality of the survey, NPFPC announced in advance that the results of this survey would not be used to evaluate the management of local authorities and would not be used as justification for fines or penalties in case a couple had more children than officially approved. This announcement relaxed pressure on the local officers to falsify achievement of population targets and should enhance the validity of information. The questions on FPSC and village surveys were well defined to prevent misunderstanding. The majority of them were simple questions with yes/no answers. A few questions ascertained how many personnel the FPSC had, the population size and area of the township. Responses to these questions were elicited from the directors of the FPSC and heads of sampled villages. The individual woman interviews were conducted by trained local health workers and monitored by teams from NPFPC. For the non-sensitive information, the data quality is fairly good. As one example, Figure 3.1 shows the percentage distributions of ethnic minority by provinces, which were obtained from 2000 census and based on women's responses in 2001 NFPRHS, respectively. The overlaps of the two lines indicate that the sample's representative and reliability of women's responses in 2001 NFPTHS were fairly good.

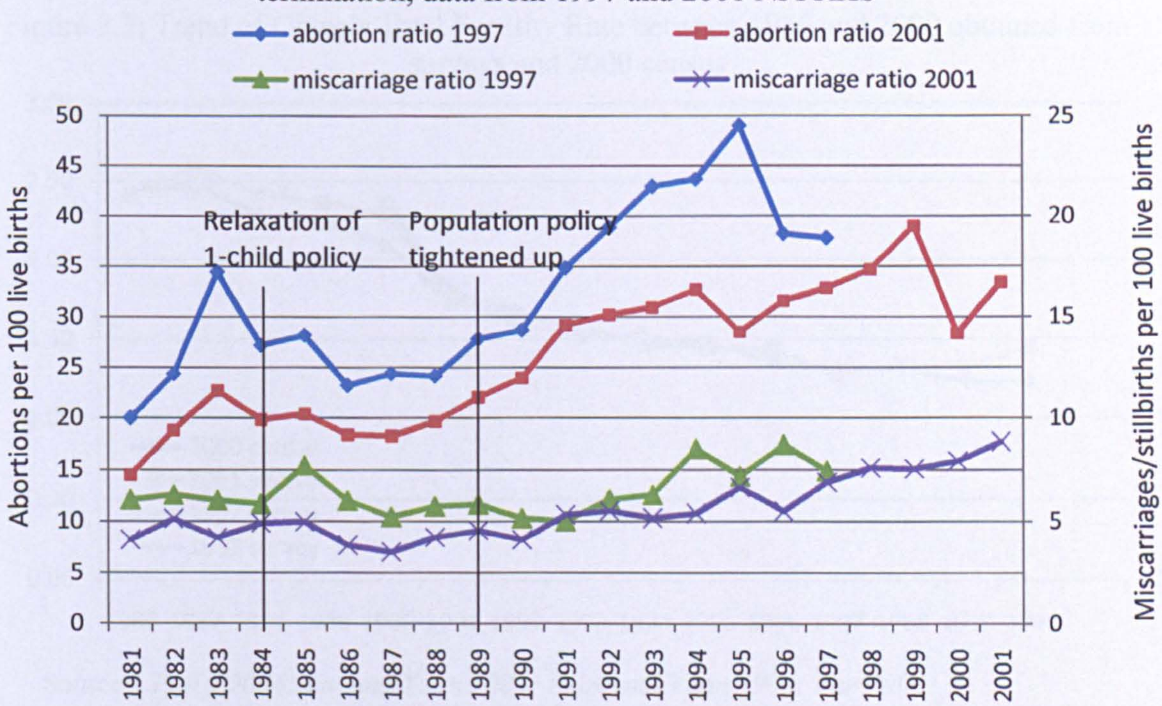
Figure 3.1: Percentage distribution of ethnic minorities at provincial level in China: comparing data obtained from the 2001 NFPRHS and the 2000 census



The major concern of the survey is that women might under-report abortions and number of live births. Abortion has been legal in China since 1953. It is normally not a stigma for married women to report their history of abortion within marriage. Moreover, married women in rural areas are entitled to a free abortion service and a good care after abortion. There is no reason to assume that married women would 'deliberately forget' previous abortions but this would not be necessarily true among unmarried women because social stigma still exists among them. However, comparing corresponding abortion-live-birth ratios and miscarriage/stillbirth-live-birth ratios derived from married women in surveys of 1997 and 2001 NFPRHSs, it is found that all the 1997 survey estimates are higher than the 2001 survey estimates, mostly about 5 to 6 percentage points higher with a maximum divergence of 20 points in 1995 for abortion ratios and 1 to 2 points higher with one overlapping in 1991 for miscarriage/stillbirth ratios (see Figure 3.2). On the other hand, fertility levels derived from the two surveys as well as the 2000 census are remarkably consistent (see Figure 3.3). The results of comparison are difficult to explain. One possible reason is that non-live-births are underreported in the 2001 survey. But this would raise another question: why only non-live-births were underreported but not live births in the 2001 survey? Under the circumstance of penalty for unapproved births in China, it would be more likely to underreport women's live births rather than abortions. Thus the reason of the abortion gap between the 1997 survey and the 2001 survey is unclear.

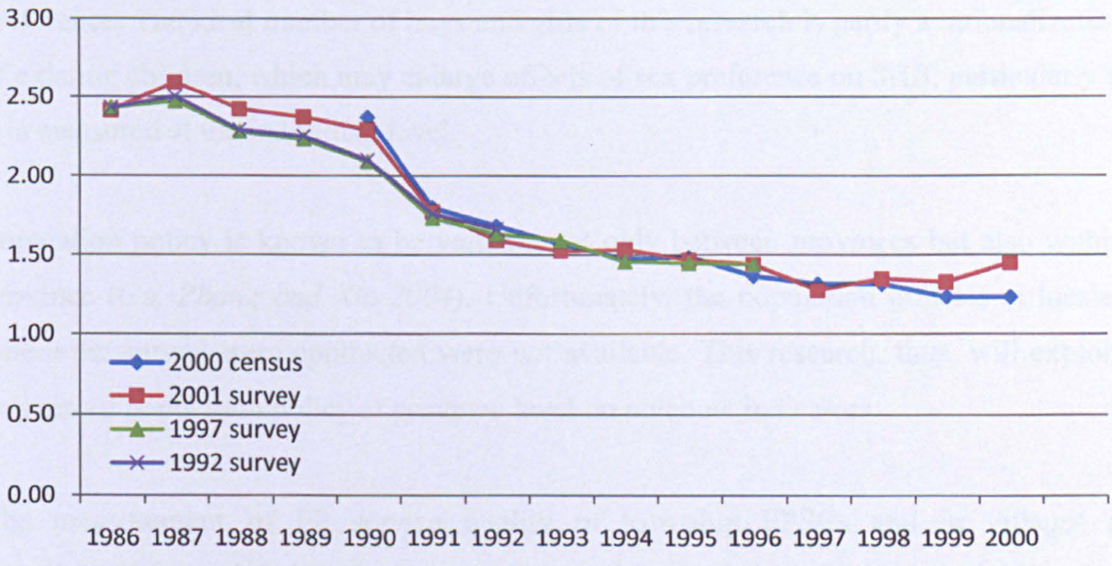
Nevertheless, we do find some agreement of the abortion ratios between the 1997 and 2001 series. The two surveys agree in showing a rise between 1981 and 1983 when the 1-child policy was strictly implemented and a fall in 1984 when the 1-child policy was somewhat relaxed. The two abortion series rose again in 1989 when population policy was tightened up. The increase was interrupted during the last two years preceding the surveys. The decline of the last two-year's abortion ratios may be due to participants reporting their most recent abortions to the year of 1995 in the 1997 survey and the year of 1999 in the 2001 survey. Although the 1997 and 2001 abortion series indicates the possibility of underreporting of abortion in the 2001 survey, this does not on balance counteract the consistent movement of abortion ratios in the two surveys with population policy modification. It appears that any underreporting of abortions in the 2001 survey would slightly bias downward the abortion level but not the trend. Moreover, we do not find such trends in miscarriage/stillbirth ratios in both surveys, which support the statement of the reliability of the abortion trend.

Figure 3.2: Abortion and miscarriage/stillbirths per 100 live births, by year of termination, data from 1997 and 2001 NFPRHS



Some researchers have argued that the fertility level of this survey was under-reported (*Wang 2004*). However, there is no hard evidence to support this view. On the contrary, the 2000 census reports China's TFR to be 1.4 (*NSB 2003*), which is identical to this survey. Comparing results from data of the 1997 NFPRHS, the total fertility rates for the same years from both surveys were closely similar: 1.43 (2001 survey) vs. 1.43 (1997 survey) in 1996, 1.45 vs. 1.44 in 1995, 1.54 vs. 1.45 in 1994, and 1.59 vs. 1.63 in 1993 (Figure 3.3) (*Pan J 2004*). Several other assessments have reached a near-consensus that China's fertility level declined to a total fertility rate of around 1.5 by the late 1990s (*Cai 2008; Retherford et al. 2005; Zhang and Zhao 2006*). After the 2000 census, the fertility rates reported from annual surveys were still very low, with TFRs of 1.39, 1.38, 1.40, and 1.44 recorded in 2001, 2002, 2003,and 2004 (*NBS 2002–2005*). By the late 1990s, China's FP programme had begun to move away from targets and penalties towards a gentler, client-oriented approach (*Gu 2000; Winckler 2002*). In addition, wherever such fines continue to be imposed, rising prosperity in the 1990s has allowed some parents to be better able to afford the 'luxury tax' on additional children. In fact, officials in some localities have tried to raise revenue by encouraging parents to violate policies as long as the specified fines were paid (*Tan 1998; Pomfret 2000*). Therefore, we do not expect much underreporting of live births in this survey if there is any.

Figure 3.3: Trend of China's Total Fertility Rate between 1986 and 2000 obtained from surveys and 2000 census



Sources: *Pan J 2004; Yu and Yuan 2004; Feini and Yuan 1996; Yan 2006*

I have also compared national SRBs obtained from the 2001 survey with those from previous censuses or surveys. Data from 1990 (census), 1995(survey) and 2000 (census) indicated that the SRBs for the whole China in 1989, 1994 and 1999 were 111.3, 115.6 and 116.9, respectively (*Liu 2007*). Based on this survey, I obtained the overall SRBs of 116.3, 128.1 and 131.0 for the three years, respectively. It is difficult to assess the relative validity of these data sources. Census data have an advantage in their scale but this survey has an advantage in its depth. Up to now, there is no evidence to say the SRBs from the 2001 survey were over estimated. Nevertheless, the previous SRBs were accepted by the Central Government and many researchers. Under such circumstance, I calculated that the numbers of potential "*missing girls*", supposing that previous values of SRBs were true. It was found that 67 girls in 1989, 94 girls in 1995 and 77 girls in 1999 might be underreported in the 2001 NFPRHS, which were accounted for 2 to 5 per cent of live births for each corresponding year. Thus, I suspect there would be minor biases of SRB and fertility in this survey. However, it is not expected that the biases will distort the trend of the outcomes.

3.1.6 Limitations

The major concerns of this research are there might be underreporting of female births and abortions of this survey. Although I have demonstrated that the extent of underreporting could be small and the trends would not be biased, these concerns could not be completely eliminated. There are also limitations in the measure of son preference. The ideal number of boys and girls of this research is partly a rationalization of existing children, which may enlarge effects of sex preference on SRB, particularly if it is measured at the individual level.

Population policy is known to be variable not only between provinces but also within province (*Gu, Zhang and Xie 2004*). Unfortunately, the population policies at locales where the survey were conducted were not available. This research, thus, will explore impacts of population policy at province level on outcome indicators.

The measurement of FP service quality of township FPSCs and in villages is transformed by using latent class analysis rather than the observed variables. The interpretation of latent classes is not straightforward. Moreover, the nature of FP services is limited to provision of contraceptive methods at FPSCs under administration of NPFPC, which is independent of the public health system.

3.2 Methods of analysis

3.2.1 Introduction

The main statistical methods used in this study include descriptive methods, (e.g. frequency, mean, number, percentage and cross-tabulations), Chi-square test, life-table method, latent class analysis (LCA), parity progression ratio, multilevel binomial/multinomial logistic regression and multilevel Poisson regression. A Chi-square test is used to test distribution differences between categories of outcome indicators (i.e. education, FP services at FPSCs). Fertility level is measured by parity progression ratios. Life-table methods and Tukey's trimean are used in the analysis of the birth interval between the first and the second birth. LCA will be used to transfer a number of categorical manifest variables into a few latent variables with several latent classes that represent the characteristics of FP services at township's FPSCs and in villages. Multilevel approaches will be used to explore determinants of the nature of FP services at grassroots institutions, probability of a second birth, risk of abortion, and sex of first and/or second birth. SAS 9.1 (*SAS Institute Inc*) is used for most data analysis. Latent GOLD 4.5 (*Statistical Innovations Inc., Belmont, MA*) is used for LCA, and MLwiN 2.20 (*Centre for Multilevel Modelling, University of Bristol*) is used for multilevel analysis.

3.2.2 Analysis Strategy

The study starts with assessing the association of provincial policy fertility with other high-level variables e.g. geographical region and socioeconomic development indicators. The main statistical approach for this purpose is bivariate analysis, which shows the distribution pattern of policy fertility between these indicators. Geographical Information Systems (GIS) is used to show geographical distribution of population policy, GDP per capita, proportion of ethnic minority groups and strength of son preference at provincial level.

Following the assessment of the above relationships, the characteristics of FP services at townships and in villages is explored using LCA. The manifest variables are transferred into one latent variable. Several latent class models (LCMs) containing one or more classes are estimated, from which, the "best-fit" LCM is decided, based on predefined selection criteria. The detailed information on how to fit LCM, how to select the "best-fit" model, and how to interpret the latent classes will be introduced in the next section.

Then, the main analyses start. Firstly, the data on women are separated into three subgroups, which correspond to provinces dominated by 1-child, 1.5-child and 2 or more-child policies, respectively. Hypotheses under each category of population policy are examined and tested by using appropriate statistical approaches. Findings of the above analyses are finally compared in order to identify variations in the relationship between reproductive outcomes and population policies and other indicators.

3.2.3 Parity progression ratios (PPR) and total fertility rate (TFR_{ppr}) based on PPR

A woman's decision about whether to have a next birth does not depend primarily on her age. More important considerations are her marital status, time elapsed since marriage if she is married but does not yet have any children, time elapsed since her last birth if she already has children, and the number of children she already has. The TFR calculated from PPRs takes all these considerations into account. TFR_{ppr} has also advantages of allowing us to make comparisons separately for births of different orders. Another consideration of using TFR_{ppr} as one of the fertility measures in this study is that TFR calculated from age-specific fertility rates (TFR_{asfr}) based on 2001 NFPRHS has already been published by Pan (*2004*), while TFR_{ppr} derived from the same data is not seen.

Before calculating $TFR_{ppr,}$ we need first to calculate PPRs. PPRs can be defined as the fractions of women who ultimately progress from their own birth to first marriage, from first marriage to first birth, from first birth to second birth, and so on. There are two types of PPR. One is cohort PPR, which derives PPR for a given birth cohort. However, cohort data are usual difficult to obtain, but a single census or survey is widely available. For a census or survey, we can use an alternative method, called period PPR, because women are asked to look back over their lives and recall the dates of past events. Period PPR estimates PPR on a period basis, that is, of working out a PPR which applies to a particular time period. Cohort PPRs for survey data are usually based on women aged

40-49 because women of these ages were usually finished childbearing (*Retherford et al. 2010*). The disadvantage of lacking of up-to-dateness of the resulting measures is obvious. Here I will use the period PPR to estimate fertility level in this study.

Based on Feeney and Yu's (1987) and Ni Bhrolchain's (1987) work, the TFR_{ppr} is calculated from the PPRs as

$$TFR_{ppr}=P_{B\text{-}M}P_{M\text{-}1}+P_{B\text{-}M}P_{M\text{-}1}P_{1\text{-}2}+P_{B\text{-}M}P_{M\text{-}1}P_{1\text{-}2}P_{2\text{-}3}+P_{B\text{-}M}P_{M\text{-}1}P_{1\text{-}2}P_{2\text{-}3}P_{3^+\text{-}4^+}/(1-P_{3^+\text{-}4^+}) \quad (3.2)$$

where the basic notations for PPRs and parity transitions are as follows:

- $P_{B\text{-}M}$=PPR for the transition from a woman's own birth to her first marriage
- $P_{M\text{-}1}$=PPR for the transition from first marriage to first birth
- $P_{1\text{-}2}$= PPR for the transition from first to second birth
- $P_{2\text{-}3}$= PPR for the transition from second to third birth
- $P_{3^+\text{-}4^+}$= PPR for the transition from third or higher-order to next higher-order birth

The term $P_{B\text{-}M}P_{M\text{-}1}$ is the expected number of first births, the term $P_{B\text{-}M}P_{M\text{-}1}P_{1\text{-}2}$ is the expected number of second births, and so on. The open parity interval is specified here as 3 or more because third or higher-order births are rare in China. The term $P_{3^+\text{-}4^+}/(1-P_{3+})$ is obtained by assuming that P_3 and all higher-order PPRs equal P_3^+ and pulling out a geometric series (*Feeney and Yu 1987*; *Retherford et al 2010*) (if *r* is a positive number less than1, the geometric series $r + r^2 + r^3 + ... = r/(1-r)$.)

The period life table for the transition from birth to first marriage (B-M) is truncated at 21 years (the difference between the beginning and ending life table ages of 15 and 35), whereas for each higher-order transition, it is truncated at 10 years of duration in parity. First marriages after age 35 and next births after 10 years of duration in parity are rare in China and are ignored. Moreover, I assume in the analysis that no births occur before first marriage. This assumption is reasonable in China because premarital births are stigmatised in Chinese culture and therefore are rare. Preliminary analysis confirmed this assumption. In case of the small number of births that occur before marriage, date of first marriage is coded or recoded back to date of first premarital birth. In the case of twins or higher-birth multiple births, birth orders are arbitrarily assigned.

There are two approaches to calculating period PPR. One is called the "true parity cohort" approach and the other the "synthetic parity cohort" approach (*Hinde 1998*). In the first method, the survey data are used to identify all the births of a given order occurring to the women in the sample during a specified period ('index period'). The subsets of women who experience a birth of the specified order during the index period are the followed up to the date of the survey to see if they have a subsequent child before the survey. The date of birth of the subsequent child is then noted.

The PPR for a given true parity cohort can be estimated using the following formula (*Hinde 1998*):

$$\text{True parity cohort } PPR_{j\text{-}(j+1)} = \frac{\text{Total number of women who had a } (j+1)\text{th birth during the period, who had a } j\text{th birth in the index year}}{\text{Number of women who had a } j\text{th birth in the index year}} \quad (3.3)$$

However, since there is a need to allow for the $(j+1)$th birth to occur, the true parity cohort procedure produces PPRs which necessarily apply to quite a long period before the survey. Most of the births which are included in the calculation of the true parity cohort PPRs will usually have occurred several years before the survey. To obtain PPRs which are more up to date, we need to use "synthetic parity cohort" approach and using the following formula to calculate q_x* first (*Hinde 1998*):

$$q_x^* = \frac{\text{Number of women who had a } j\text{th birth in the } x\text{th year before the current year and had their } (j+1)\text{th birth in current year}}{\text{Total number of women who had a } j\text{th birth in the } x\text{th year before the current year} - \text{Number of these women who have had their } (j+1)\text{th birth before the start of the current year}} \quad (3.4)$$

The period PPR from the jth to the $(j+1)$th birth is then calculated as

$$PPR_j = 1-(1-q_0)\,(1-q_1)\,(1-q_2)\ldots(1-q_k) \quad (3.5)$$

where k is the length of the period (0 to20 from birth to marriage, 0 to 9 from marriage to first birth or from jth to $(j+1)$th birth.

3.2.4 Life table method

There are two aspects of interest in the analysis of fertility. One is the proportion of women at each parity who eventually move to the next highest parity, or the PPR. The other is the time it takes to make the transition from one parity to the next for those women who continue reproduction, or the distribution of birth intervals. The basic approach underlying the analysis of birth intervals is the life table.

In this section, I illustrate the method by constructing a life table for the interval from first birth to second birth. The same procedures can be applied to higher order births or for the interval from marriage to first birth for married women. All tables calculated in this study are single decrement life tables, in that only one type of event, e.g., a second birth, is considered. The reasons other than a second birth are censored.

Following standard life table notation the symbol χ is used to refer to duration in exact months and n to refer to the width of the intervals of exposure. Let ${}_nC_x$ denote the total number of censorings (e.g., women reaching the interview without second birth) in the interval x to $x+n$, and ${}_nE_x$ denote the number of events in the interval x to $x+n$. For the first interval of exposure this entry is the total number of women who have had first birth, denoted N_x. For each subsequent interval, the number observed at duration $x+n$ is calculated as:

$$N_{x+n}=N_x - {}_nC_x - {}_nE_x \qquad 3.6$$

The number of women exposed to the risk of having a second birth through interval of exposure, denoted N_x*, is estimated by taking away half of the censored observations from N_x:

$$N_x{*}= N_x - {}_nC_x/2 \qquad 3.7$$

Note that N_x* is the adjusted number at risk. It is assumed that censoring is uniform in the interval.

The proportion of women having a second birth in the interval x to $x+n$ among women having a first birth at the beginning of the interval, denoted ${}_nq_x$, is estimated as

$${}_nq_x= {}_nE_x/\ N_x{*} \qquad 3.8$$

The proportion having a second birth in the interval x to $x+n$ among all women who have had a first birth is denoted by ${}_nb_x$. The cumulative proportion having a second birth by duration x among all women having a first birth is denoted by B_x. Since by assumption all women do not have a second birth at duration 0, both ${}_nb_0$ and B_n are equal ${}_nq_0$ for the category of exposure starting at duration 0 (${}_nb_0 = B_n = {}_nq_0$). For subsequent categories of duration, the proportion having a second birth in the interval x to $x+n$ among all women is estimated as:

$${}_nb_x=(1-B_x)\,{}_nq_x \tag{3.9}$$

The cumulative proportion having a second birth by duration $x+n$ among all women is then calculated as :

$$B_{x+n}=B_x + {}_nb_x \tag{3.10}$$

Multiple births are treated as one birth in the analysis of birth intervals.

Moreover, Tukey's (1977) trimean is used to measure the distribution of birth interval. It is calculated as:

$$\text{Trimean}=(Q_1+2Q_2+Q_3)/4 \tag{3.11}$$

where Q_1, Q_2 and Q_3 are defined as the durations by 25, 50 and 75 per cent of the women who will have a subsequent birth within a fixed years (normally 5 years after an index birth) will have had it. An advantage of the trimean as a measure of centrality is that it combines the median's emphasis on centre values with the some attention to the extremes (*Weisberg 1992*).

3.2.5 Introduction to latent class analysis

It is noted that variables concerning the nature of FP services collected from township and village surveys of 2001 NFPRHS are highly correlated and almost equally important. It is not necessary and inappropriate to include all of these variables in in-depth analysis. Nevertheless, each of the variables has its own importance. It is appropriate to transfer these variables into one or several latent variables by a method of data mining, which contains the key information of these observed variables and reveals the nature of FP services at grassroots institutions. LCA is used for this purpose.

Overview

LCA is a method for analyzing the relationships among manifest data when some variables are unobserved. Traditional LCA was originally introduced by Lazarsfeld in 1950 and involved the analysis of relationships among polytomous manifest variables. Goodman (*1974*) made the model applicable in practice by developing an algorithm for obtaining maximum likelihood estimates of the model parameters. Many important extensions of the classical LC model have been proposed since then. Recent extensions of LCA allow for manifest variables that represent nominal, ordinal, continuous, and count data (*Vermunt and Magidson 2005*).

LCA may be thought of as a categorical variable analogy to factor analysis. Although factor analysis is frequently used in practice with variables of scale types including dichotomous, nominal, ordinal, and count variables, the linearity assumption will generally be violated, yielding biased estimates, and goodness-of-fit indices may not be valid (*Magidson & Vermunt 2004*). The conditional distributions of indicators in LCA are assumed to be binomial or multinomial. Thus, LCA is more appropriate than factor analysis to deal with categorical manifest variables. A significant feature of LCA is that it allows the original dataset to be segmented into a number of exclusive and exhaustive subsets: the latent classes.

Model Assumptions for LCA

The basic latent class model (LCM) involves a latent variable and a number of manifest variables. All the variables are categorical and the relationships among them are described by the simple Bayesian network. The latent variable influences all the manifest variables at the same time and renders them correlated. Categories of the latent variable correspond to classes of individuals in a population. When all latent classes are controlled, only a random relationship among manifest variables remains. This means that, within each latent class, each manifest variable is statistically independent of every other variable, equivalent to saying that the latent variable is the only reason for the correlations. The term 'latent' means that the 'latent' variable and 'latent' classes are not directly observed but rather are identified based on a function of manifest indicators.

As described by Magidson and Vermunt (*2004*), the basic two assumptions of LCA are:

- √ The responses on the indicators are the result of an individual's position on the latent variable(s).

- √ The manifest variables have nothing in common after controlling for the latent variable(s), which is often referred to as *local independence*.

Model description

Under the above assumptions, a LCM can be expressed by using unconditional probabilities of belonging to each latent class, and conditional response probabilities as parameters. Assume that we have 4 nominal manifest variables *A*, *B*, *C* and *D*. Variable A takes values $i = 1,\ldots,$ I. Variable B takes values $j = 1,\ldots,$J, whereas variable C takes values $k = 1,\ldots,$ K, variable D takes values l=1, 2,..., L. Let π_{ijklt} denote the joint probability that an individual will be at level i with respect to variable A, at level j with respect to variable B, at level k with respect to variable C, and at level l with respect to variable D. One latent variable X takes values $t = 1,\ldots,$ T. The different values of t refer to different latent classes. Then we have the fundamental equation of LCM:

$$\pi_{ijklt} = \pi_t^X \pi_{it}^{A|X} \pi_{jt}^{B|X} \pi_{kt}^{C|X} \pi_{lt}^{D|X} \qquad (3.12)$$

where π_t^X denotes the probability of being in latent class t of latent variable X. The sum of π_t^X is one. $\pi_{it}^{A|X}$ denotes the conditional probability, which an individual will be at level i with respect to variable A, conditional on being at level t with respect to the latent variable X. The three other conditional probabilities $\pi_{jt}^{B|X}$, $\pi_{kt}^{C|X}$ and $\pi_{lt}^{D|X}$ are defined analogously.

Model fit

A goal of LCA is to determine the smallest number of latent classes T that is sufficient to explain the associations observed among the manifest variables (*Magidson & Vermunt 2003*). The analysis begins by fitting 1-cluster (T=1) baseline model, which specifies mutual independence among the variables. Assuming that baseline mode is the *null* model, which does not provide an adequate fit to the data, a 2-cluster (T=2) LCM is then fitted to the data. This process continues by fitting successive LCMs to the data, each time adding one more cluster (T+1) until the simplest model is found that provides an adequate fit.

Several complementary approaches are available for assessing the fit of LCM. The most commonly used approach is the likelihood ratio chi-squared statistic L^2. The formula for L^2 is (*Magidson & Vermunt 2003*):

$$L^2 = 2\sum_{ijkl} f_{ijkl} \ln\left(\frac{f_{ijkl}}{\hat{F}_{ijkl}}\right) \quad (3.13)$$

where $\hat{F}_{ijkl}$ denotes the expected cell frequencies and f_{ijkl} denotes observed frequencies. Model chi-square represents the amount of the relationship between the variables that remains unexplained by a model; the larger the value, the poorer the model fits the data. If the value of L^2 is lower than the critical value of chi-square for the desired probability level (usually 0.05), then we conclude that the model fits the data.

Parameter estimate and inferences

Although maximum likelihood (ML) estimation is used to estimate the model parameters, it can be very difficult to find the maximum of the likelihood function without computer assistance. By using a computer program, this task becomes easy. There are two essential procedures to establish ML estimates of parameters: the Expectation-Maximization (EM) procedure and the Newton-Raphson (NR) procedure (*Vermunt & Magidson 2006*).

EM is a very stable iterative method for ML estimation with incomplete data. It has simple forms and is easy to program, and offers computational advantages over NR (as it does not have to compute second derivatives of the likelihood function). Nevertheless, EM does not directly evaluate the full likelihood function and can be extremely slow to converge to a solution, and has a disadvantage in terms of constructing confidence intervals. On the contrary, NR methods can converge remarkably quickly, but can fail to converge when iteration begins far from the desired root. In this study, ML estimates are computed by beginning with the EM method. When iteration is close to the desired root, the NR is used to reach the final solution.

Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC)

Although the maximum likelihood method can be used to estimate the values of parameters, it cannot be used to compare different models without some corrections. The reason is that the conditional test by subtracting L^2 and the number of free parameters between models with T and T+1 classes do not have an asymptotic chi-squared distribution. An alternative approach is to utilize an information criterion weighting both model fit and parsimony (*df* or number of parameters). Such measures include AIC and BIC. AIC favours models with many variables, but Kashyap proved that AIC is inconsistent (*Kashyap 1980*). On the contrary, BIC is a consistent estimate and tends to choose models that are simple due to a heavy penalty on complexity. The most widely used information criterion in LCA is the BIC statistic which can be defined as BIC(L^2) = L^2 – ln (N) df (*Raftery 1986*). A more general definition of BIC is based on log-likelihood (LL) and the number of parameters (M) instead of L^2 and df; that is

$$BIC_{LL} = -2LL + \ln(N)M \tag{3.14}$$

A model with a lower BIC_{LL} value is preferred over a model with higher BIC_{LL} value. In this study, BIC is used for model selection.

If the baseline model (one class, H_0) provides an adequate fit to the data, no LCA is needed, since there is no association among the variables to be explained. In most cases, however, H_0 will not fit the data in which case L^2 (H_0) can serve as a baseline measure of the total amount of association in the data. This suggests a third approach for assessing the fit of LCMs by comparing the L^2 associated with LCMs for which T>1 with the baseline value L^2 (H_0) to determine the percent reduction in L^2. Since the total association in the data may be quantified by L^2 (H_0), the percent reduction measure represents the total association explained by the model. This less formal approach can complement the more statistically precise L^2 and BIC approaches (*Magidson 2003*).

As an example of how these measures are used, suppose that the L^2 suggests that a 3-class model falls short of providing an adequate fit to some data (say p =0.04) but explains 89 per cent of the total association. Moreover, suppose a 4-class is the simplest model that fits according to the L^2 statistic but that this model only explains 91 per cent of the association. In this case, it may be that on practical grounds the 3-class model is preferable since it explains almost as much of the total association as the 4-class one.

Latent class assignment and interpretations

The final step of LCA is to classify each observation into one and only one latent class. The classification is based on the latent classification probabilities, or, in other words, posterior class membership probabilities. The posterior membership probabilities [3] can be obtained using Bayes theorem as follows:

$$\hat{\pi}^{X|ABCDX}_{tijkl} = \hat{\pi}^{ABCDX}_{tijkl} / \sum_{t=1}^{T} \hat{\pi}^{ABCDX}_{tijkl}, \quad t=1, 2, \ldots, T \tag{3.15}$$

where the numerator and denominator in Equation (3.15) are the ML estimates for the terms appearing in Equation (3.12). Once the NR procedure converges, the posterior membership probabilities simultaneously work out. Cases are then assigned to the class for which the posterior probability is highest. For example, according to a 3-class LC model, someone with response pattern A=1, B=1, C=1, and D=1 has posterior membership probabilities equal to 0.92, 0.08, and 0.00. Such a person is, thus, assigned to the first class. The interpretation of latent classes mainly depends on the posterior probabilities: the higher the probability, the more likely the answer of the category of a given manifest variable.

In summary, LCA can transfer a number of categorical variables to one categorical latent variable. The selecting criteria for the "best-fit" LCM in this study are:

1. With smallest number of latent classes that is sufficient to explain the associations observed among the manifest variables.
2. The lower the value of BIC, the better the model.
3. The P value of L^2 statistic and percent reduction in $L^2$are used to complement the BIC statistic.

Observations are assigned to the latent class for which the posterior probability is the highest. Moreover, the interpretation of each latent class will consider the posterior membership probabilities and response structure of conditional probabilities of observed variables for that class. The higher the probability is, the more likely it is to have the connotation of the category of a given manifest variable.

3.2.6 Introduction to multilevel modelling

Multilevel modelling will be used to explore determinants of reproductive outcomes. There are several reasons for doing so in this study. Firstly, the data used for this research are hierarchical – individual women in 2001 NFPRHS were not taken at random but by cluster sampling from townships and provinces. Since women may share common township-level and province-level characteristics, women within the same cluster may be more similar in their behaviour than women across clusters. In other words, the clustered nature of the data means that there may be correlation between women at each level so that it cannot be assumed that the observations are independent. Standard statistical tests lean heavily on the assumption of independence of the observations. Violation of the assumption will result in underestimation of standard errors and result in confidence intervals for the parameter estimates that are too narrow so that variables may appear to be significant when in fact they are not, particularly the indicators measured at the group level. Multilevel modelling provides an efficient means to correct the standard errors.

Secondly, multilevel analysis can be used to identify variations of outcome measures between high-level units such as townships and provinces. The relationships between individual reproductive outcomes and higher-level indicators may not be constant between townships and across provinces. For instance, the risk of abortion may vary between qualities of FP services and between population policies because the approaches of FP promotion (e.g. "using IUD after the 1st birth and using sterilisation after the 2nd birth" approach is adopted by some township FP centres but not by others) and implementation of population policies (e.g. coercive abortion due to unproved pregnancy is common in some areas but not in others) may be different between townships and between provinces; the influence of the quality of FP services on abortion may be less strong in provinces with 1-child policy than in provinces with 1.5-child policy because FP services in the former provinces may be reduced due to easy access of FP services in public health sector. A national survey indicated that 49.8 per cent of contraceptive users obtained their methods from public hospitals, while only 29.5 per cent did from FP sectors (*Zhou 2004*). Unfortunately, the nature of FP services in this research is only measured in the FP system, which is under the jurisdiction of the NPFPC, which means that FP services under administration of the Ministry of Health cannot be measured in this analysis.

Thirdly, multilevel modelling can examine residuals at higher levels to determine if there are any unusual townships or provinces present in the data. Such results remind us to explore further why these townships or provinces are unusual. This cannot be measured by standard regression techniques.

Logistic regression models

Multilevel models have been widely used in demographic researches and longitudinal (repeated measures) data (*Brown, Li and Padmadas 2007; Hossain 2005; McNay, Arokiasamy and Cassen 2003*). For data with discrete responses, logistic regression is one of the most popular models to predict the probability of occurrence of an event. The formulas of single and multilevel binomial and multinomial logistic regression are given as below.

Single-level binomial/multinomial logistic modelling

For single-level logistic regression modelling, suppose that y_i is the (0, 1) response for individual i and the probability that y_i=1 is denoted by π_i. X_{ij} (j=1...k) are the explanatory variables. A general model for binomial response data is:

$$Logit(\pi_i) = ln[\pi_i/(1-\pi_i)] = \beta_0 + \sum_j \beta_j X_{ij}, \qquad j=1,...,k \qquad (3.16)$$

Where β_0 is the intercept and β_j, are the regression coefficients of X_j. The unknown parameters β_0 and β_j are usually estimated by ML. The interpretation of the β_j parameter estimates is as the additive effect on the log of the odds for a unit change in the jth explanatory variable. In the case of a dichotomous explanatory variable, $e^{\beta j}$ is the estimate of the odds of having the outcome, e.g., males compared with females. A positive regression coefficient means that that explanatory variable increases the probability of the outcome, while a negative regression coefficient means that variable decreases the probability of that outcome; a large regression coefficient means that the risk factor strongly influences the probability of that outcome; while a near-zero regression coefficient means that that risk factor has little influence on the probability of that outcome.

Multinomial logistic modelling has a different form as that of binomial logistic modelling. Suppose that $\boldsymbol{y_i}$ is the unordered categorical response for individual i, and the response variable has t categories. The probability of being in category s by $\pi_i^{(s)}$=Pr$(y_i = s)$. In a multinomial logistic model, one of the response categories is taken as the reference category. A set of t-1 equations is then estimated, contrasting each of the remaining response categories with the reference category. Suppose that the last category is taken as the reference. For a single explanatory variable $\boldsymbol{x_i}$, a single-level multinomial logistic regression model with logit link is written:

$$ln\ (\pi_i^{(s)}/\pi_i^{(t)}) = \beta_0^{(s)} + \beta_1^{(s)} x_i\ , \qquad s=1,...,t-1 \qquad (3.17)$$

A separate intercept and regression coefficient is usually estimated for each contrast, as indicated by the s superscripts, although it is possible to constrain some or all to be equal. The parameter $\boldsymbol{\beta_1^{(s)}}$ is interpreted as the additive effect of a 1-unit increase in x on the log-odds of being in category s rather than category t.

Multilevel binomial logistic modelling

Single-level binomial logistic modelling (Equation 3.16) can be extended to a 3-level binomial regression model:

$$ln[\pi_{ijk}/(1-\pi_{ijk})] = \beta x_{ijk} + \gamma w_{jk} + \eta z_k + u_{jk} + v_k \quad (3.18)$$

Where $ln[\pi_{ijk}/(1-\pi_{ijk})]$ is the logit in which π_{ijk} is the probability of woman i (level-1) in township j (level-2) in province k (level-3), x_{ijk}, w_{jk}, and z_k are vectors of level-1, level-2, and level-3 characteristics, β, γ and η are vectors of estimated parameter coefficients and u_{jk} and v_k are unexplained residual terms at level-2 and level-3 respectively. Their variances, the 'level-2 effect' and 'level-3 effect', measure the extent to which the outcome measurements of women in the same cluster resemble each other as compared with that among women in different cluster. As we control for more variables at level-2 and level-3 in the fixed part of the model, we expect any remaining unexplained variance at each of these levels to be reduced.

Multilevel multinomial logistic modelling

Two-level multilevel multinomial logistic models are used to explore determinants of the characteristics of FP services at grassroots institutions in this study. Variables are from province level (level 2) and township-village level (level 1). A two-level multinomial logistic regression model with one explanatory variable x takes this form:

$$ln\ (\pi_{ij}^{(s)}/\pi_{ij}^{(t)}) = \beta_0^{(s)} + \beta_1^{(s)} x_{ij} + u_j^{(s)}\ , \qquad s=1,\ldots,t\text{-}1 \quad (3.19)$$

Where $\pi_{ij}^{(s)}$ denotes the probability of being in category s for township i in province j. $u_j^{(s)}$ is province-level random effect, assumed to be normally distributed with mean 0 and variance $\sigma_u^{2(s)}$. The random effects are contrast-specific, as indicated by the s superscript, because different unobserved province-level factors may affect each contrast.

Poisson regression model

The Poisson distribution is a discrete probability distribution that expresses the probability of a number of events occurring in a fixed period of time if these events occur with a known average rate and independently of the time since the last event. It is sensible to make use of the Poisson distribution to model the counts of abortion in this study.

Based on the Poisson distribution, we can define the probability that x abortions occur within a time period of a woman's life course as being

$$P_x = \frac{\mu^x e^{-\mu}}{x!} \tag{3.20}$$

where

- e is the base of the natural logarithm (e = 2.71828...)
- x is the number of occurrences of abortions
- $x!$ is the factorial of x
- μ is the expected number of abortions that occur during the given interval.

I am actually more interested in the rate of abortion rather than the actual counts, as each woman would have different time exposure to the risk of abortion. If the raw counts of abortions are used, a woman with longer exposure would have large counts thus masking the true relationships with explanatory variables. To work with the rates rather than counts, an additional parameter known as an ***offset*** is needed. It is usual to use a logarithmic transformation to model the mean. Thus, the *offset* can be set to be equal to the log (base e) of the expected abortions per 100 women-years. The Poisson distribution has a property that the expected value of x is equal to the variance of x, so that $E(x)=var(x)= \mu$).

Poisson model

The Multilevel Poisson model is an extension of the single-level Poisson model. Suppose we have a number of women, indexed i, with y_i abortions in the ith woman. The single-level Poisson model can be expressed as follows (Langford and Day 2001):

$$\left.\begin{aligned} & y_i \sim \text{Poisson}(\pi_i) \\ & y_i = \pi_i + e_{0i}X_{0i}^{*} \\ & \log(\pi_i) = \log(E_i) + \beta_0 + \beta_1 X_{1i} \\ & X_{0i}^{*} = \pi_i^{0.5} \end{aligned}\right\} \tag{3.21}$$

where β_0 is an intercept parameter, and β_1 is a slope parameter associated with a variable X_1. The term $\log(E_i)$ is included in the model as an offset (E_i is the expected number of abortions), with a parameter fixed as 1. The variable X_0^* is a vector comprising the square root of the expected values π_i to allow for Poisson distribution of the case y_i. In addition, if we assume there is only Poisson variation in the data, the variance of the residuals, var(e_{0i})=1. This equation can be extended to multilevel model. The two-level model (i.e. woman *i* nested within township *j*) can be written as:

$$\left.\begin{array}{l} y_{ij} \sim \text{Poisson}(\pi_{ij}) \\ y_{ij} = \pi_{ij} + e_{0ij}x^{*}_{0ij} \\ \log(\pi_{ij}) = \log(E_{ij}) + \beta_{0j} + \beta_{1j}X_{1i} \\ \beta_{0j} = \beta_0 + u_{0j} \\ \beta_{1j} = \beta_1 + u_{1j} \\ \begin{bmatrix} u_{0j} \\ u_{1j} \end{bmatrix} \sim \text{N}(0, \Omega_u), \quad \Omega_u = \begin{bmatrix} \sigma^2_{u0} & \sigma_{u01} \\ \sigma_{u01} & \sigma^2_{u1} \end{bmatrix} \\ x_{0ij}^{*} = \pi_{ij}^{0.5} \end{array}\right\} \tag{3.22}$$

where u_{0j} and u_{1j} are the residual intercepts and residual slopes for each of the higher-level units; σ^2_{u0}, σ^2_{u1} and σ_{u01} are overall variation of the intercept, slopes and covariance between the intercepts and slopes for the higher-level units. In this case, we model the Poisson variation at level 1, and assume the variation at higher levels to be multivariate normally distributed.

Parameter estimation

For discrete response multilevel models, as in multilevel binomial/multinomial logistic model and Poisson regression model, ML estimation is computationally intensive. It is suggested to use quasi-likelihood methods to estimate parameters in these analyses. Quasi-likelihood methods are based on a Taylor series expansion and transform a discrete response model to a continuous response model *(Rasbash 2009)*. After applying the linearisation, the model is then estimated using iterative generalised least squares (IGLS) or reweighted IGLS (RIGLS). The transformation to a linear model requires an approximation to be used. There are several types of approximation available in *MLwiN*, such as marginal quasi-likelihood (MQL), predictive (or penalized) quasi-likelihood (PQL). Both of these methods can include either first order terms or up to second order terms of the Taylor series expansion. The first order MQL procedure offers the crudest approximation and may lead to estimates that are biased downwards in logistic model but tend to overestimate some variance parameters in Poisson model (Rasbash et al. 2005), particularly if sample sizes within level 2 units are small or the response proportion is extreme. An improved approximation procedure is second order PQL, but this method is less stable and convergence problems may be encountered. One solution is starting with the first order MQL procedure in the analysis to obtain starting values for the second order PQL procedure. Intermediate choices, first order PQL and second order MQL, are also useful. However, the estimates of intermediate procedures, especially the random effects, could also be under-estimated. An alternative to likelihood-based estimation procedures is to use a Monte Carlo Markov Chain (MCMC) method (*Rasbash et al 2005*). Unlike IGLS and RIGLS, which find restricted ML point estimates for the unknown parameters of interest in the model, MCMC methods do not calculate the exact form of the posterior distribution but instead produce simulated draws from it (*Browne 2009*). MCMC methods are run for many iterations and at each iteration an estimate for each unknown parameter is produced. These estimates will not be independent as, at each iteration, the estimates from the last iteration are used to produce new estimates. This procedure is known as a *Markov chain*, as every new value generated for a parameter only depends on its previous values through the last value generated. In order to find good starting values for the MCMC methods, Browne (*2009*) suggested running the IGLS or RIGLS estimation methods prior to running MCMC. As in MLwiN, the current values obtained by IGLS or RIGLS will be stored and can be used for running MCMC estimation.

In this study, I will use first order MQL first, followed by second order PQL. However, if second order PQL does not converge, MCMC procedures will be used for parameter estimation. Since there may be substantial differences between estimated values of parameters derived from second order PQL and MCMC, I will use either second order PQL or MCMC fitting all models in analysis of one topic. Moreover, MCMC method provides selection criteria for 'best-fit' model, called Deviance Information Criterion (DIC), which can be used to roughly decide whether a more complex model represents an improvement over a simple one.

To run MCMC, I will basically use the default settings, e.g., burn-in period of 500 (the period when the chains are converging and these iterations are omitted from the sample from which summaries are constructed) and Metropolis-Hastings sampling (for non-Normal responses, MLwiN will not allow Gibbs sampling). However, the default monitoring run length of 5000 iterations (the number of iterations, after the burn-in period, for which the chain is to be burnt) may be too short for non-Normal models. As suggested by Browne (*2009*), I would check the Raftery-Lewis diagnostic to make sure whether we have run the MCMC algorithm for long enough. Based on preliminary analysis, 15,000 – 20,000 iterations are appropriate for most multilevel logistic and Poisson analyses in this study.

Deviance Information Criterion (DIC)

As mentioned in Section 3.2.3, the BIC statistic is used as the selection criterion of "best-fit" LCM. For multilevel analysis, I will use DIC to check whether a more complex model is better than a simple one. The DIC is a hierarchical modelling generalization of the AIC and BIC. It is particularly useful in Bayesian model selections where the posterior distributions of the models have been obtained by MCMC simulation. To obtain the DIC, we first need to know the average deviance from the 15,000 – 20,000 iterations ($\bar{D}$) and the 'effective' number of parameters (pD). The deviance is defined as the posterior distribution of the log likelihood (*Wikipedia 2010c*):

$$D(\theta)= -2\log(P(y|\theta)) + C \qquad (3.23)$$

Where y are the data, θ are the unknown parameters of the model and $P(y|\theta)$ is the likelihood function. C is a constant that cancels out in all calculations that compare different models, and which therefore does not need to be known.

The expectation $\bar{D} = E^{\theta}[D(\theta)]$ is a measure of how well the model fits the data; the larger this is, the worse the fit. The effective number of parameters of the model is computed as $pD=\bar{D} - D(\bar{\theta})$, where $(\bar{\theta})$ is the expectation of θ. The larger this is, the easier it is for the model to fit the data. Then the DIC is calculated as (*Browne 2009; Wikipedia 2010c*):

$$DIC = pD + \bar{D} = D(\bar{\theta}) + 2pD = 2\bar{D} - D(\bar{\theta}) \qquad (3.24)$$

The DIC diagnostic consists of the sum of two terms that measure the 'fit' and the 'complexity' of a particular model. The idea of comparing different models is that models with smaller DIC should be preferred to models with larger DIC. Models are penalized both by the value of $\bar{D}$, which favours a good fit, but also by the effective number of parameters pD. Since $\bar{D}$ will decrease as the number of parameters in a model increases, the pD term compensates for this effect by favouring models with a smaller number of parameters.

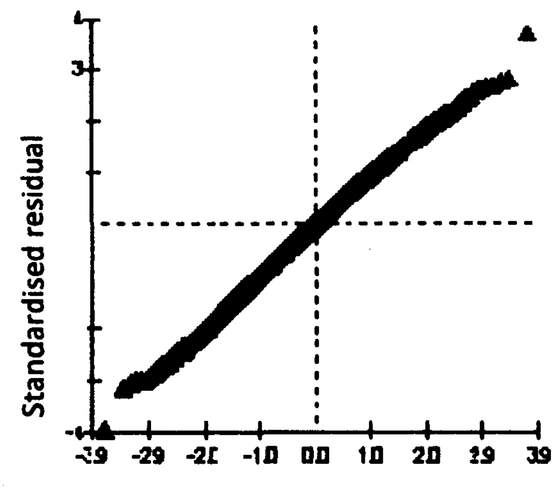
However, the DIC diagnostic has not had universal approval for model comparison (*Browne 2009*). Even so, it is used in this study as an approximate method for multilevel model selection.

Normal distribution diagnosis

We have routinely assumed in multilevel logistic regression models that the residuals at higher levels are multivariate normal. As a diagnostic tool, it is always useful to examine the estimated higher-level residuals to make sure that the assumptions we placed on the model are valid.

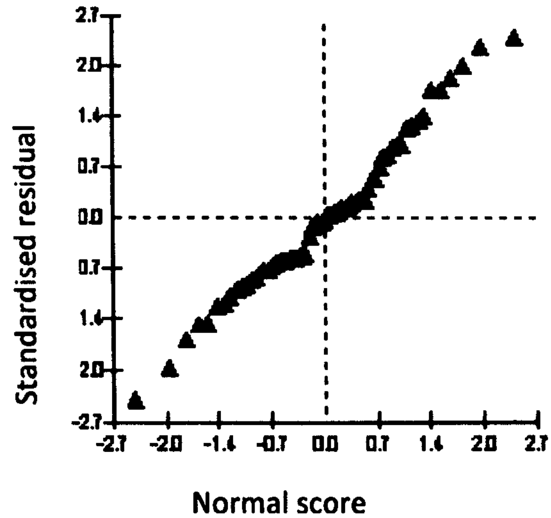
The assumption of Normal distributions may be checked using a Normal probability plot, in which the ranked residuals are plotted against corresponding points on a Normal distribution curve. If the Normality assumption is valid, the points on a Normal plot should lie approximately on a straight line. The following examples are given by the user's guide to MLwiN, which examined whether student's exam scores were normal distributions at student level and at school level (*Rasbash et al. 2005*).

Figure 3.4: Normal plot of standardised level-1 (student) residuals * normal scores



Source: A user's guide to MLwiN *(Rasbash et al. 2005, P41*)

Figure 3.5: Normal plot of standardised level-2 (School) residuals * normal scores



Source: A user's guide to MLwiN *(Rasbash et al. 2005, P41)*

Both of the above plots look fairly linear, and thus show reasonable normal distributions. The Normal plot will be also used in this study to examine whether the higher-level (township-village-level and province-level) residuals of multilevel models follow normal distributions.

Number of units at each level in this study

Table 3.2: summarises the division of the data in this study into individual, village-township and provincial levels. There are 31 units at level three, 830 units at level two, and 29512 individual women at level one.

Table 3.3: Total number of observations at each level of the data used in this study

Level	Total number of units
Individual women at reproductive age (level 1)	29512
Villages and townships (level 2)	830
Provinces (level 3)	31

1. China in 2000 had 331 prefecture-level governments. This study has 420 prefecture-level units owing to inclusion of prefecture-level city districts in municipalities such as Beijing and Shanghai (*Gu et al. 2007*).
2. China is constituted by six regions: Northeast China, Northwest China, Southwest China, South Middle China, North China and China East China. Each region is formed by several provinces.
3. Posterior probabilities are the probabilities of an event given certain prior probabilities. The posterior probability for a given observation indicates the probability of that observation being classified in a given class.

Chapter 4: The Association of Policy Fertility with Socioeconomic Development and Geographical Region at Provincial Level

4.1 Introduction

As described in Chapter 1, China's population policy varies between provinces, between rural and urban areas and between ethnic minority groups and Han people. By using the policy indicator, "policy fertility", this chapter explores how policy varies between social, culture and economic indicators at provincial level and between geographical regions. The primary hypotheses of this chapter are low policy fertility will be associated with high GDP per capita, low proportion of rural population and ethnic minorities, and less strong son preference at provincial level.

This chapter is arranged to report first the distribution of policy fertility, and social economic indicators, followed by presenting associations of policy fertility with selected social and economic indicators. Section 4.5 shows geographic distributions of population policy, GDP per capita, proportion of minority and strength of son preference. The last section provides a discussion of results and a short summary of this chapter.

4.2 Data description

The policy fertilities of 30 provinces (excluding Tibet) in China in 1990s range from 1.06 to 2.37. Of them, six are below 1.3, nineteen between 1.4 and 1.7, and five above 2.0. Although Tibet's policy fertility is not available, it can be classified into the group of 2-child policy because no specific requirements in family planning have been imposed in this autonomous region. Thus the last group includes six provinces and equivalent autonomous regions.

The GDP per capita at provincial level ranges from 2,199 Yuan in Guizhou to 23,062 Yuan in Shanghai among the 31 provinces in mid-1990s, with an average of 6,582 Yuan. The GDP per capita is below 4,000 Yuan in six provinces, between 4,000 and 5,000 Yuan in nine provinces, between 5,000 and 7,000 Yuan in six provinces, between 7,000 and 10,000 Yuan in five provinces, and greater than 10,000 Yuan in five provinces, respectively.

The average annual income in rural areas at provincial level ranges from 1,185 Yuan in Gansu to 5,277 Yuan in Shanghai. However, this indicator is highly related to GDP per capita at provincial level (linear R^2=0.9). It is, thus, omitted in further analysis.

The proportion of rural population is lowest in Shanghai (11.7%) and highest in Chongqing (81.1%). The proportions are below 50 per cent in seven provinces, above 75 per cent in five provinces, and ranges from 50 per cent to 75 per cent in nineteen provinces.

The proportion of ethnic minority groups is lowest in Jiangxi and Shanxi provinces, each accounting for 0.3 per cent of its population, and highest in Tibet, accounting for 93.9 per cent of its population. The proportions of minority groups are below 1 per cent in eight provinces, between 1 per cent to 5 per cent in nine provinces, between 5 per cent and 20 per cent in six provinces, and above 20 per cent in eight provinces.

Strength of son preference is an aggregated variable, which is defined as the ratio of the total ideal number of boys plus number of children regardless of sex over the total ideal number of girls plus number of children regardless of sex, using data from 2001 NFPRHS. The ratios range from 0.85 in Shanghai to 1.22 in Guangdong; they are less than 1.0 in thirteen provinces, between 1.01 and 1.09 in eleven provinces, and above 1.10 in seven provinces.

4.3 Association of policy fertility with social, culture and economic indicators at provincial level

Scatter charts are employed in this section to show relationships between policy fertility and social, culture and economic indicators. Several regression models, including linear, exponential, logarithmic, power and polynomial (quadratic and cubic), are fitted using the least squares approach. A "best-fit" trend line is displayed on each chart. The "best-fit" model is mainly based on the R-squared values estimated from the models. The greater the value, the better the model is. However, since this value usually increases with the complexity of regression model, identification of the "best-fit" model is balanced between model simplicity and the R-squared value. For instance, if the R-squared value of a cubic polynomial regression model does not increase much over a quadratic model, the later will be regarded as the "best-fit" model.

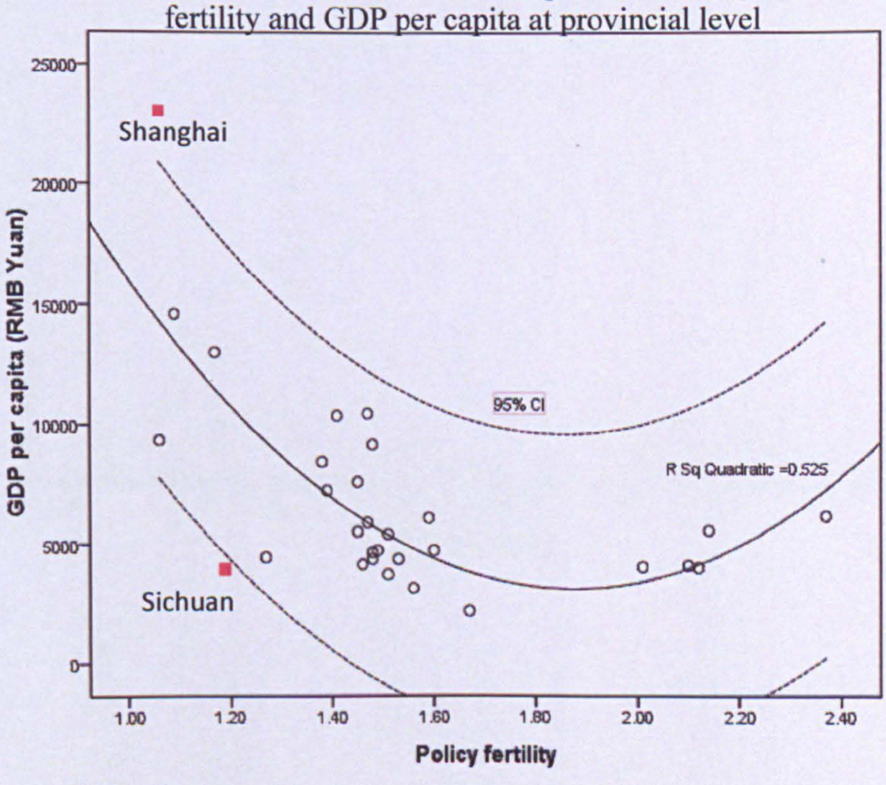
4.3.1 Association of policy fertility with GDP per capita

Table 4.1 shows R-squared values of several regression models that estimate the relationship between policy fertility and GDP per capita at provincial level. The R-squared values indicate that the quadratic polynomial is the "best-fit" model, which explains 52.5 percent of the total variance that is shared between policy fertility and GDP per capita. Although the R-squared value of the cubic polynomial model is somewhat higher, it is not improved much, compared with the quadratic polynomial model. Figure 4.1 shows the distribution of GDP per capita against policy fertility and the trend line of quadratic polynomial regression. The trend line demonstrates that their relationship follows a U-shape pattern. GDP per capita decreases with policy fertility to a low point at where the policy fertility is about 1.9. Then it slightly increases with policy fertility. The two curves surrounding the trend line define the 95 per cent confidence interval (95% CI). Shanghai stands out of the upper limit curve and Sichuan is below the lower limit curve of the 95% CI of the trend line.

Table 4.1: R-squared values of regression models that explain relationship between policy fertility and GDP per capita at provincial level

Models	Exponential	Linear	Power	Logarithmic	Polynomial	
					Quadratic	Cubic
R-squared value	0.234	0.253	0.294	0.324	**0.525**	0.535

Figure 4.1: Scatter plot and trend line that depict relationship between policy fertility and GDP per capita at provincial level



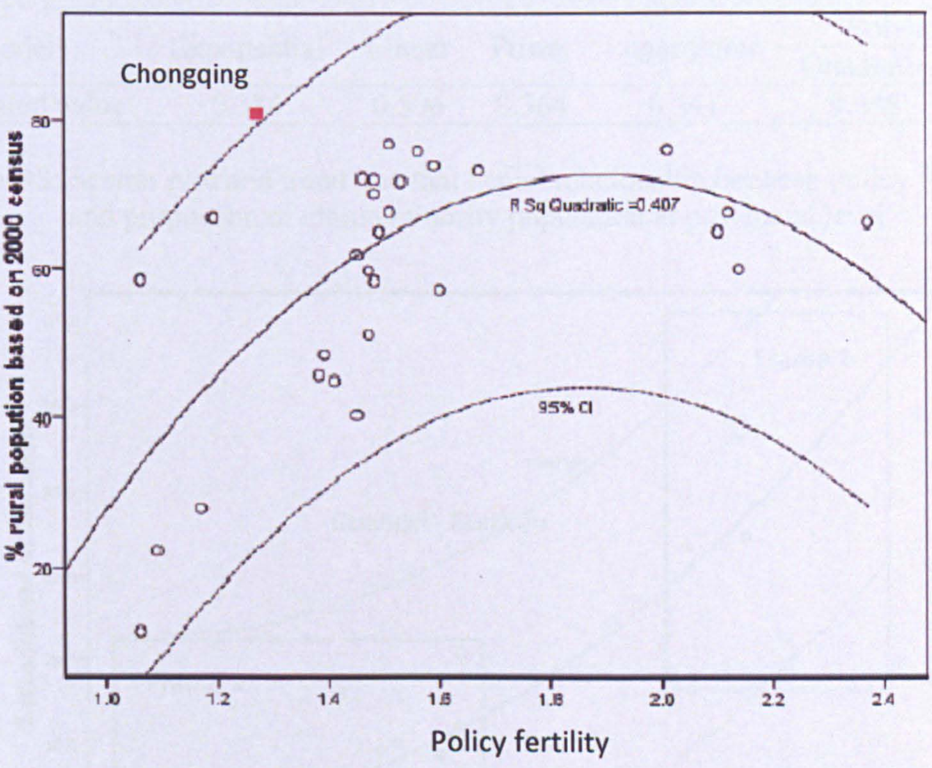
4.3.2 Association of policy fertility with proportion of rural population

As indicated by the R-squared values shown in Table 4.2, the quadratic polynomial regression is the "best-fit" model, which explains 40.7 per cent of the variation between policy fertility and proportion of rural population. Figure 4.2 shows the quadratic polynomial trend line and its 95% CI. The trend is n-shaped. The highest point of the trend line is also where the policy fertility is about 1.9. Before the point, the proportion of rural population rises with policy fertility; after that, it declines with policy fertility. However, Chongqing is out of the upper limit curve of 95% CI of the trend line.

Table 4.2: R-squared values of regression models that explain relationship between policy fertility and proportion of rural population at provincial level

Models	Exponential	Linear	Power	Logarithmic	Polynomial	
					Quadratic	Cubic
R-squared value	0.221	0.205	0.258	0.284	**0.407**	0.412

Figure 4.2: Scatter plot and trend line that depict relationship between policy fertility and proportion of rural population at provincial level



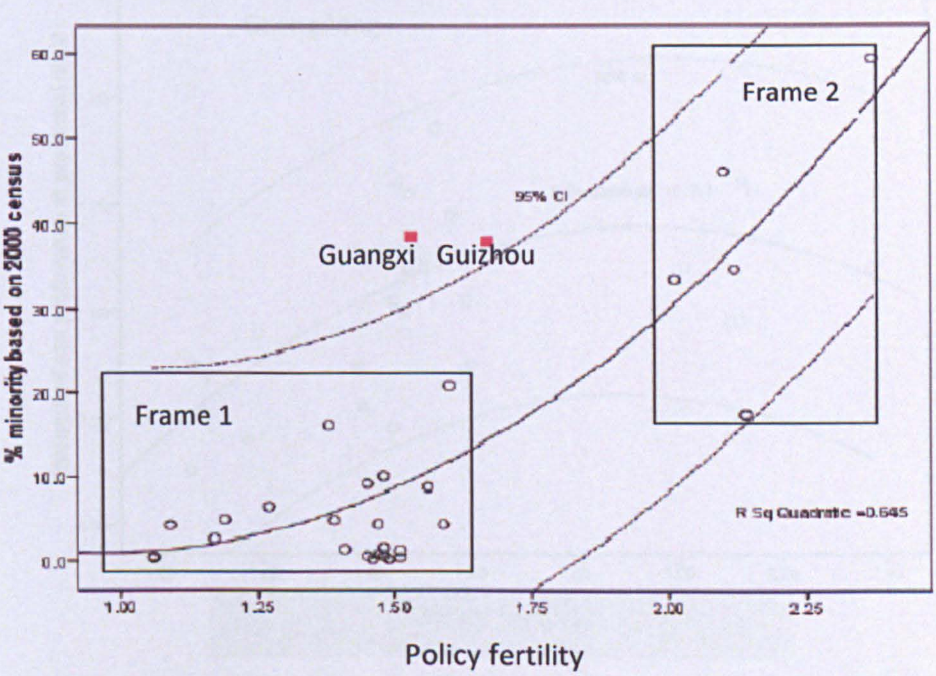
4.3.3 Association of policy fertility with proportion of ethnic minority groups

Results shown in Table 4.3 indicate that quadratic polynomial regression is again the "best-fit" model to interpret the relationship between policy fertility and proportion of ethnic minority population at provincial level. Approximately two-thirds of the variation in the policy fertility can be explained by proportion of ethnic minorities. Moreover, unlike the above two relationships, policy fertility monotonically increases with proportion of minority groups (see Figure 4.3). In other words, the higher the proportion of minority groups, the higher is policy fertility. Nevertheless, as shown in Figure 4.3, the slope of the trend line in frame 1 is more flat, while that in frame 2 is steeper. More specifically, policy fertility is increased by 0.03 with one percent increase of ethnic minorities in provinces predominated by 1- or 1.5-child policy, compared with 0.009 in provinces predominated by 2-child policy. Guangxi Zhuangzu autonomous region and Guizhou province are the two outliers beyond the 95% CI of the trend line.

Table 4.3: R-squared values of regression models that explain relationship between policy fertility and proportion of ethnic minority at provincial level

Models	Exponential	Linear	Power	Logarithmic	Polynomial	
					Quadratic	Cubic
R-squared value	0.384	0.596	0.364	0.541	**0.645**	0.646

Figure 4.3: Scatter plot and trend line that depict relationship between policy fertilities and proportion of ethnic minority population at provincial level



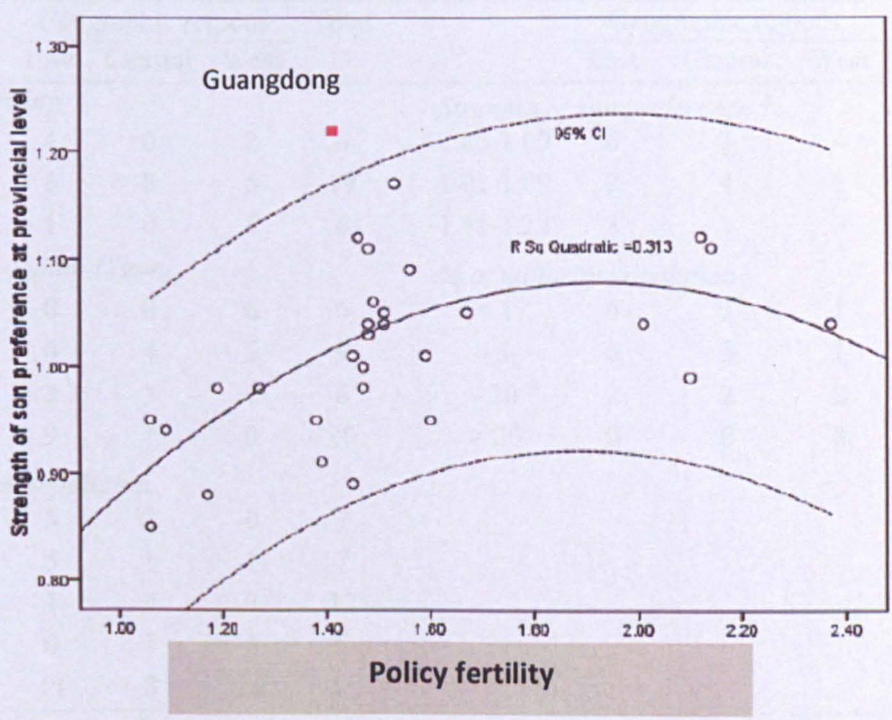
4.3.4 Association of policy fertility with strength of son preference

As indicated by Table 4.4, quadratic polynomial regression is, again, the "best-fit" model to explain the relationship between policy fertility and strength of son preference at provincial level. The shape of the trend line shown in Figure 4.4 is somewhat similar to the relationship between policy fertility and proportion of rural population. The R-squared value (0.313) of the "best-fit" model demonstrates that about one-third of the variations of policy fertilities can be "explained" by strength of son preference between provinces. Thus the association of strength of son preference with policy fertility is relatively weaker than the above three relationships. Again, the trend direction changes at about 1.9 of the policy fertility. Strength of son preference shows a positive relationship and then a negative one with policy fertility before and after that point. Guangdong province is above the upper limit of 95% CI of the trend line.

Table 4.4: R-squared values of regression models that explain relationship between policy fertility and strength of son preference at provincial level

Models	Exponential	Linear	Power	Logarithmic	Polynomial	
					Quadratic	Cubic
R-squared value	0.200	0.186	0.242	0.225	**0.313**	0.317

Figure 4.4: Scatter plot and trend line that depict relationship between policy fertilities and of son preference at provincial level



4.4 Geographic distribution of policy fertility and selected socioeconomic indicators

China is often divided into three large geographic regions: East Region, Central Region and West Region. East Region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan provinces/municipalities. The Central Region includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan provinces, while the West Region includes Inner Mongolia, Guangxi, Sichuan, Guizhou, Yunnan, Tibet, Chongqing, Shannxi, Gansu, Qinghai, Ningxia and Xinjiang provinces, municipality and autonomous regions. Traditionally, the East Region is most developed, which is followed by the Central Region and then the West Region. Table 4.5 shows frequency distributions of policy fertility and selected socioeconomic development indicators at provincial level, by geographic regions. Results in this table indicate that distributions of these indicators follow a geographic gradient: development level decreases but policy fertility increases from East Region to West Region. More specifically, East Region is more likely to implement stringent population policy, more likely to have high GDP per capita, but low proportions of rural population and ethnic minorities, and weaker son preference than the other two regions. Selected data are further illustrated by a Geographic Information Systems (GIS) (Maps 4.1-4.4), which give clear pictures on the geographical distributions of China's population policy, social culture and economic development.

Table 4.5: Frequency distributions of population policy and socioeconomic development indicators at provincial level, by China's geographical region

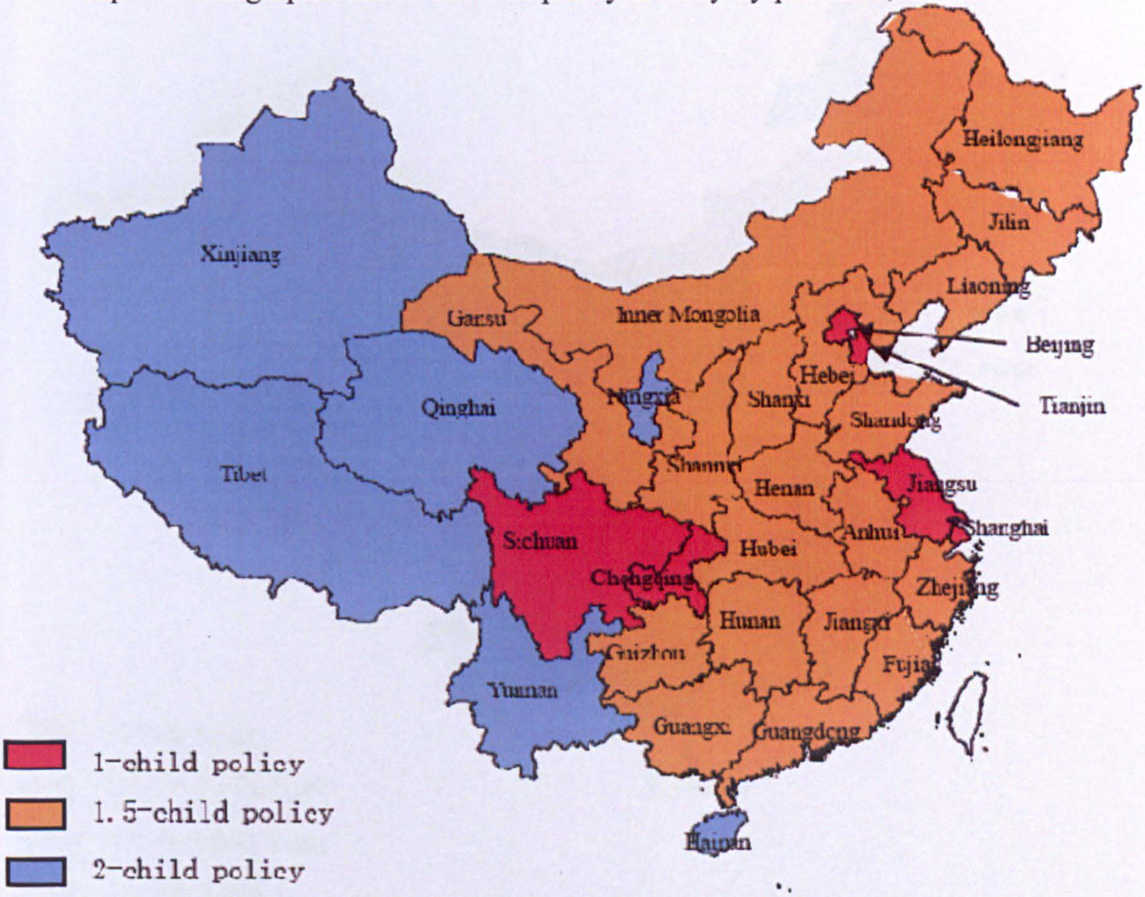
	Geographic regions			Total		Geographic regions			Total
	East	Central	West			East	Central	West	
Policy fertility					*Strength of son preference †*				
1.0-1.3	4	0	2	6	0.85-1.00	6	3	4	13
1.4-1.7	6	8	5	19	1.01-1.09	2	4	5	11
2.0-2.4	1	0	5	6	1.11-1.22	3	1	3	7
GDP per capita (Yuan)					*% of minority population*				
< 4000	0	0	6	6	< 1	4	3	1	8
- 5000	0	4	5	9	- 5	5	3	1	9
- 7000	2	3	1	6	- 20	2	2	2	6
- 10000	9	1	0	10	> 20	0	0	8	8
% of rural population									
< 50	5	2	0	7					
- 65	5	1	1	7					
- 75	1	4	7	12					
> 75	0	1	4	5					
Total	11	8	12	31					

† Strength of son preference = (no. of ideal boys + no. of children regardless sex) / (no. of ideal girls + no. of children regardless sex) ×100, using data from 2001 NFPRHS

4.4.1 Policy fertility

The policy fertilities are classified into the three categories mentioned above. Map 4.1 shows the three categorical population policies by provinces. Four provinces and equivalent municipalities in eastern China and two provinces (Sichuan and Chongqing) in southwest China are dominated by 1-child policy. The 2-child policy is mainly implemented in provinces located in western and southwest China. The vast majority of provinces in Central Region and parts in East and West Regions are dominated by a 1.5-child policy.

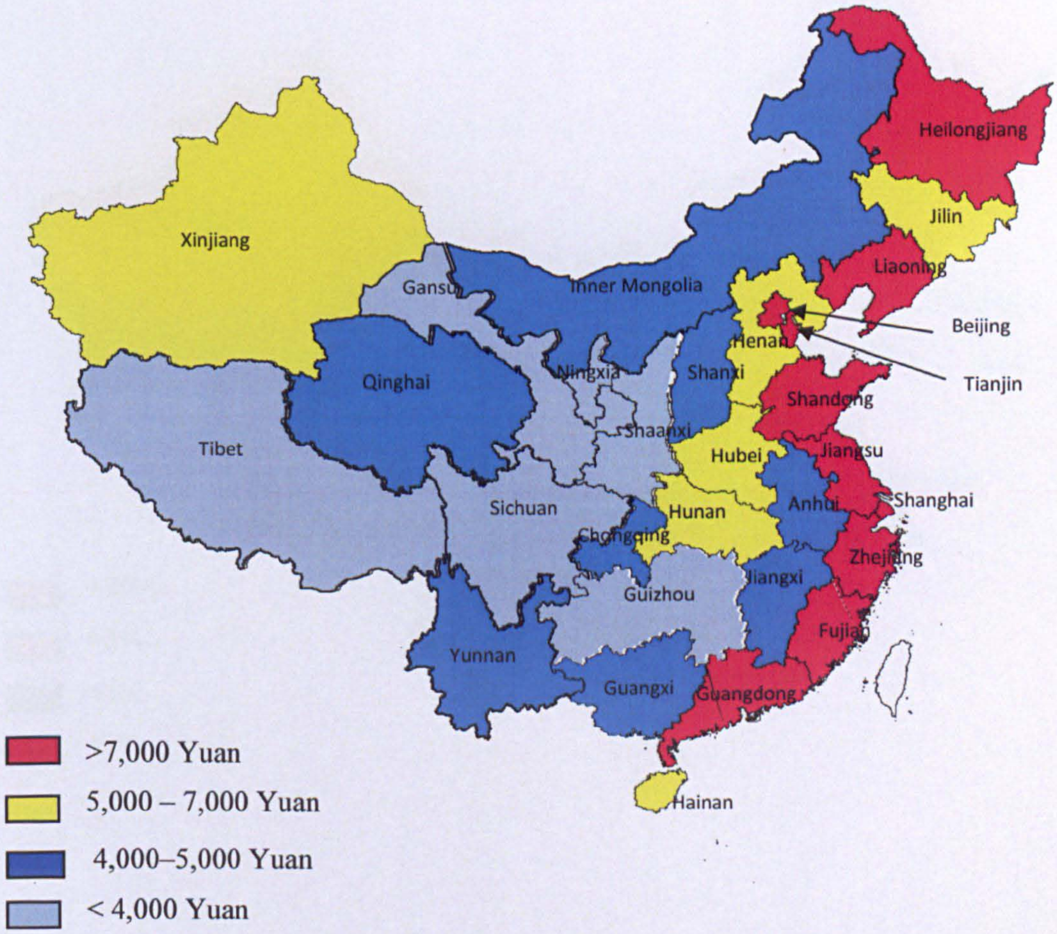
Map 4.1: Geographic distribution of policy fertility by province, China



4.4.2 GDP per capita

Map 4.2 shows the geographic distribution of GDP per capita at provincial level. The eastern coastal areas take the lead in economic development. Most of provinces in Central Region and Xinjiang in West Region are at middle level (GDP per capita ranges from 4,000 Yuan to 7,000 Yuan); while all the least economically developed provinces belong to West Region. The economical development level generally declines from East Region to West Region.

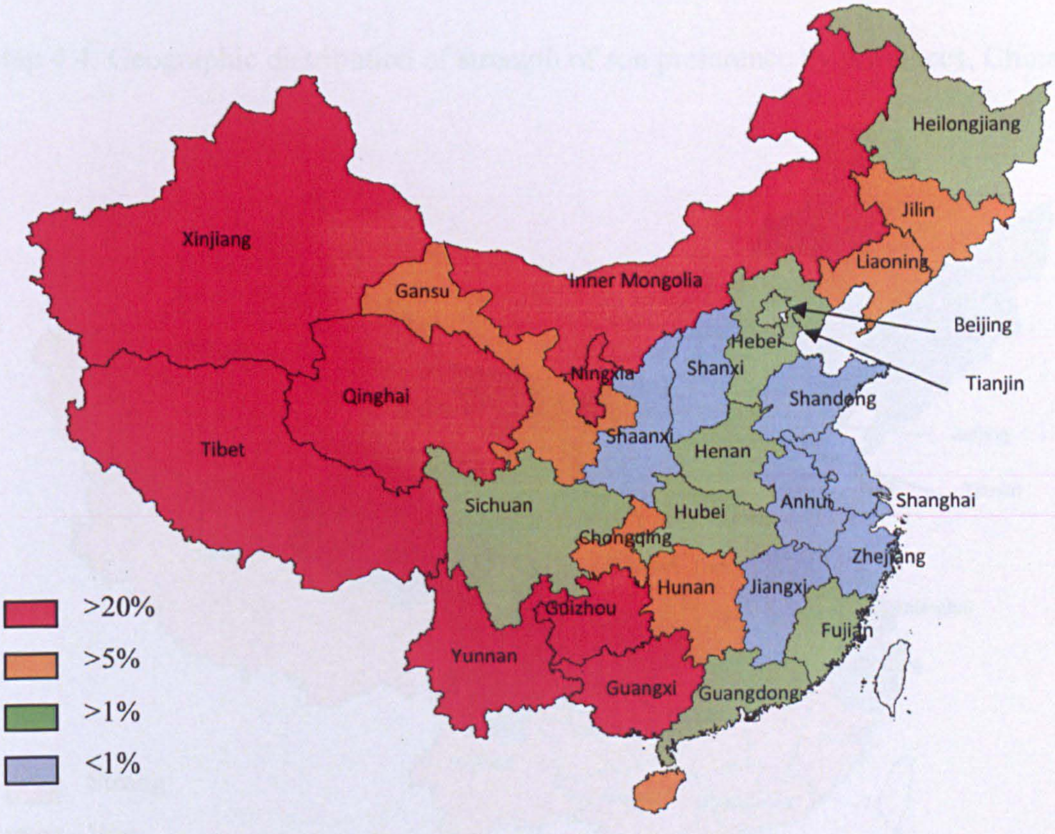
Map 4.2: Geographic distribution of GDP per capita by province, China



4.4.3 Proportion of ethnic minority

As shown in Map 4.3, three provinces in southern China, three in western China and two in northern China have a proportion of ethnic minority groups more than 20 per cent. Six provinces in eastern China and two in central China have a proportion of ethnic minorities less than 1 per cent. The others are between 1 per cent and 20 per cent. From a broad view, the proportion of ethnic minorities decreases from west to east, which is opposite to the economic development.

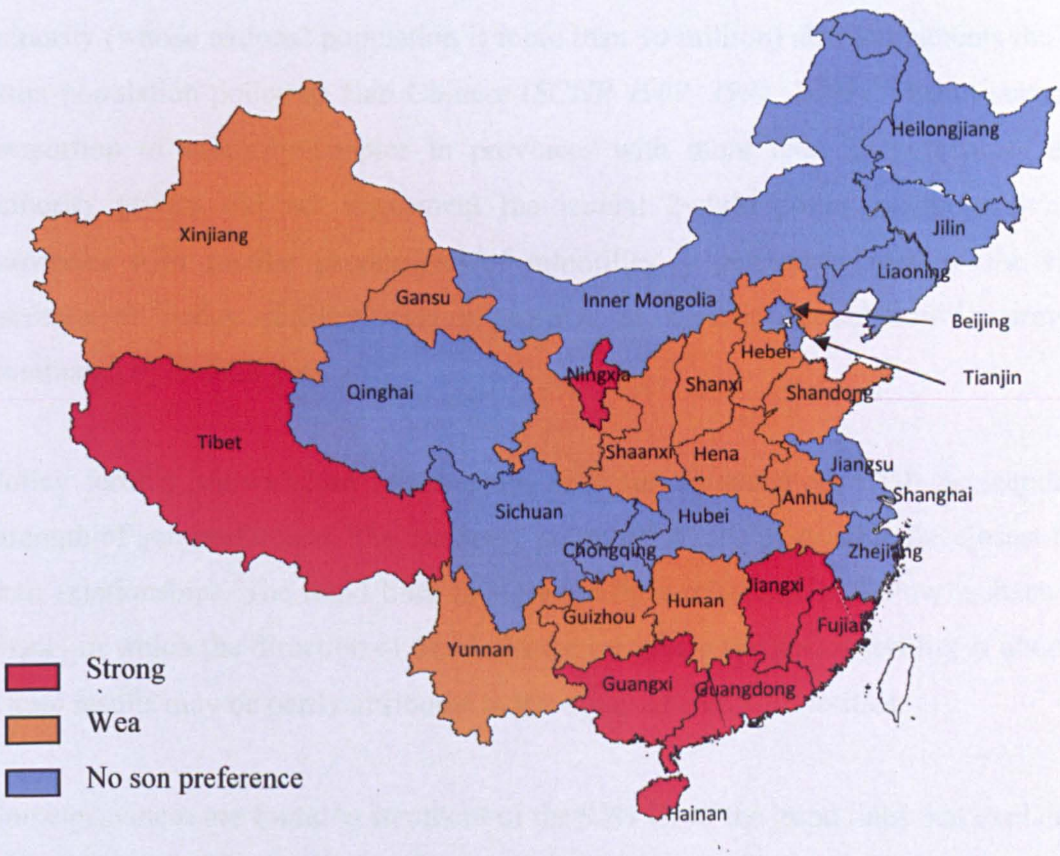
Map 4.3: Geographic distribution of proportion of ethnic minority by province, China



4.4.4 Strength of son preference

Map 4.4 shows the geographic distribution of strength of son preference. Son preference is strong in Tibet, Ningxia and five southern provinces, namely Jiangxi, Fujian, Guangdong, Guangxi and Hainan. There is no son preference in four northeast provinces, provinces located in Yangtze River delta and four provinces in western and central China, including Qinghai, Sichuan, Chongqing and Hubei. Provinces with weak son preference form two belts. One starts from Xinjiang and Gansu (northwest China), to Shaanxi, Shanxi, Henan, Hebei and Anhui (central China), and ends in Shandong (eastern China). The other starts from Yunnan to Guizhou and ends in Hunan province.

Map 4.4: Geographic distribution of strength of son preference by provinces, China



4.5 Discussion and summary

This chapter presents relationships of policy fertility with socio-economic indicators at provincial level. Results of regression models show that policy fertility increases with the proportion of ethnic minorities. This outcome is not surprising because most minorities implement the lenient 2-child policy. Consequently, the greater volume of the minority population is, the higher the policy fertility. However, policy fertility increases more rapidly with the proportion of ethnic minorities when the proportion is less than 20 per cent than those when the proportion is above 20 per cent. One interpretation of this result is that, among the former group of provinces, the ethnic minorities would be usually allowed to have two children. Nevertheless, among the latter group of provinces, population policy is not even between minority groups. In Yunnan (minority groups account for 33 per cent of its population) and Qinghai provinces (minority groups account for 46 per cent of its population), minority couples who are urban residents normally implement the 1-child policy, while their rural counterparts can have two (*SCQP 1986, 1992, 2003; SCYP 1991, 1997, 2002*). In Hainan province, the Zhuang minority (whose national population is more than 10 million) also implements the same strict population policy as Han Chinese (*SCHP 1989, 1995, 2003*). Thus a substantial proportion of minority couples in provinces with more than 20 percent of ethnic minority groups did not implement the lenient 2-child policy as those living in provinces with smaller proportions of minorities, which contributed to the slower increase of policy fertility with proportion of minority population in provinces dominated by 2-child policy.

Policy fertility shows close relationships with rural population, GDP per capita and strength of son preference. The quadratic polynomial models provide the closest fits of their relationships. The trend lines that predict their relationships follow u-shape or n-shape, in which the direction of trend changes at where the policy fertility is about 1.9. These results may be partly attributed to the effect of ethnic minorities.

Some provinces are found to stand out of the 95% CI of the trend lines that explains the above relationships. For instance, the policy fertilities of Shanghai and Sichuan are not well explained by the relationship between GDP per capita and policy fertility. Shanghai is the most developed municipality in China, and has with highest GDP per capita and lowest proportion of rural population. Moreover, Shanghai is known as the province-level municipality that is most open to outside and most influenced by western culture in China. Sichuan is another extreme example. It is one of the least developed provinces. Historically, Sichuan was the most populous province in China, accounting for about 10 per cent of China's total population. Owing to great pressure of population control, Sichuan implemented the 1-child policy rather than the 1.5-child policy in its rural areas (*SCSP 2002*), which is very unusual for a province in China with so high proportion of rural population. Chongqing was separated from Sichuan to be a municipality under the direct jurisdiction of central government in 1997. It had even higher proportion of rural population than Sichuan. Chongqing implemented the same population policy as Sichuan before its own population policy enacted in 2002 (*SCCM 2002*). This makes Chongqing an outlier of the relationship between policy fertility and proportion of rural population.

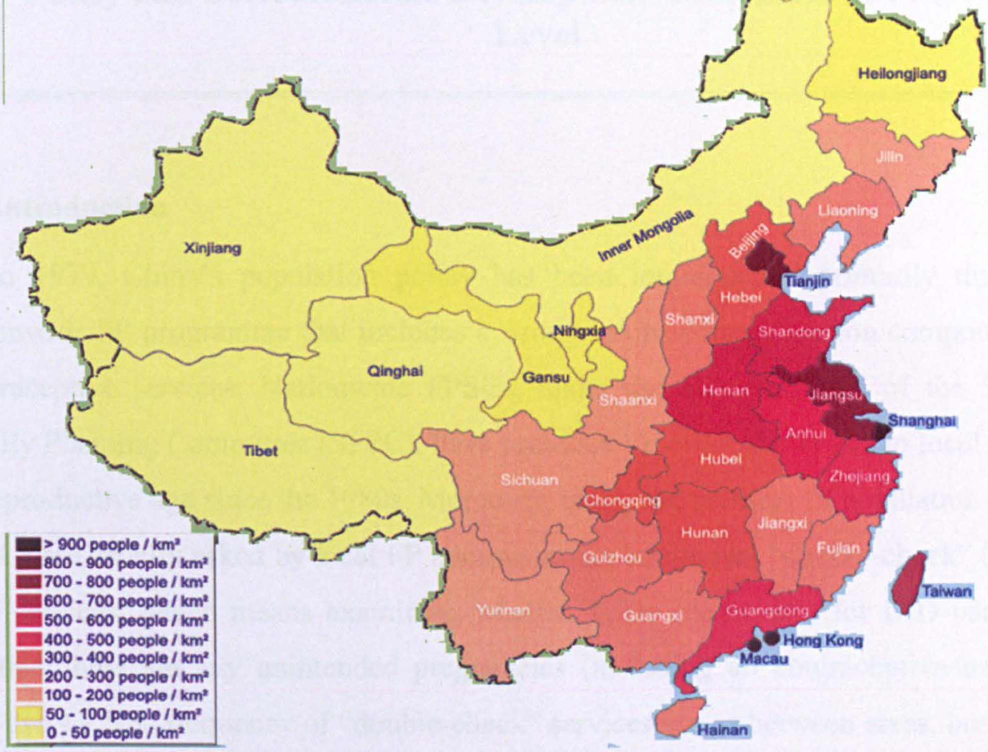
With regard to the relationship between policy fertility and proportion of ethnic minorities, Guangxi Zhuangzu Autonomous Region and Guizhou province are the two exceptions. Data of the 2000 census show that about 16 million of Guangxi's population belonged to ethnic minorities, which accounted for 38 per cent of its total population. Among the ethnic minorities, 14.2 million (84.4 per cent) were Zhuang. Based on the Family Planning Regulations of Guangxi in 1988 and the amendment in 2002, couples who belong to Zhuang minority implement the 1.5-child policy rather than 2-child policy (the central government recommended that ethnic minority whose population were below 10 million implemented 2-child policy in 1984). Minorities other than Zhuang (about 6.0 per cent of Guangxi's total population) implement the 2-child policy (*SCGZA 1988, 2002*). This leads to a relatively low policy fertility (1.53) in Guangxi despite that it had high proportion of minority groups. Guizhou province has a similar proportion of minority groups (37.8%) as Guangxi. However, no one single ethnic group has a population of more than 10 million. Miao, the largest ethnic minority in Guizhou, had a population of 4.3 million, accounting for 32.3 per cent of minority population in the province; the second largest ethnic group, Buyi Zu, accounted for 21.0 per cent of Guizhou's minority population (2.8 million). Theoretically, all minorities in Guizhou implement the 2-child policy (SCGP 1987, 1998, 2002). It is one of the least developed provinces with about 73 per cent of rural population. I cannot find a good reason to explain why policy fertility in Guizhou is even lower than Yunnan and Hainan provinces where there are lower proportions of ethnic minorities.

Son preference is a deeply rooted social tradition, particularly in rural areas of China. The relaxation of the strict 1-child policy in rural areas in 1984 was, to some degree, government's compromise to that strong tradition. The similar trend of Figures 4.2 and 4.4 indicates son preference is related to rural population. It is surprising that Guangdong province, with relatively low level (45%) of rural population, has the highest strength of son preference. Son preference usually has negative association with economic development. Guangdong, a close neighbour to Hong Kong, is regarded as one of the most developed provinces in China. The economic effect fails to explain the strength of son preference in Guangdong. Perhaps son preference is strong both in rural and in urban areas in Guangdong province regardless of the couples' economic status.

Geographically, the 1-child policy is dominant in several most developed provinces in eastern China as well as the former most populous province – Sichuan and Chongqing. The lenient 2-child policy is dominant in several western provinces, where there are high proportion of minority population but low populations density (see Map 4.5). The regional features of China's economic development are very outstanding. The eastern coastal areas take the lead in economic development, but the central and western regions are relatively backward. The proportion of ethnic minority groups follows a geographical gradient: decreasing from West to East. It is noted that son preference is particularly strong in several neighbouring provinces in South China, including Guangdong, Fujian, Jiangxi, Guangxi and Hainan provinces (map 4.4). Compared with Guangdong and Fujian provinces, Jiangxi, Guangxi and provinces are far less developed. No son preference was observed in the four northeast provinces and provinces in Yangtze River Delta. Unexpectedly son preference was not observed in Sichuan, Chongqing and Qinghai where are economically less developed. All these results indicate that causes of son preference are rather complex.

A multivariate approach is not used for data analysis in this chapter. One reason is that there are problems in doing multivariate analysis when the number of observations is small (only 31 observations in this analysis), i.e. derived parameters being statistically unreliable. Another reason is that the 'best models' that fit the relationships between policy fertility and socioeconomic indicators at province level are nonlinear, suggesting a multivariate linear regression model is inappropriate for the analysis. However, a more complex model would increase the number of explanatory variables and make results more difficult to interpret.

Map 4.5: Geographical distribution of population density, China



Source: Wikimedia. Accessed 2 April 2010.

In summary, policy fertility is associated with provincial economic development, strength of son preference, and the proportion of rural population and ethnic minority groups. Their relationships can be best described by quadratic polynomial regression models. The directions of their trend lines that estimate these relationships alter among provinces predominated by 2-child policy. These consequences may be due to differentials of the associations of minority groups with social and economical development indicators between provinces that implemented lenient population policies and those that implemented more stringent population policies. The 1-child policy is dominant in the most developed provinces in East region and Sichuan and Chongqing where there are high pressures of population control. The 2-child policy is mainly implemented in western China where there are high proportions of minorities. Economic development declines from East China to West China. Son preference is strong in south China as well as Tibet and Ningxia autonomous regions but no such preference is apparent in Yangtze River delta, northeast provinces and Qinghai, Sichuan, Chongqing and Hubei in western and central China.

CHAPTER 5: Characteristics of Family Planning Services at Grassroots Institutions and Their Association with Population Policy and Socioeconomic Development Indicators at Provincial Level

5.1 Introduction

Since 1979, China's population policy has been implemented primarily through a nationwide FP programme that includes a strong information/education component and contraceptive services. Nationwide FPSCs, under the administration of the State of Family Planning Committee (SFPC), have provided FP clinical services to local couples of reproductive age since the 1980s. Moreover, under the pressure of population control, FPSCs are usually asked by local FP administrators to conduct "double-check" (*Shuāng chá*) services, which means examining whether IUDs are in situ (for IUD users) and whether there are any unintended pregnancies (including all contraceptive users and non-users). The frequency of "double-check" services varies between areas, but usually takes place two to four times a year. Therefore, the characteristics of FP services at FPSCs substantially reflect the performance of local population policy.

Free contraceptive methods are available not only at FPSCs, but also in villages. However, only short-term contraceptive methods are provided by village FP cadres because provision of the long-term methods, such as IUD and sterilisation, demand greater skills, which are beyond FP cadres' capacity. Other tasks of FP cadres in rural villages include organising "double-check" services, collecting FP and reproductive information from local residents and communicating it to upper-level FP authorities, and making FP propaganda.

By using data collected in the 2001 NFPRHS, this chapter explores characteristics of FP services at township FPSCs and in villages. The relationships between characteristics of local FP services and political, geographical and socioeconomic development indicators at provincial level are also explored. The main hypotheses of this chapter are that vigorous promotion of long-term contraceptive methods at grassroots institutions will be associated with low policy fertility and high GDP per capita at the province level.

The first two sections of this chapter investigate characteristics of FP services at FPSCs and in villages. Section 5.4 presents the associations of the above characteristics with political, geographical and socioeconomic development indicators at provincial level. Section 5.5 provides discussion of results.

5.2 Characteristics of FPSCs at townships

A total of 830 townships were sampled in the 2001 NFPRHS. Among them, 54 townships did not have FPSCs. Thus, 776 FPSCs are included in the investigation of characteristics of FPSCs using latent class analysis (LCA). The data on FPSC contain information mainly on three dimensions: basic infrastructure; FP services; and reproductive health (RH) services provided at the FPSCs. Obviously, the three dimensions are closely related. Good FP services need good infrastructure and are usually related to good provision of RH services. Examination of our data confirmed this to be the case. One strategy of analysis is to include all data of the three dimensions into one LCA model so that no information is omitted. However, preliminary analysis demonstrated that this approach produced complicated results, in which the outcomes were difficult to interpret. Alternatively, analysis can be focused on provision of FP services at FPSCs, which is directly related to fertility and abortion among Chinese couples and thus preferred in this study. The analysis starts with data description, then LCA and outcome interpretation.

5.2.1 *Data description*

As shown in Table 5.1, nearly 98 per cent of FPSCs provided condoms, which is followed by daily pills (96%), IUDs (93%), once-a-month pills (90%) and visiting pills (71%). Female and male sterilizations were available at about 39 per cent and 17 per cent of FPSCs, respectively. About one-fourth of FPSCs provided emergency pills, while one in eight FPSCs provided Norplant. Although induced abortion is not a contraceptive method, it is a primary back-up method in case of contraceptive failure in China. It is thus also included in this dimension. About 70 per cent of FPSCs provided abortion service. Side-effects are the main reason for discontinuation of contraceptive methods. Nearly 55 per cent of FPSCs provided different types of drugs for side-effects, including pain killers, drugs that reduce irregular bleeding or spotting after IUD insertion and antibiotics that are used to prevent infection after induced abortion.

Table 5.1: Percentage of FPSCs providing specific family planning (FP) methods

FP methods	% of "yes" (N=776)
Condoms	97.8
Daily pills	95.6
IUDs	93.4
Once-a-month pills	89.7
Spermcide	80.3
Visiting pills	71.3
Female sterilization	39.4
Emergency pills	24.7
Male sterilization	16.6
Norplant	12.2
Induced abortion	70.2
Side-effects drugs	54.8

5.2.2 LCA

Model selection

LCA starts by fitting the null model H_0 to the data of FP services at FPSCs, followed by fitting 2 to 5-class models. Outcomes of model fits are shown in Table 5.2. The 1-class and 2-class models fail to fit the data because $L^2(H_0)$ and $L^2(H_1)$ with DF= 764 and 751 are too large to be explained by chance. The p-values of 3-class, 4-class and 5-class indicate that the fits of these models are adequate. BIC criteria indicate that the 4-class model (4 points less than the 3-class model) is preferred over the 3-class and 5-class models. However, comparing reduction of L^2 from the baseline model (H_0), the value of L^2 of the 4-class model (59.4% reduction) is not improved much over that of the 3-class model (51.7% reduction). The 3-class model is simpler than the 4-class model; and the bootstrap p-value also indicates that 3-class model is sufficient to fit the data. It is thus adopted in this study.

Table 5.2: Latent class models fit to data of FP methods at township's FPSCs

	Model	BIC(LL)	Npar	L^2	df	Bootstrap p-value
H_0	1-Class	8313.1	12	1407.3	764	1.10E-40
H_1	2-Class	8007.9	25	1015.6	751	3.30E-10
H_2	3-Class	7758.0	38	679.2	738	**0.94**
H_3	4-Class	**7736.7**	51	571.4	725	1
H_4	5-Class	7740.4	64	488.6	712	1

Class assignment of observations and interpretation of latent classes

For a latent class model (LCM) with twelve manifest dichotomous variables, there are 2^{12} = 4,096 possible response patterns. However, because of the large amount of inter-

FPSC agreement, only 180 of these patterns were observed. Owing to the great size of response patterns, the detailed distributions on these patterns are not shown here, but an example is shown in Table 5.3.

Observations are assigned to the class for which the posterior probability is highest. For instance, three FPSCs (see Obs freq in Table 5.3) with response pattern of the first row in Table 5.3 has posterior probabilities equal to 0.19 for class 1 (C1), 0.73 for class 2 (C2) and 0.08 for class 3 (C3). Thus, they are assigned to class 2. The response pattern of the second row has posterior probabilities equal to 0.91, 0.09 and 0.00 for the three classes, respectively. Therefore one FPSC that has this response pattern is assigned to class 1. Similarly, two FPSCs that have response pattern of the third row in Table 5.3 are assigned to class 3. Overall, 294 FPSCs (37.9%) are assigned to the first class, 406 (52.3%) to the second class, and 76 (9.8 %) to the third class.

Table 5.3: An example of response pattern of observed variables, observed frequency, posterior probabilities and assigned class in a latent class model

Combination of observed variables												Obs	Posterior prob.			Assig.
M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	freq	C1	C2	C3	Class
1	0	1	0	1	1	0	0	1	0	1	0	3	0.19	0.73	0.08	2
1	1	0	1	1	1	1	1	1	0	1	0	1	0.91	0.09	0.00	1
1	0	0	0	1	0	1	0	1	0	0	0	2	0.00	0.16	0.83	3

Notes: M1-M12 represent oral pills, once-a-month pills, visiting pills, emergency pills, condoms, spermcides, drugs for side effects, female sterilization, IUDs, Norplant, male sterilization, respectively. "1" in the table represents positive value of the observed variable, and "0" represents negative value of the observed variable.

The interpretation of the latent classes depends on the posterior probabilities: the higher probability, the more likely is the class to have the combination of values shown on the left-hand side of Table 5.3. Moreover, the interpretation of latent classes needs also to consider conditional probabilities of the LCM. A conditional probability, for each observed variable and each latent class, is the probability of the variable being positive or negative for a member of the latent class. For instance, the conditional probability that a FPSC in class 1 does not provide daily pills is 0.0001 (first row and first column in Table 5.4). Alternatively, the probability of providing daily pills is 1 – 0.0001 = 0.9999. This means that, if we randomly select one FPSC from those in class 1, the probability of selecting a FPSC that provided daily pills is 99.99 per cent. The probability of not providing daily pills is 0.01 per cent. Thus, FPSCs in class 1 are more likely to provide daily pills. So class 1 takes positive value on this observed variable. Since each category of every observed variable in each latent class has a conditional probability, the overall patterns of conditional probabilities provide the measurement structure that defines the latent classes.

Table 5.4: Estimated conditional probabilities of the "best-fit" 3-class model, by observed variables on family planning services at FPSCs

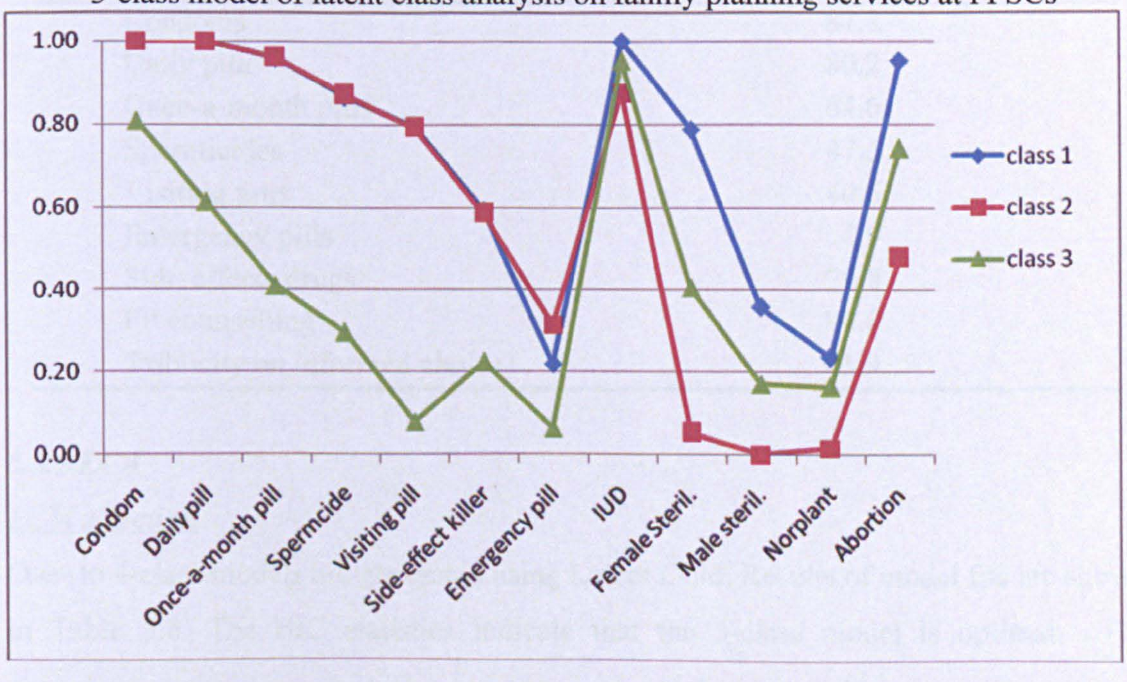
Observed	Latent variable			Observed	Latent variable		
variables	class 1	class 2	class 3	variables	class 1	class 2	class 3
Daily pills				Drugs for side-effects			
No	0.0001	0.0001	0.3873	0	0.4071	0.4145	0.7764
Yes	0.9999	0.9999	0.6127	1	0.5929	0.5855	0.2236
Once-a-month pills				Female Sterilisation			
No	0.0422	0.0402	0.5902	0	0.2123	0.9477	0.5938
Yes	0.9578	0.9598	0.4098	1	0.7877	0.0523	0.4062
Visiting pills				IUDs			
No	0.2053	0.2079	0.9212	0	0.0001	0.1260	0.0500
Yes	0.7947	0.7921	0.0788	1	0.9999	0.8740	0.9500
Emergency pills				Norplant			
No	0.7805	0.6849	0.9365	0	0.7651	0.9845	0.8358
Yes	0.2195	0.3151	0.0635	1	0.2349	0.0155	0.1642
Condoms				Abortion			
No	0.0000	0.0000	0.1938	0	0.0477	0.5225	0.2585
Yes	1.0000	1.0000	0.8062	1	0.9523	0.4775	0.7415
Spermcides				Male sterilisation			
No	0.1346	0.1307	0.7051	0	0.6427	0.9997	0.8288
Yes	0.8654	0.8693	0.2949	1	0.3573	0.0003	0.1712

Table 5.4 shows the estimated conditional probabilities obtained from the 3-class model. However, I prefer to show these probabilities in graphical rather than tabular form because the former provides a visual display of the parameter estimates. Figure 5.1 shows the conditional probabilities in each class with a positive value to each of the 12 variables.

From this figure, we can see that the probabilities of providing short-term contraceptive methods, including condoms, daily pills, once-a-month pills, spermcides, visiting pills as well as drugs for side-effects, are almost identical between class 1 and class 2. Only for emergency pills, do FPSCs in class 2 have a higher value than those in class 1. They are lowest in class 3. For the long-term methods, including IUDs, male and female sterilizations, Norplant, as well as abortion, the conditional probabilities are highest in class 1, followed by those in class 3 and lowest in class 2. These results indicate that FPSCs in class 1 are effective at providing almost all types of FP services; those in class 2 are effective at providing short-term but inadequate to provide long-term FP methods; FPSCs in class 3 are moderate at providing long-term but poor at providing short-term

FP methods. Moreover, as shown in Figure 5.1, the probability differences of IUD services between classes are small, while those of sterilizations and abortion, particularly female sterilization, are great. Considering FP promotion is one of the main approaches that China implements its population policy, the availability of FP methods and induced abortion at a FPSC reflects the approaches of FP promotion and endeavours of local population policy implementation. Since the target responsibilities for population and FP management (including targets for population control and targets for long-term contraceptive use) have been established at all levels of governments, long-term contraceptive methods are particularly stressed where there is great pressure of population control, such as using IUDs after the first birth and sterilization after the second birth. It is very likely that class 1 represents this type of FP performance because the sterilizations in class 1 are far more available than other two groups. In a locality where the long-term methods are not stressed, couples would have more freedom than their counterparts to choose their own methods and may be more likely to use the short-term methods rather than long-term methods. Class 2 may represent this type of FP performance. Hence I named the latent variable concerning FP services at FPSCs "capacity of FP services". The first class of the latent variable is named "good provision of short- and long-term" methods, the second class "good provision of short-term and poor provision of long-term" methods, and the third class "poor provision of short-term and moderate provision of long-term" methods.

Figure 5.1: Estimated conditional probabilities of observed variables with positive value, 3-class model of latent class analysis on family planning services at FPSCs



5.3 LCA of characteristics of FP services at villages

A total of 830 villages (one village was sampled in one township) were investigated in the 2001 NFPRHS. Information on public facilities, village doctors, midwives, FP cadres, contraceptive methods, approaches of FP promotion, public health services and environment deterioration, etc was collected. Since this study focuses on FP, only data related to FP methods are used in this analysis. Again, this section starts with data description, followed by LCA and outcome interpretation.

5.3.1 FP services

Data description

Eight hundred and twenty-four villages (99.3%) had at least one FP cadre. The percentage of village cadres providing specific contraceptive methods, FP counselling and publicity of informed choice of FP methods are shown in Table 5.5. Condoms and daily pills were the two most available methods, which were provided at 87 per cent and 80 per cent of villages, respectively. About 65 per cent of villages provided once-a-month pills, followed by spermcides (48%) and visiting pills (40%). Emergency pills were only available at about 5 per cent of villages. Nearly one-fifth of villages provided side-effect drugs. Four in five villages had FP counselling services and two in five publicised informed choices of FP methods.

Table 5.5: Percentage of rural villages providing specific types of FP services provided in rural villages

FP services	% of "Yes" (N=830)
Condoms	87.2
Daily pills	80.2
Once-a-month pills	64.6
Spermicides	47.6
Visiting pills	40.5
Emergency pills	4.9
Side-effects drugs	20.8
FP counselling	80.6
Publicity on informed choice	41.9

5.3.2 LCA

LCM selection

One- to 4-class models are generated using Latent Gold. Results of model fits are shown in Table 5.6. The BIC statistics indicate that the 3-class model is optimal. The reduction of L^2 from null model of 3-class model is 83.1 per cent, and it is much higher than that of the 2-class model (70.8%).

Table 5.6: Latent class models fit to data of family planning services in villages

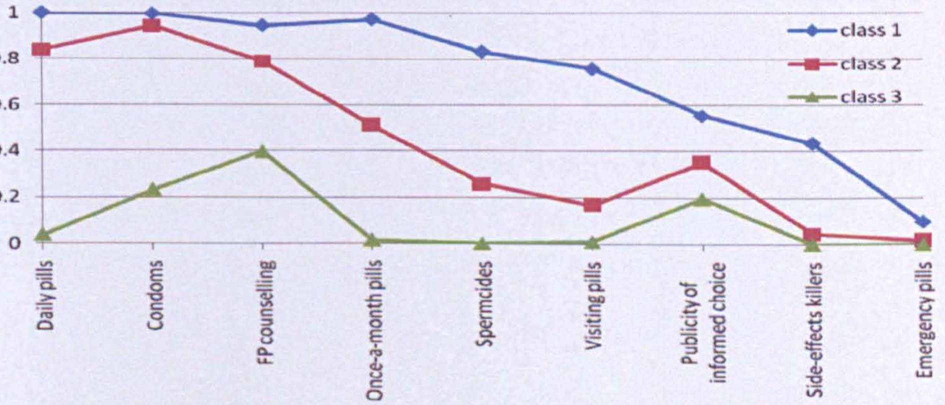
	Model	BIC(LL)	Npar	L^2	*df*	p-value
H_0	1-Class	7989.6	9	1627.6	502	7.20E-119
H_1	2-Class	6904.0	19	474.7	492	0.71
H_2	3-Class	**6772.2**	29	275.8	482	1.00
H_3	4-Class	6793.5	39	229.8	472	1.00

Class assignment of observations and interpretation of latent classes

While there are 2^9=512 possible response patterns, because of the large amount of inter-village agreement, only 96 of these patterns were observed. Villages are assigned to the latent class for which the posterior probability is highest. Overall, 43.6 per cent of villages are estimated to be in class 1, 43.0 per cent in class 2 and the remaining 13.4 per cent in class 3.

Figure 5.2 shows the estimated conditional probabilities of observed variables with positive values, by categories of latent classes. The response structure indicates that the availability of each type of contraceptive methods at villages among the three latent classes follows a gradient: highest availability at villages in class 1, followed by those in class 2 and lowest availability in class 3. While the majority of contraceptive methods and other FP services are available at villages in class 1, few were available at villages in class 3, except for condoms, FP counselling and publicity of informed choice. Thus, the three classes for the latent variable that represents capacity of FP services at villages can be named: "good" capacity for class 1, "moderate" capacity for class 2 and "poor" capacity for class 3.

Figure 5.2: Estimated conditional probabilities of observed variables in each class with positive value, 3-class model of latent class analysis on FP services in villages



5.4 Associations of characteristics of FP services at townships and in villages with political, geographical and socioeconomic development indicators at provincial level

5.4.1 Introduction

This section explores associations of the above two latent variables with political, geographical and socioeconomic development indicators at provincial level. Analysis approaches include cross-tabulation and two-level multinomial logistic regression. Table 5.7 shows explanatory variables that are used for multilevel logistic regression analysis. The data on average household income in villages, population size of a township and GDP per capita at province level are natural logarithm transformations. These continuous explanatory variables are further centred (subtracting a variable's mean from each case's value of that variable) because centring predictor variables can reduce the chances of numerical instability in the iterative generalised least squares (IGLS) and reweighted IGLS (RIGLS) estimation methods and reduce the correlation in the chains produced by the Monte Carlo Markov Chain (MCMC) methods (*Rasbash 2005*). While running multilevel modelling, only one level-2 (provincial level) variable will be introduced into the model each time to see whether it is significantly associated with the outcome variable. If not, it will be dropped for further analysis. The next step is to include all significant province-level explanatory variables into one multilevel modelling (full model). However, if any of level-2 explanatory variables is no longer statistically significant in the full model, it will be then deleted, leaving only significant variables in the final model. Since some level-2 variables are correlated, to avoid collinearity problem, I will also assess different combinations of these variables in multilevel analysis in order to obtain a valid explanation of the association of explanatory indicators and the outcome measure.

Table 5.7: Outcome responses and explanatory variables and their codes / values for multilevel logistic regression models

Outcome responses	Code/value
Capacity of FP services at township FPSCs	Class 1 (good provision of short- and long-term methods), class 2 (good provision of short-term, poor provision of short-term methods, reference), class 3 (poor provision of short-term, moderate provision of long-term methods)
Capacity of FP services at villages	Class 1 (good), class 2 (moderate), class 3 (poor, reference)
Explanatory variables	
Township-village level	
Average household income in village	Natural logarithm, 4.79 – 9.67, centred at 7.43
Population size of a township	Natural logarithm, 7.54 – 13.22, centred at 10.29
Provincial level	
GDP per capita	Natural logarithm, 7.70 – 10.05, centred at 8.63
Population policy	1: 1-child, 2: 1.5-child, 3: 2-child (reference)
Geographical region	1: East region, 2: Central region, 3: West region (reference)
% of rural population	1: <60%, 2: 60% - 70%, 3: 70% - 75%, 4: >75% (reference)
% of ethnic minorities	1: <3 %, 2: 3% – 9% (reference), 3: >9%

As mentioned earlier, 54 townships did not have FPSCs and are therefore not included in the above analysis. However, absence of a FPSC at a township may convey special meanings, such as unavailable due to poverty or unnecessary due to easy access to FP services from public health sector. Thus, they are grouped as one cluster and compared with the others.

5.4.2 Predictors of establishment of FPSCs

As can be seen in Table 5.8, townships without a FPSC are more likely to be in the West region and where there are moderate proportions of ethnic minority groups. However, provinces dominated by 1.5-child policy, those located in the Central region or with lowest level of ethnic minority groups are more likely to establish FPSCs than their respective counterparts.

Table 5.8: Percent of townships without FPSCs, by selected political, geographical and socioeconomic indicators at provincial level

Indicators	N	FPSC No	FPSC Yes	P value
Population Policy				
1-child	152	15.1	84.9	<0.001
1.5-child	633	3.5	96.5	
2-child	45	20.0	80.0	
Region				
East	291	5.8	94.2	0.001
Central	303	3.3	96.7	
West	236	11.4	88.6	
GDP per capita (Yuan)				
<4200	198	8.6	91.4	0.600
-6000	322	5.9	94.1	
-9000	150	6.0	94.0	
>9000	160	5.6	94.4	
% of rural population				
< 60	266	6.4	93.6	0.001
-70	177	10.2	89.8	
-75	256	2.0	98.0	
>75	131	10.7	89.3	
% of minority				
< 3	406	3.0	97.0	<0.001
- 9	215	13.0	87.0	
>9	209	6.7	93.3	
Total	830	6.5	93.5	

Multilevel logistic regression analysis

Table 5.9 shows parameter estimates of three binomial logistic models from fitting data on the establishment of FPSCs at townships. Model 1 and model 2 are single- and two-level models without any explanatory variables respectively. The DIC diagnostic reduces from 401.5 in model 1 to 336.1 in model 2, which indicates that the two-level model is better than single-level model. However, the level-2 variance (Wald test p value=0.083) indicates there are marginal differences of the probabilities of establishing township FPSCs between provinces. Individual provincial-level variable excluding GDP per capita (no significant difference between provinces) is added to the two-level model, one variable for one model. Population policy and the proportion of ethnic minority groups show significant associations with the outcome variable and are thus included in the final model (model 3). Compared with model 2, the DIC diagnostic as shown below is reduced by 0.8 in model 3, so model 3 is little improved. As indicated by the coefficients of fixed effects in model 3, provinces dominated by 1.5-child policy were significantly more likely to set up FPSCs than those dominated by 2-child policy. However, the probabilities of establishing FPSCs were largely similar between provinces where dominated by 1-child policy and 2-child policy. Provinces with the lowest proportion of minority groups are significantly more likely to have FPSCs than those with moderate proportion of minority groups. The between-province variance has decreased from 4.308 in model 2 to 2.391 in model 3, which indicates some of the variance in the outcome measure between provinces is explained by differences of population policy and minority proportion composition.

Table 5.9: Parameter estimates of single- and two-level binomial logistic models from fitting data on establishment of township's FPSCs

	Single-level model	Two-level models	
	Model-1	Model-2	Model-3
	Coefficient(s.e.)	Coefficient(s.e.)	Coefficient(s.e.)
Fixed Effects			
Intercept term	2.676 (0.142) **	3.233 (0.481) **	0.252 (1.142)
Level-2 variables			
Policy fertility			
1-child policy			0.939 (1.333)
1.5-child policy			2.468 (1.067)*
% of minority			
<3%			1.961 (0.962)*
>9%			1.215 (1.006)
Random effects			
Level-2 variance		4.308 (2.488)	2.391 (1.657)
DIC	401.5	336.1	335.3

*p<0.05, **p<0.01

5.4.3 FP services at FPSCs

As shown in Table 5.10, about 38 per cent of FPSCs are allocated to latent class 1, which corresponding to good services for both long- and short-term FP methods and abortion; about a half (52.3%) of FPSCs are classified into latent class 2, which corresponding to FPSCs having good prevision of short-term contraceptive methods but poor for long-term methods and abortion service; the remaining 10 per cent are classified as class 3, which corresponds to poor services of short-term contraceptive methods and moderate on long-term methods and abortion service. The Chi-square tests indicate that FP services at FPSCs vary between categories of population policy, geographical regions, economical development, proportions of ethnic minority groups and rural population. For example, good provision of long-term conceptive methods (class 1) is most likely in Central region and in provinces dominated by 1.5-child policy. On the contrary, poor provision of long-term methods is most likely in East region, the most economically developed provinces, provinces with a dominant 2-child policy, and where there were lowest of proportion of rural population.

Table 5.10: Percentage distribution of latent classes that represent the availability of family planning services at township FPSCs, by selected political, geographical and socioeconomic indicators at provincial level

Indicators	N	Class 2 (Good short-term, poor long-term)	Class 1 (good short- and long-term)	Class 3 (poor short-term, moderate long-term)	p-value
Population Policy					
1-child	129	58.9	26.4	14.7	0.001
1.5-child	611	49.9	41.6	8.5	
2-child	36	69.4	16.7	13.9	
Region					
East	274	77.4	16.4	6.2	<0.001
Central	293	34.5	56.7	8.9	
West	209	44.5	39.7	15.8	
GDP per capita (Yuan)					
<4200	181	33.7	54.7	11.6	<0.001
-6000	303	40.3	47.5	12.2	
-9000	141	74.5	17.0	8.5	
>9000	151	78.1	17.9	4.0	
% of rural population					
< 60	249	64.3	30.1	5.6	<0.001
-70	159	47.2	37.1	15.7	
-75	251	45.4	45.0	9.6	
>75	117	48.7	40.2	11.1	
% of ethnic minorities					
< 3	394	58.1	36.3	5.6	<0.001
- 9	187	38.5	44.4	17.1	
> 9	195	53.8	34.9	11.3	
Total N	776	52.3	37.9	9.8	

Multilevel logistic regression analysis

Since the outcome variable has three categories (latent classes), multinomial logistic regression is used to explore determinants of FP services at FPSCs. Class 2 serves as the reference group. Suppose $\pi_i^{(2)}$ represents the probability for the *i*th township in the base category, and $\pi_i^{(1)}$ and $\pi_i^{(3)}$ denote the probabilities in class 1 and class 3 respectively. Equation 3.17 represents two single-level models for the log ratios ln $(\pi_i^{(1)}/\pi_i^{(2)})$ and $\ln$ $(\pi_i^{(3)}/\pi_i^{(2)})$ respectively. These can be extended to two-level model.

Suppose $\pi_{ij}^{(2)}$ represent the probability for the *i*th township *j*th province in the base category, and $\pi_{ij}^{(1)}$ and $\pi_{ij}^{(3)}$ denote the probabilities in class 1 and class 3, and equation 3.19 represents two two-level models for log ratios $\boldsymbol{ln}\ (\pi_{ij}^{(3)}/\pi_{ij}^{(2)})$ and $\boldsymbol{ln}\ (\pi_{ij}^{(1)}/\pi_{ij}^{(2)})$ respectively.

The parameter estimates of single- and two-level multinomial logistic models are shown in Table 5.11. The DIC diagnostic suggests that model 2 (two-level model without level-2 indicators) provides a much better fit than model 1 (the single-level model). The significant level-2 variance indicates that there is unexplained province-level variation in the FP services at FPSCs between provinces. Thus level-2 variables are added to model 2. Preliminary analyses showed that population policy, geographical region and GDP per capita were significantly associated the capacities of FP services at FPSCs but that proportion of rural population and ethnic minority groups were not. Thus the significant level-2 explanatory variables were included in a two-level model. However, when all the three variables were added in the two-level model, none of them shows a significant relationship to the outcome measure. This result may be due to collinearity among the three explanatory indicators. Therefore, not all but combination of any two is added in model 2. Their parameter estimates are shown in Table 5.12.

Table 5.11: Parameter estimates of single- and two-level multinomial logistic models from fitting data on family planning services at FPSCs

	Outcome Category[&]	Single-level model Model-1 Coefficient (s.e.)	Two-level models Model-2 Coefficient (s.e.)
Fixed Effects			
Intercept term	Class 1	-0.317 (0.078)**	-0.525 (0.329)
	Class 3	-1.919 (0.145)**	-2.181 (0.385) **
Level-1 variable			
Population size	Class 1	-0.122 (0.127)	0.075 (0.160)
	Class 3	-1.285 (0.196)**	-1.080 (0.232) **
Level-2 variables			
Policy fertility	Class 1		
	Class 3		
Random effects			
Level-1 variance			2.689 (1.062) *
Level-2 variance			3.220 (1.575) *
Intercept - level-2 covariance			2.099 (1.035) *
DIC		1413.3	1179.1

& reference category is class 2; *p<0.05, **P<0.01

Model 3 in Table 5.12 includes population policy and GDP per capita as level-2 explanatory variables, Model 4 includes population policy and geographical region, and model 5 includes GDP per capita and geographical region. The differences of DIC diagnostics between the three models are very small. Compared with model 2, the level-2 variances in the last three models are no longer significant at 0.05 level, suggesting population policy, geographical region or GDP per capita are partially responsible for the differences of FP services at FPSCs between provinces. The between-province variance and DIC diagnostic are lowest in model 3, indicating that the combination of population policy and GDP per capita provides a better explanation of between-province variation in FP services.

Table 5.12: Parameter estimates of two-level multinomial logistic models from fitting data on family planning services at FPSCs

	Outcome Category[&]	Model-3	Model-4	Model-5
		Coefficient(s.e.)	Coefficient(s.e.)	Coefficient(s.e.)
Fixed Effects				
Intercept term	Class 1	-2.929 (1.099)**	-1.943 (1.088)	-1.057 (0.626)
	Class 3	-2.966 (0.960)**	-2.009 (1.117)	-2.551 (0.988)**
Level-1 variable				
Population size	Class 1	0.090 (0.161)	0.072 (0.159)	0.092 (0.166)
	Class 3	-1.028 (0.238)**	-1.042 (0.241)**	-1.024 (0.239)**
Level-2 variables				
Population policy				
1-child policy	Class 1	1.664 (1.336)	1.528 (1.350)	
	Class 3	0.819 (1.330)	0.508 (1.600)	
1.5-child policy	Class 1	2.699 (1.150)*	2.681 (1.195)*	
	Class 3	0.702 (1.016)	0.778 (1.353)	
GDP per capita	Class 1	-2.644 (0.691)**		-2.243 (1.114)*
	Class 3	-2.484 (0.935)**		-2.591 (1.656)
Geographical region				
East	Class 1		-2.399 (0.675)**	0.052 (1.073)
	Class 3		-2.233 (1.029)*	0.085 (1.666)
Central	Class 1		0.006 (0.611)	1.485 (0.679)*
	Class 3		-0.364 (1.056)	0.525 (1.012)
Random effects				
Class-1 variance		1.580 (0.677)*	1.458 (0.670) *	1.347 (0.633)*
Class-3 variance		2.515 (1.377) †	3.162 (1.705) †	2.937 (1.623) †
Covariance		1.037 (0.731)	1.215 (0.806)	1.106 (0.748)
DIC		1172.1	1173.0	1174.3

& reference category is class 2; † P<0.1, *P<0.05, **P<0.01

From the fixed effects of the three models, we can see that population size of a township has a significant negative coefficient on the contrast of class 3/class 2 among three models, which indicates the greater the population size of a township, the more likely is the FPSC to be classified into class 2. None of the coefficients on contrast of class 1 /

class 2 is statistically significant, indicating that township's population size does not affect the assignment of a FPSC to class 2 or class 1.

At province level, 1.5-child policy shows significant impact on the outcome variable. The FPSCs in provinces dominated by 1.5-child policy are more likely to be allocated into class 1 rather than class 2; the difference between class 2 and class 3 is not statistically significant.

Parameter estimates of model 3 and model 5 indicate that economic development is also associated with the outcome measure: the more economically developed the province, the more likely are the FPSCs to be assigned into the reference category - class 2.

Geographical region shows different effects on the outcome measure in model 4 and model 5. When population policy is controlled, FPSCs in East region are significantly more likely to be allocated to class 2 rather than class 1 or class 3. However, this effect is not seen in the Central region. When GDP per capita is controlled, the likelihood of being in class 1 or class 3 is similar to that of class 2 in the East region; while in the Central region, FPSCs are more likely to be allocated to class 1 rather than class 2. Such patterns may be due to the close relationship between geographical region and economic development. The East region is known to be more developed than other areas. Once GDP per capita is controlled, the association between East region and FP services disappears.

The level-2 variances for contrast class 1/class 2 of three models are all statistically significant, indicating that there is still a significant between-FPSC difference after controlling townships' population size and province level effects. Since we do not have much information collected in the township survey, the reason for this between-FPSC difference is not clear. The random effect covariances are all positive, indicating that provinces that have high probability of FPSCs in class 1 (good provision of long-term contraceptive methods and abortion) also tend to have high probability of FPSCs in class 3 (provides moderate services of this kind). This can also be seen from the correlation matrix in Table 5.13. The correlations between class 1 and class 3 at province level are around 0.55 in the three models. This consequence is expected since both classes are better equipped to provide long-term contraceptive methods and induced abortion than class 2.

Table 5.13: Province-level correlation matrix of model 3, 4 and 5

	Model 3			Model 4			Model 5	
	Class 1	Class 3		Class 1	Class 3		Class 1	Class 3
Class 1	σ^2_{v0}: 1.000		Class 1	σ^2_{v0}: 1.000		Class 1	σ^2_{v0}: 1.000	
Class 3	σ^2_{v01}: **0.520**	σ^2_{v1}: 1.000	Class 3	σ^2_{v01}: **0.566**	σ^2_{v1}: 1.000	Class 3	σ^2_{v01}: **0.556**	σ^2_{v1}: 1.000

5.4.4 FP services in villages

The percentage distributions of latent classes that demonstrate FP services in rural villages are shown in Table 5.14. Nearly 50 per cent of villages are assigned to class 1 (good FP services). Class 2 (moderate FP services) and class 3 (poor FP services) account for 38.7 per cent and 12.0 per cent of villages, respectively. FP services in villages vary between categories of province-level indicators. For instance, 50 per cent of villages in provinces with a dominant 1.5-child policy are assigned to class 1; the proportion in provinces dominated by 2-child policy is about 39 per cent. About 10 per cent villages in the former provinces were classified into the "poor" group, compared with 31 per cent in the latter provinces. The developed eastern provinces and those with the lowest proportion of rural population or ethnic minority groups are less likely to have villages with poor FP services but more likely to have villages with good FP services.

FP services in villages also show positive relationships to the capacity of FP services at FPSCs. When the FPSCs were good at provision of short-term methods (class 1 and class 2), more than 50 per cent of villages also had good FP services. However, if the FPSCs were poorly equipped to provide short-term contraceptive methods (class 3), the villages were more likely to have moderate and poor FP services.

Table 5.14: Percentage distribution of latent classes that represents the availability of FP services at villages, by selected township- and province-level indicators

Indicators	N	FP services in village			p-value
		good	moderate	poor	
Population Policy					
1-child	152	48.7	35.5	15.8	0.000
1.5-child	633	50.2	40.0	9.8	
2-child	45	37.8	31.1	31.1	
Region					
East	291	53.3	41.6	5.2	0.000
Central	303	46.5	46.5	6.9	
West	236	47.9	25.0	27.1	
GDP per capita (Yuan)					
<4200	198	38.4	29.8	31.8	0.000
-6000	322	50.6	42.2	7.1	
-9000	150	50.7	46.0	3.3	
>9000	160	58.8	35.6	5.6	
% of rural population					
< 60	266	56.0	39.8	4.1	0.000
-70	177	43.5	39.0	17.5	
-75	256	45.3	41.8	12.9	
>75	131	51.1	29.8	19.1	
% of minority					
< 3	406	50.5	40.6	8.9	0.040
- 9	215	46.5	40.0	13.5	
> 9	209	49.8	33.5	16.7	
Family planning services at FPSCs					
No FPSC	54				0.000
Good for short- and long-term contraceptive services	294	50.3	34.4	15.3	
Good for short-, poor For long-term contraceptive services	406	54.9	36.5	8.6	
Poor for short-, moderate for long-term contraceptive services	76	15.8	65.8	18.4	
Total	830	49.3	38.7	12.0	

Multilevel logistic regression analysis

Parameter estimates of single- and two-level multinomial logistic models from fitting data of FP services at villages are shown in Table 5.15. This time, level-1 variables include not only average household annual income that was obtained from the village survey but also the latent variable about FP services at FPSCs. Since village FP cadres usually received technical support from service providers at FPSCs, it is expected that FP services at FPSCs would affect the quality of FP services at villages.

DIC values indicate that model 2 (two-level model) is a great improvement over the single-level model. The significances of level-1 variables in model 2 are similar to those of single-level model but their coefficient values slightly decline. The level-2 variance in model 2 is not statistically significant, suggesting level-2 predictors may not be of much importance to explain the differences of FP services in villages between provinces.

Individual province-level variables are then added in model 2. Population policy, geographical region, proportion of rural population and GDP per capita are significantly associated with an outcome and thus all of them are included in model 3. Nevertheless, population policy and proportion of rural population are not statistically significant at all in model 3. Thus model 4 is fitted, in which the two non-significant level-2 variables are excluded (model 4 Table 5.15). DIC diagnostics also confirm that model 4 is marginally better than model 3. The pattern of significances of estimated coefficients in model 3 and model 4 is very similar.

From the fixed effects of model 4, we can see that the average household annual income in a village significantly affects FP services. The higher the income of the village, the more likely it is to have good FP services, regardless of the nature of FP services at FPSCs. As can be seen from the estimated coefficient values, the log odds ratio is highest at townships without FPSCs, indicating that village FP services were intensified in these townships. Nevertheless, among townships whose FPSCs were classified into class 3 (poor provision of short-term contraceptive methods but moderate the long-term methods), the quality of FP services in villages tends to be poor rather than moderate.

GDP per capita has a significant positive impact on the classification of FP services at villages. The higher GDP per capita the provinces, the more likely the villages had good or moderate FP services rather than poor services.

The correlation between class 1 and class 2 of village FP services at province level is 0.229, indicating the correlation between the two classes at province level is relatively small.

Table 5.15: Parameter estimates of single- and two-level multinomial logistic models from fitting data on family planning services in villages

	Outcome Category[&]	Single-level model: Model-1 Coefficient(s.e.)	Two-level models: Model-2 Coefficient(s.e.)	Model-3 Coefficient(s.e.)	Model-4 Coefficient(s.e.)
Fixed Effects					
Intercept term	Class 1	0.226 (0.392)	0.674 (0.522)	1.611 (0.869)	0.851 (0.517)
	Class 2	1.581 (0.292) **	1.906 (0.538) **	1.288 (0.865)**	1.111 (0.523)*
Level-1 variable					
Vill. income	Class 1	1.227 (0.186) **	1.089 (0.227) **	0.838 (0.251) *	0.809 (0.221)**
	Class 2	0.891 (0.185) **	0.642 (0.234) **	0.352 (0.249)	0.332 (0.227)
FP services at FPSCs					
No a FPSC	Class 1	1.579 (0.598) **	1.565 (0.651) *	1.483 (0.667) *	1.533 (0.616)*
	Class 2	0.040 (0.556)	-0.010 (0.652)	0.013 (0.633)	-0.011 (0.600)
Class 1 (good short- and long-term methods)	Class 1	1.673 (0.433) **	1.318 (0.474) **	1.150 (0.482) *	1.430 (0.434)**
	Class 2	-0.030 (0.351)	-0.463 (0.446)	-0.613 (0.427)	-0.451 (0.385)
Class 3 (poor short- and moderate long-term methods)	Class 1	1.232 (0.424) **	1.161 (0.461) *	1.010 (0.456) *	1.239 (0.442)**
	Class 2	-0.531 (0.335)	-0.726 (0.447)	-0.918 (0.407) *	-0.784 (0.400)*
Level-2 variables					
population policy					
1-child policy	Class 1			-0.081 (0.625)	
	Class 2			-0.135 (0.660)	
1.5-child policy	Class 1			0.612 (0.559)	
	Class 2			-0.029 (0.585)	
Geographical regions					
East	Class 1			-2.677 (1.199) *	-1.005 (0.657)
	Class 2			0.075 (1.093)	0.849 (0.741)
Central	Class 1			-0.530 (0.618)	0.487 (0.434)
	Class 2			1.409 (0.591) *	1.796 (0.460)**
GDP per capita					
	Class 1			4.715 (1.493) **	2.748 (0.713)**
	Class 2			2.299 (1.310) #	1.569 (0.763)*
Rural population					
<60 %	Class 1			-0.181 (0.664)	
	Class 2			0.605 (0.680)	
60 – 70 %	Class 1			-0.064 (0.483)	
	Class 2			0.370 (0.521)	
70 - 75%	Class 1			0.685 (0.647)	
	Class 2			0.791 (0.670)	
Random effects					
Class-1 variance			1.188 (0.760)	0.320 (0.528)	0.194 (0.230)
Class-2 variance			2.009 (1.038)	0.198 (0.511)	0.257 (0.275)
Covariance			1.320 (0.842)	0.380 (0.521)	0.051 (0.243)
DIC		1538.7	1456.4	1462.9	1453.3

& reference category is class 3; *p<0.05, **P<0.01, #p=0.051

Summary of results

Table 5.16 summarises the relationships of characteristics of FP services at townships and villages to province level indicators. We can see that population policy is an important determinant of FP services at grassroots institutions. However, the effects of different population policies on the characteristics of FP services vary at province level. Provinces dominated by 1.5-child policy particularly emphasized FP services at townships and villages. GDP per capita, geographical region and ethnic minority proportion at province level make some contributions to the above differences as well as establishment of FPSCs between provinces. However, there are still some unobserved indicators that may have affected the performance of FP services at FPSCs and in villages. A township with a large population size tends to have good FP services at FPSCs. Weak provision of short-term contraceptive methods at FPSCs results in poor FP services in villages. High income in rural villages is positive associated with the quality of FP services at village level.

Table 5.16: Summary of the associations of characteristics of FP services at grassroots institutions with two level indicators based on multilevel logistic regression analysis

	FPSCs at townships		FP services
Indicators	Estab. of FPSCs	FP services	at villages
Township-village level			
Average annual income	-	-	√
Population size	-	√	-
FP services at FPSCs	-	-	√
Province level			
Population policy	√	√	×
GDP per capita	×	√	√
Geographical region	×	√	√
% of rural population	×	×	×
% of ethnic minorities	√	×	×

Notes: √ significant determinants, × not significant, - not applicable

5.5 Discussion

As a strategy for population control, FP has been persistently promoted in China since the 1970s. FPSC is the primary unit that provides technical services of FP to local couples. Village cadres play important role on the distribution of short-term contraceptive methods and serve as the primary mechanism of FP administration and promotion in rural villages. It is thus not surprising that the majority (93.5%) of townships established FPSCs and 99 per cent of villages had FP cadres in the 2001 survey.

Based on the results of LCAs, two latent variables, each containing three latent classes that capture characteristics of FPSCs or villages, were obtained. As can be seen from the results of LCAs, classifications of the capacity of FP services in villages are ordered: good, moderate and poor for class 1, class 2 and class 3 respectively. However, classification of the capacity of FP services at FPSCs was not amenable to simple ordering. This latent variable conveys two main groups of manifest variables: provision of short-term contraceptives and of long-term contraceptives. An emphasis on long-term contraceptives may reflect strict implementation of population policy (which is different from strict population policy). More discussion on this topic will be addressed below.

Results in this analysis show that provinces dominated by 1.5-child policy or with a small proportion of minority groups are significantly more likely to set up FPSCs. This outcome is expected because "after 1st child to use IUD and after 2nd child to use sterilisation" policy is most likely to be implemented in these provinces and among Han Chinese. Consequently, townships in these provinces are encouraged to set up FPSCs to provide FP surgical services.

Not only the establishment of FPSCs but also the capacity of FP services at FPSCs is affected by population policy. It is notable that, among provinces with a dominant 1.5-child policy, FPSCs are significantly more likely to provide long-term contraceptive methods as well as abortion (because the difference between class 1 and class 2 of the latent variable concerning FP services at FPSCs lies in the availability of long-term contraceptives and abortion). This outcome is consistent with the finding that FPSCs are more likely to set up in provinces dominated by 1.5-child policy.

Economic development is found to be positively associated with provision of short-term contraceptives and negatively associated with long-term methods. These consequences may be because couples in developed areas are better educated than those in less developed areas. Short-term and long-term contraceptive methods are alternatives to achieve fertility regulation. Better-educated couples usually prefer short-term methods rather than sterilisation and Norplant, which would lead to a de-emphasis in the provision of long-term methods at FPSCs in developed areas. Moreover, the developed provinces are more likely to implement the strict 1-child policy. Sterilisation is less favoured in these areas because couples with only one child might expect relaxation of the strict population policy and have more children someday. To have another birth in case of the death or disability of their first child is another consideration for not using sterilisation among one child families. The pattern of FP services at FPSCs in the East region (the most developed region) is consistent with the results of economic development.

A significant difference in FP services between townships is observed in the Central region, where the long-term contraceptive services at FPSCs are much better. Explanation of this consequence is the same as that of 1.5-child policy because the Central region is dominated by 1.5-child policy. Based on the theory that emphasis on long-term contraceptives is related to strict implementation of population policy, population policy is thus more strictly implemented in provinces with a dominant 1.5-child policy, in economically less developed provinces and in Central region of China than elsewhere.

At village level, FP services are affected by average village income as well as by FP services at FPSCs. Villages with higher household annual income are more likely to have "good" rather than "poor" FP services in villages. The reason seems obvious because rich villages can raise more financial support to provide good FP services. Villages in townships without FPSCs tend to have good FP. However, if FPSCs are poor at providing short-term methods, FP services at villages also tend to be poor. These results seem contradictory but reasonable. The main task of FPSCs is to provide surgical services of FP methods. A township might not set up a FPSC because such services can be obtained from public hospitals, but provision of short-term methods cannot be replaced by hospitals. However, poor provision of short-term methods at

FPSCs may reflect that short-term methods were not emphasized in the townships, which resulted in poor FP services in villages within those townships.

Economic development has positive effects on FP services in villages. This is because villages in more developed areas may receive more support from local governments. Geographical region also shows positive effects on FP services when only this variable is added in the 2-level model: FP services in villages tend to be good or moderate rather than poor in both the East and Central regions (data not shown). When both geographical region and GDP per capita are included the model, the effects of the East region largely disappear. The link between region and FP services is therefore due to the effect of GDP per capita.

While FP services at grassroots institutions were mainly driven by State-centric birth plans before the 1994 Cairo population conference, the national FP programme began to move beyond narrow demographic targets by broadening its goals and liberalizing methods in the late 1990s (*Yu, Lu, and Liu 2001*). The December 2001 Population and Family Planning Law of China further legitimated institutions and policies that authorized FP program methods and goals. Many of them have been operating for decades, including the Article 21 "*Couples of reproductive age who practise family planning shall receive, free of charge, the basic items of technical services specified by the State. The funds needed for rendering the services specified in the preceding paragraph shall, in accordance with relevant State regulations, be listed in the budget or be guaranteed by social insurance plans" (PFPL 2001)*. From the above analysis, it is clear that FP services at grassroots institutions in rural areas of China are unequal between provinces with different population policies, between different geographical regions and between developed and less developed areas, and associated with local population size. These results indicate that these reforms are far from complete in principle and far from completed in practice. Nevertheless, since the 2001 NFPRHS was conducted only about 5 years after changes in national FP program methods, it is unrealistic to see great improvement during such a short period. Though no hard evidence exists to assess the current status of FP services at grassroots institutions throughout China, based on my personal field experience across more than 10 provinces, the inequalities of FP services mentioned above largely remain unchanged. China needs to expand access to FP methods in the less developed rural areas, and the motive for doing so should be clients' needs rather than population targets.

Limitations

There are some limitations in this analysis. First, as mentioned in Chapter 3, the nature of FP services at township level are limited to the FP sector that is under the administration of NPFPC. The public health sector also provides FP services. Since free contraceptive services are mainly provided by the NPFPC, characteristics of FP services at FPSCs represent the dominant but not the entire FP service. Moreover, quality of care in FP services is a multidimensional issue that may be defined and measured differently. The basic definition of quality of care in FP services defined by Bruce (1990) contains six elements: 1) choice of contraceptive methods, 2) information given to patients, 3) technical competence, 4) interpersonal relationships, 5) continuity and follow-up, and 6) the appropriate constellation of services. We only have data on the choice of contraceptive methods, which may partly reflect competence in the other 5 elements, but is obviously inadequate to measure the overall quality of FP services.

Second, in multilevel logistic regression analysis, some level-2 predictors were excluded from the final model due to statistical non-significance. Statistical significance may differ when using different reference groups. I mainly chose the category that has extremely low or high proportion of a dependent variable as the reference group. Even so, non-significance of a variable does not necessarily mean no effect at all the variable on the outcome measure.

Thirdly, level-2 (province level) variances remain significant or marginally significant in models fitting data of FP services at FPSCs and in villages, suggesting there are unknown predictors that contributed to the differences of outcome responses at province level. We could not do further analysis due to data limitation.

Chapter 6: Fertility, Abortion and Sex Ratio at Birth in Provinces Dominated by One-Child Policy

6.1 Introduction

China's 1-child policy is unique in the history of the world for population control. It was initiated in 1979 and planned to be implemented for one generation. However, after 40 years, its end is not in sight. As well as its effect on reducing the fertility level, the 1-child policy has had a variety of other effects, i.e. increasing the risks of induced abortion and imbalanced SRB and accelerating population aging (*Zeng et al. 1993; Sun 2003*; *CRCA 2008*).

In view of the negative effects of the 1-child policy, some researchers have suggested that the government relax the strict policy, but this suggestion has not been adopted by the government due mainly to concerns of a quick rebound of fertility. This is possible because large family and son preference is a very long tradition in China and might not be eliminated by government's authoritarian efforts during just 40 years. On the other hand, there is little evidence to show the potential consequences if the strict population policy is relaxed. It is unrealistic to do an intervention study for this purpose. Nonetheless, we have seen a natural experiment to examine effects of the policy modification on reproduction in China, namely to compare reproduction between provinces dominated by different population policies. Since China has been a united country for thousands of years, the traditional values are similar nationwide, particularly those associated with family size and sex of children. Strict population policy is mainly implemented in developed areas. Evidences from developed countries show that economic development leads to decline of fertility *(Kohler, Billari & Ortega. 2006*). Thus we expect that fertility rebound after policy relaxation in areas carrying out strict population policy would not exceed the level in the less-developed areas where more lenient population policies are currently implemented. If we know what extent and in what way that different population policies affect reproduction, this knowledge would inform the government to take wiser actions to meet the challenges that we are now facing. This gives me a good reason to conduct this study.

Starting in this chapter, I will explore the fertility, abortion and SRB in sites dominated by different population policies. Through which, I hope to produce some solid evidences for policy-makers and family planning programme-managers to re-think current population policies and strategies and modify them in favour of the country in the long run. Similar studies are rarely seen in literatures.

The main hypotheses of this chapter are that fertility level and progression to second birth will be low, abortion rate before and after the first birth will be high and sex ratio at birth (SRB) of the first birth will be imbalanced. This chapter is arranged to report parity progression ratios (PPRs), total fertility rates (TFR_{ppr}) and birth interval first, followed by examining predictors of the second birth. Section 6.3 calculates abortion rates before and after a first birth and presents factors that are associated with risks of abortion after the index birth. Section 6.4 assesses SRB of the first and second births during 1979-2000 and explores predictors of a male child as a first or a second birth in 1990s. Section 6.5 contains some discussion and summary of the chapter.

6.2 Fertility level and birth interval between first and second births

6.2.1 PPR and TFR_{ppr}

Considering data accuracy and availability, I select births that were born between 1986 and 2000 in this analysis. The progression from woman's own birth to her first marriage, first marriage to first birth, first to second birth, second to third birth, and third and higher order to fourth and higher order birth, denoted $P_{B\text{-}M}$, $P_{M\text{-}1}$, $P_{1\text{-}2}$, $P_{2\text{-}3}$ and $P_{3^+\text{-}4^+}$, were calculated. Based on which, TFR_{ppr} is computed using equation 3.2 on page 49. A "true parity cohort" approach is used to calculate PPRs between 1986 and 1991 because the births of a given order occurring to the women in the sample during 10-years period are available. A "synthetic parity cohort" approach is used to calculate PPRs for years after 1992 because the observed period is less than 10 years after index births.

The resulting series for the years 1986-2000 are shown in Table 6.1. These series are plotted together in Figure 6.1. As can be seen from this figure, there were very small changes across the whole period in the progression from a woman's own birth to her marriage ($P_{B\text{-}M}$) and from her marriage to the first birth ($P_{M\text{-}1}$). Both series are close to one, with a slight decrease of $P_{B\text{-}M}$ in 2000 (0.937), indicating almost all women married and had at least one child.

The progression from first to second birth, P_{1-2} follows a different trajectory. Starting at a value of 0.532 in 1986, P_{1-2} declined to 0.362 in 1991, then slightly rose during the following three years and moved downward again after 1994 to 0.224 in 2000. The series of P_{1-2} tells us that less than a half of women have had a second birth since 1989 when the 1-child policy was intensified. By the year 2000, less than one-fourth of couples had a second birth.

The ratios P_{2-3} followed a trajectory similar to P_{1-2}. They gradually declined from 0.248 in 1986 to 0.088 in 2000 with several small waves. The ratios $P_{3^+-4^+}$ are close to those of P_{2-3} before 1994. However, they moved steeply up and down afterwards. The fluctuations of $P_{3^+-4^+}$ during the last few years preceding the survey may be because the numbers of women with three or more children during these years are small.

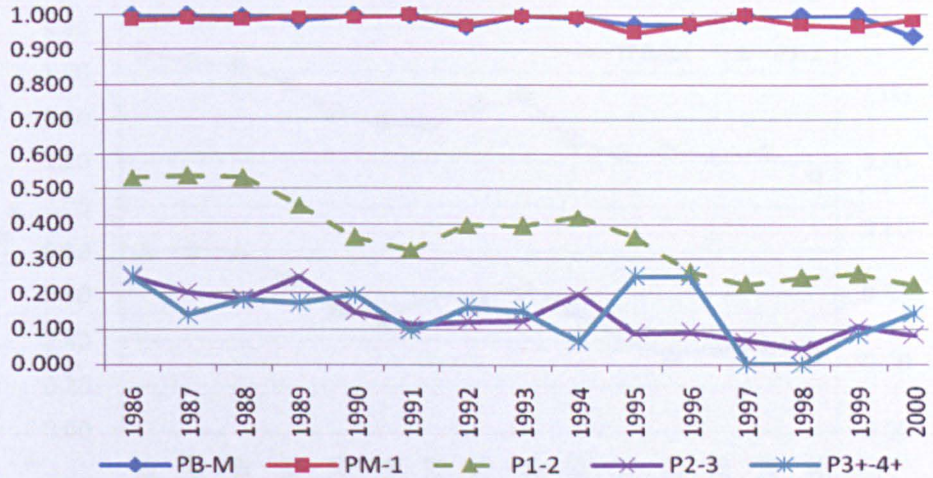
The values of TFR_{ppr} between 1986 and 2000 are shown on the far right column in Table 6.1. The fertility rates declined from 1.69 in 1986 to 1.15 in 2000 with a small wave in 1993-94. As already shown, the policy fertilities in provinces dominated by 1-child policy range from 1.06 to 1.27. Thus, the TFR_{pprs} in rural areas of these provinces have been within this range since 1996.

Table 6.1: Period parity progression ratios and total fertility rates (TFR_{ppr}) in provinces dominated by 1-child policy: 1986-2000

	Progression					TFR_{ppr}
Year	P_{B-M}	P_{M-1}	P_{1-2}	P_{2-3}	$P_{3^+-4^+}$	
1986	1.000	0.986	0.532	0.248	0.250	1.69
1987	1.000	0.990	0.538	0.204	0.139	1.65
1988	0.998	0.986	0.532	0.184	0.182	1.62
1989	0.984	0.995	0.453	0.248	0.171	1.56
1990	1.000	0.995	0.362	0.148	0.195	1.42
1991	1.000	1.000	0.324	0.112	0.095	1.36
1992	0.966	0.971	0.396	0.120	0.160	1.36
1993	0.998	0.997	0.395	0.123	0.150	1.45
1994	0.991	0.996	0.421	0.199	0.064	1.49
1995	0.974	0.951	0.364	0.088	0.250	1.30
1996	0.974	0.974	0.263	0.091	0.250	1.23
1997	1.000	1.000	0.226	0.066	<0.001	1.24
1998	1.000	0.974	0.246	0.043	<0.001	1.22
1999	1.000	0.967	0.256	0.106	0.083	1.24
2000	0.937	0.986	0.224	0.082	0.143	1.15

Notes: P_{B-M}, P_{M-1}, P_{1-2}, P_{2-3} and $P_{3^+-4^+}$ are defined as the progression from woman's own birth to her first marriage, first marriage to first birth, first to second birth, second to third birth, and third and higher order to fourth and higher order birth, respectively

Figure 6.1: Period parity progression ratios for provinces dominated by 1-child policy: 1986-2000



Notes: see Table 6.1

Table 6.2 shows the estimated numbers of births in 1990 and 1999 by birth order. Recall that $P_{B\text{-}M}P_{M\_1}$ is the expected number of first births, $P_{B\text{-}M}P_{M\text{-}1}P_{1\text{-}2}$ is the expected number of second births, and so on. The data in 2000 are not used because they are more likely to be underreported. Differences in the estimates between the two calendar years and percentage of the total difference are also computed. As can be seen from the table, 63.8 per cent of the change in TFR_{ppr} between the two calendar years stems from change in the second birth, but only 15 to 16 per cent from changes in the first or third birth. Less than 5 per cent is due to the change of the fourth or higher order birth.

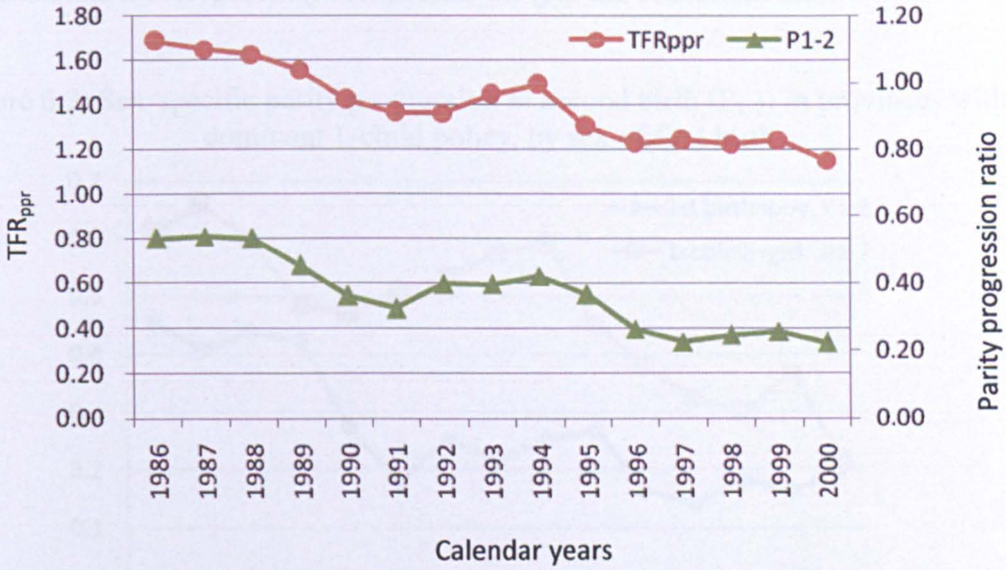
Table 6.2: Decomposition of the change in the total fertility rate (TFR_{ppr}) between 1990 and 1999 into components attributable to change in each birth order, in provinces dominated by 1-child policy

	B1	B2	B3	B4+	TFRppr
Exp. number of birth in 1990	0.995	0.360	0.053	0.010	1.419
Exp. number of birth in 1999	0.967	0.248	0.026	0.002	1.243
Difference between 1990-1999	0.028	0.112	0.027	0.008	0.176
% of total difference	16.14	63.78	15.39	4.67	100

Notes: B1=$P_{B\text{-}M}*P_{M\text{-}1}$=expected number of first birth; B2= $P_{B\text{-}M}*P_{M\text{-}1}*P_{1\text{-}2}$=expected number of second birth; B3= $P_{B\text{-}M}*P_{M\text{-}1}*P_{1\text{-}2}*P_{2\text{-}3}$=expected number of third birth; B_4^+= $P_{B\text{-}M}*P_{M\text{-}1}*P_{1\text{-}2}*P_{2\text{-}3}*P_{3^+\text{-}4^+}/(1-P_{3^+\text{-}4^+})$ =expected number of fourth or higher order birth

Comparison of trends in TFR_{ppr} and in progression to second birth is elaborated in Figure 6.2. The shapes of the two series are very similar, which also indicate the TFR_{ppr} is mainly influenced by $P_{1\text{-}2}$ in provinces dominated by 1-child policy during the observed period.

Figure 6.2: Total fertility rates based on parity progression ratios (TFR_{ppr}) and progression to second birth (P_{1-2}) for provinces dominated by 1-child policy: 1986-2000

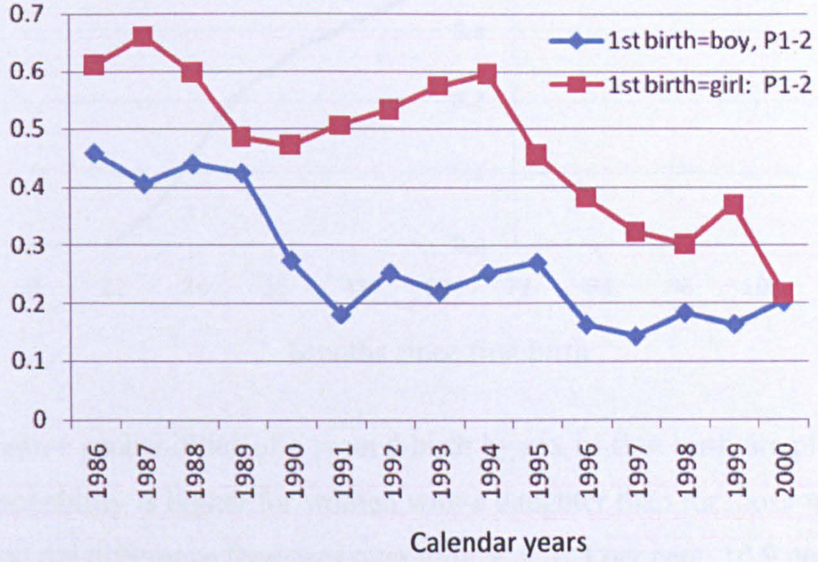


6.2.2 Decomposition of progression to second birth by sex of first birth

Sex of the first birth is a crucial factor affecting the probability of a second birth. Accordingly, the ratios of P_{1-2} are decomposed into two components by sex of first birth, denoted P_{1-2}-boy if first birth is a boy and P_{1-2}-girl if the first birth is a girl. As can be seen in Figure 6.3, the ratios of P_{1-2}-girl are higher than those of P_{1-2}-boy between 1986 and 1999. These results are expected and may reflect the implementation of a 1.5-child policy in some rural areas even in provinces with a dominant 1-child policy. However, son preference may partly contribute to higher level of P_{1-2}-girl because some couples might have an unapproved second birth if they had only one daughter. The two series converge in 2000. This result is perhaps due to underreporting of second births for women with only a daughter. Previous study (Zhang 2004) demonstrated that underreporting was more likely to occur in the last few years before survey, especially by couples without a son.

Close scrutiny of Figure 6.3 reveals large differences between P_{1-2}-girl and P_{1-2}-boy during 1990-1994. The ratios of P_{1-2}-girl slightly increased during this period but those of P_{1-2}-boy dropped sharply in1990 and 1991 and then fluctuated slightly during 1992 - 1994. As we know, China's population policy was intensified in 1989 and became more stringent when the responsibility system was introduced in 1991. The increasing gap between the two ratios for the years 1990-94 may reflect these policy changes. China adopted new FP approaches after the 1994 Cairo International Conference on Population and Development (ICPD). Thus the gap has somewhat narrowed since 1995.

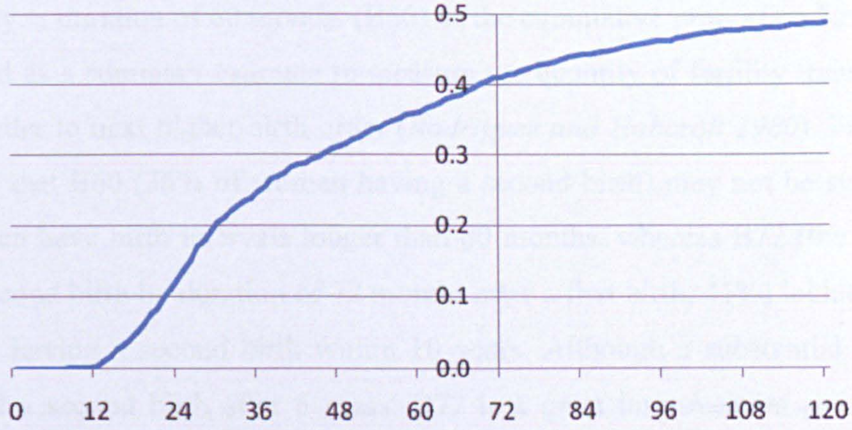
Figure 6.3: Sex-specific parity progression to second birth (P_{1-2}) in provinces with a dominant 1-child policy, by sex of first birth



6.2.3 Cumulative probability of second birth within 10 years after a first birth

There are two aspects of interest in fertility in this study. One aspect is the parity progression ratio, which is related to the quantity of fertility. The other aspect is the time it takes to make the transition from one parity to the next for those women who continue reproduction, or the distribution of birth intervals, which is related to the timing of fertility. Figure 6.4 shows the transition from first to second birth in provinces dominated by 1-child policy. This analysis is focused on the 3094 women who had their first birth between 1979 and 1995, to allow reasonable exposure to the 'risk' of a second birth. Six years of waiting time (i.e., 1996 to 2001) is appropriate in this study. I will discuss more on this issue below. As shown in Figure 6.4, the cumulative probability of women having a second birth rapidly increased during 12 - 72 months after a first birth, from zero to 41 per cent. After the 72^{nd} month, the rate slows down, from 41.3 per cent in the 73^{rd} month to 48.5 per cent in the 120^{th} months, with only 7.7 per cent of increase during this four-year period.

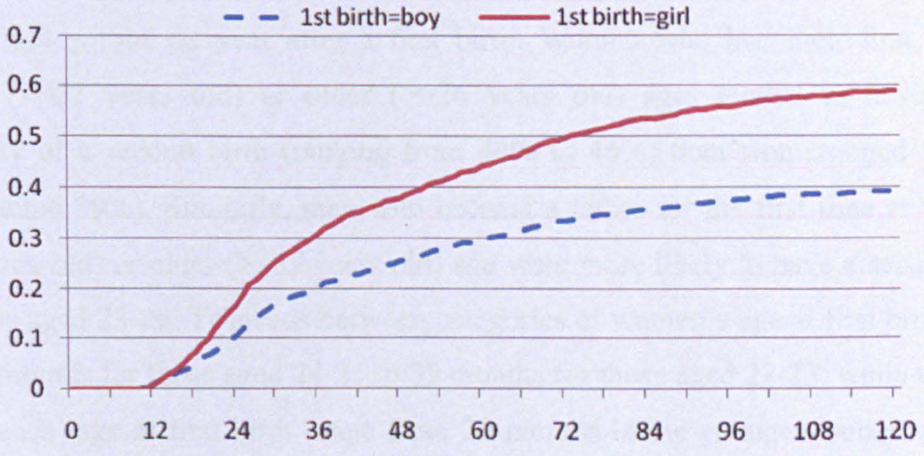
Figure 6.4: Probability of second birth among women who had a first birth between 1979 and 1995 in provinces with a dominant 1-child policy.



Months since first birth

The cumulative probabilities of a second birth by sex of first birth are plotted in Figure 6.5. The probability is higher for women with a daughter than for those with a son at all duration and the difference increases over time, e.g., 6.3 per cent, 10.9 per cent, 12.6 per cent, 14.4 per cent and 16.3 per cent in the second, third, fourth, fifth and sixth year after a first birth, respectively. By the end of the tenth year, the difference reaches 19.7 per cent, indicating that nearly one-fifth more women with only a daughter have a second birth than women with only a son.

Figure 6.5: Probability of second birth among women who had a first birth in provinces with a dominant 1-child policy, by sex of first birth



6.2.4 Probability of a second birth within 72 months after a first birth (B72) and average birth interval (trimean)

Traditionally, a duration of 60 months (B60) of the cumulative proportion having a next birth is used as a summary estimate to measure the quantity of fertility transition from one birth order to next higher birth order (*Rodriguez and Hobcraft 1980*). From Figure 6.4, we see that B60 (36% of women having a second birth) may not be sufficient, as many women have birth intervals longer than 60 months, whereas B72 (the proportion having a second birth by duration of 72 months after a first birth, 41%) included 84.2 of the women having a second birth within 10 years. Although a substantial number of women had a second birth after 6 years, B72 is a great improvement over B60 as a summary measure of parity progression. B84 (having a second birth within 7 years after a first birth) is impractical because that would exclude too many women from the analysis due to incomplete exposure, and B72 includes 92.7 per cent of the women having a second birth within 7 years. Therefore B72 is settled on as the summary indicator to measure the quantum of fertility transition from first to second birth and to calculate the trimean as a measure of speed of progression for each category of selected indicators.

Table 6.3 shows estimates of B72 and trimean for a second birth by women's characteristics. The numbers of women who had at least one birth are shown in the first column of the table. Bivariate analyses show that all the selected women's characteristics are significantly associated with the probability of women having a second child within six year after a first birth. Women who had their first birth at younger (<=21 years old) or older (>=26 years old) ages tended to have higher probability of a second birth (ranging from 44% to 46%) than women aged 22 – 25 years (around 39%). Similarly, men who became a father for the first time at younger (<=22 years old) or older (>=27 years old) age were more likely to have a second birth than those aged 23-26. Trimeans between categories of women's age at first birth range from 31 months for those aged 24-25 to 35 months for those aged 22-23, while trimeans for husbands' age at first birth range from 29 months in the youngest subgroup to 35 months in the subgroup of men aged 23-24. Table 6.3 also shows that the less-educated women had higher probability of a second birth within 6 years after a first birth (48%) than their better-educated counterparts (31%). However, the difference of their average birth intervals is only about one month. About 41 per cent of Han Chinese had a second birth, compared with 47 per cent of those either one or both of a couple belonging to an ethnic minority. The estimate of trimean for ethnic minority groups is 55.8 months, which is much higher than that of Han Chinese (32.5 months). Nevertheless, it is worth noting that the number of ethnic minority groups is small.

Only 244 women preferred a daughter. Of them, 23 per cent had a second birth. Only 199 women preferred a son. Slightly more than two-fifths of them had a second birth. The majority of women were classified into the category of no sex preference. However, the probability of a second birth among them is highest among the three categories (43%). Despite the large difference in B72 between women with daughter preference and the others, the difference in birth intervals is only two months.

Sex of first birth is associated with the probability of a second birth. About 50 per cent of women who had only a daughter had a second birth within six years after a first birth, whilst about one-third of their counterparts did so. The trimean for the former group of women is 32.8 months, one month shorter than that of the latter.

Consistent with the estimates of $P_{1\text{-}2}$ in Figure 6.1, the values of B72 declined with time, from 0.525 for women who had their first birth during 1979-84 to 0.449 for women who had their first birth during 1985-90 and further downward to 0.247 for women whose first birth was born during 1991-95. The probability of a second birth was halved during the 15 years period and the average birth interval was shortest (29 months) for calendar cohort 1985-90 and highest for calendar cohort 1991-95 (44 months), indicating birth interval increased in most recent years.

Table 6.3: Summary measures for birth intervals between first (1979-95) and second birth in provinces dominated by 1-child policy, by individual characteristics

Women's characteristics	N at start	B72	Trimean (months)
Women's age at first birth			
≤21	851	0.444*	33.5
~23	1040	0.388	35.0
~25	803	0.387	30.8
26+	400	0.463	32.5
Husband's age at first birth			
≤22	584	0.463**	29.0
~24	1058	0.370	35.0
~26	749	0.397	32.6
27+	703	0.454	34.5
Women's education			
≤Primary School	1896	0.480**	32.8
Middle School+	1198	0.306	34.0
Couple's minority status			
Both Han Chinese	3013	0.411	32.5
One or both minority	81	0.470	55.8
Women's sex preference			
≤-1	244	0.230**	30.8
0	2651	0.430	32.8
1+	199	0.412	32.8
Sex of 1st birth			
boy	1620	0.335**	33.8
Girl	1474	0.498	32.8
Cohort of 1st birth			
1979-84	952	0.525**	33.5
1985-90	1233	0.449	29.0
1991-95	909	0.247	44.8

A women's sex preference= ideal number of boys – ideal number of girls
* P value <0.05, ** p value <0.01 (test the difference of the probability of 2nd birth within 72 months after 1st birth between categories of each indicator.)

Table 6.4 presents the summary measures for a second birth by categories of indicators at township/village- and province-level. Women from townships with good provision of both short- and long-term contraceptives had the highest probability (56%) of having a second birth within six years after a first birth. Slightly more than a half of women (51%) from townships without a FPSC had a second birth. About one-third (33-35%) of women from townships whose FPSCs were rated poorly in provision of short-term or long-term contraceptives did so. Nevertheless, we see the average birth interval is shortest (30.5 months) in townships with poor provision of long-term contraceptive methods, which is about 3 months shorter than that in townships with good services of both short- and long-term contraceptive methods, 4.5 months shorter than that in townships with poor provision of short-term methods and about 9 months shorter than that in townships without a FPSC. On the other hand, villages with poor FP services tend to have higher probability of a second birth and longer average birth interval than those with good or moderate FP services.

From the indicator of average household annual income in villages, we see that 52.7 per cent of women in poorest villages had a second birth with an average birth interval of 36.8 months. The proportion of women having a second birth in the richest villages is 37.7 per cent with an average birth interval of 30.3 months. The estimate of B72 is generally higher but the average birth interval is longer in the poorer villages. Similar trends of the probability of a second birth and average birth interval are observed for the economic development indicator at provincial level. About 44 per cent of women in the less developed provinces had a second birth with a trimean of 36.5 months, compared with 39 per cent in the more developed provinces with a trimean of 29.8 months. It should be noted that, at the province level, there is considerable overlap between geographical region and GDP per capita. The geographical region is, thus, omitted in this analysis. Probability of a second birth (46.5%) is highest in provinces with a moderate level of rural population, but lowest in Chongqing (35.3%), the only province with more than 75 per cent of rural population. The average birth interval between first and second birth is about 30 months in provinces with less than 60 per cent of rural population. It increases to 35 months in provinces with a moderate level of rural population and further to 41 months in Chongqing. Provinces with less than 3 per cent of ethnic minority groups tend to have lower probability of a second birth (38.1%) but a shorter birth interval (29.8 months) than those with more minority groups (44.0% and 35.2 months).

Table 6.4: Summary measures for birth intervals between first (1979-95) and second birth in provinces dominated by 1-child policy, by village-, township- and province-level indicators

	N at start	B72	Trimean
Township-village level indicators			
Family planning services at township FPSCs			
No a FPSC	490	0.510**	39.3
Good short- but poor long-term meth. provision	1650	0.354	30.5
Good long- & short-term meth. provision	563	0.560	33.3
Moderate long-, poor short-term meth. provision	391	0.327	35.0
Family planning services at villages			
Good	1541	0.403**	33.8
Moderate	1149	0.386	31.8
Poor	404	0.527	36.5
Average household income in villages (Yuan)			
<1200	442	0.527**	36.8
~1900	654	0.497	36.0
~2800	689	0.328	32.5
>2800	1309	0.377	30.3
Provincial level indicators			
GDP per capita (Yuan)			
>9000	1581	0.390**	29.8
<6000	1513	0.437	36.5
% of rural population			
<60	1581	0.390**	29.8
~70	1131	0.465	35.2
>75	382	0.353	40.9
% of minority groups			
<3	1409	0.381**	29.8
~9	1685	0.440	35.3

Notes: see notes in Table 6.3

6.2.5 Predictors of a second birth

Having described the factors affecting the probability of a second birth using bivariate analysis, the relationship between the above variables and the probability of women having a second birth within six years after the first birth are explored using three-level logistic regression models. I begin by fitting a model with a random intercept model that allows the overall probability of a second birth to vary across township-villages and provinces. The binary response is y_{ijk} which equals 1 if woman i in township/village j and province k had a second birth, and 0 if she did not have. Parameter estimates of these models are shown in Table 6.5. Of the models, model 1 is a null model fitting just the overall mean of the data. Model 2 includes level-1 (individual woman) variables, model 3 includes level 1 and level 2 (township-village) variables, and model 4 includes variables from all levlels. An additional random coefficient model (model 5) is fitted to allow effect of sex of first birth to vary between townships/villages.

As can be seen in Table 6.5, education shows a negative effect on the probability of having a second birth, with middle school or higher education being associated with significantly lower probability of having a second birth than their less-educated counterparts. There are several reasons that may contribute to this result. The better-educated women were more likely to work in government departments or government funded agencies with urban/town resident status (*chéngzhèn hùkǒu* [1]). These agencies usually implement a 1-child policy rather than 1.5- or 2-child policy, and strictly enforce the population policy. Couples who do not follow the policy might be dismissed by their employers or heavily fined and lose their bonuses. On the contrary, the less-educated women were more likely to work as peasants or housewives and are less subject to strict population policy. Moreover, they have no fear of losting their job, and hence are more likely to have unapproved births than the better-educated.

Women who had a first birth most recently are also significantly less likely to have second birth than women whose first birth was born in the reference period 1979-84. Several reasons may contribute to this result include: 1) strict population policy encounted strong resistence when it was initiated and unapproved births might be common in 1979-84; 2) a substantial number of women in the reference category might have a second birth immediately after 1984 when the strict policy was relaxed; 3) the policy was tightened in 1989 and further intensified in 1991. Women whose first birth was born during the second period and particularly the third cohort period, had less opportunity to have a second child than the reference group of women; 4) economic development and government's persistent advocacy and incentives (i.e., some benefits to couples who had only one child, particularly those with only one daughter), which would lead people to accept one child, may also play a role in the reduction of second births in more recent years.

It is expected that women whose first birth was a girl are significantly more likely to have a second birth. The log-odds of having a second birth is about 1.25 times for a girl's mother than for a boy's mother in random intercept models (model 2, 3 and 4). The reason can be partially attributed to the 1.5-child policy, which allows couples who had only a daughter to have a second birth, although the proportion of couples subject to this policy may be small in provinces dominated by 1-child policy. Another obvious reason is son preference. Couples who had a daughter would be more likely to take a risk (i.e., financial penalty) for an unapproved second child in the hope of getting a son. Nevertheless, the parameter estimate for the category of women's son preference is not statistically significant, even though it shows a positive relationship to the likelihood of a second birth. This result reflects the small sample size of this category. Compared with women who had daughter preference, those who had no sex preference are significant more likely to have a second birth. As already discussed, the indicator of women's sex preference in this study may be partly rationalized to existing children. Women who had only a daughter may be more likely to be satisfied with the only child and would not have more children, whereas women who had no sex preference may want more children no matter the sex of the first birth, recalling that wanting one son and one daughter is very common in rural China (*Chen and Zhang 2003*).

Neither women's nor their husbands' age at first birth is significantly associated with the probability of a second birth. Obviously, whether or not to have a second birth is less affected by couple's age but depends more on fertility regulation, how strong their son preference is and other factors.

FP services at FPSCs have significant effects on the probability of women having a second birth within 6 years after a first birth. Women who were from a township without a FPSC or a township that provided good services of both long- and short-term contraceptive methods were significantly more likely to have a second birth than those from a township that had good provision of short-term but poor provision of long-term methods. The possible reasons for these results may be that good FP provision of long-term contraceptive methods in townships is a reaction to high level of second births; townships without a FPSC are more likely to be located in the less developed areas where population policy is less strictly implemented. FP services in villages show no effect on the probability of having a second birth after controlling for FP services at townships' FPSCs, economic predictors at village- and province-level and other variables.

Average household annual income in villages shows a significant association with the likelihood of a second birth, with women from higher income villages being less likely to have a second birth. Similar association was seen for the economic indicator at provincial. Perhaps women from more developed areas are more likely to prefer small family size and have less strong son preference.

Compared with women in provinces with less than 60 per cent of rural population, those from provinces with a higher fraction of rural populaiton were significantly less likely to have a second birth. This result is somewhat surprising because it is generally beleved that provinces with more rural population tend to have a higher probability of a second birth. I suspect that population policy in provinces with less than 60 per cent of rural population may be strict in urban areas but less strict in rural areas, while in provinces with more rural population, like Chongqing (rural population >75%), strict population policy is also emphasised in rural areas. As a consequence, rural women in province with more rural population are less likely to have a second birth.

From the random effects, we can see that the overall high-level variance reduced from 3.491+1.363=4.854 in the null model to 3.903+0.401=4.304 in model 2, 3.260+0.763=4.023 in model 3 and further to 3.259+0.041=3.3 in model 4, indicating that predictors from women-level, township/village-level and province-level partly explain variation between high-level units. The DIC statistics slightly declined from 2907 in model 2 to 2894 in model 3 and 2888 in model 4, suggesting the 3-level logistic models, with more predictors included, is a slight improvement. Moreover, we see that level-2 (township/village) predictors particularly reduced level-2 variance and level-3 predictors particularly reduced level-3 variance. Nonetheless, level-2 variance is still statistically significant even when all the three-level predictors are included (model 4), indicating there are still some important but unmeasured factors that are responsible for the different probabilities of a second birth between townships/villages. Comparing level-2 constant variance with that of level-3, the vast majority of unexplained variation in the probability of a second birth is between townships/villages within a province rather than between provinces. This result is expected because the data used in this chapter are from provinces dominated by 1-child policy and thus variation between provinces should be small.

So far, I have allowed the probability of a second birth to vary across townships/villages and across provinces, but have assumed that the effects of the explanatory variables are the same for each township/village and province. I now modify this assumption by allowing the effect of sex of first birth to vary between townships/villages. To allow for this effect, it is necessary to introduce a random coefficient for sex of first birth at level-2. Parameter estimates of this random coefficient model (model 5) are shown in the far right column in Table 6.5. Random coefficient models that allow effects of other individual-level variables to vary between level-2 and/or level-3 units are also examined but none is significantly different. These models are omitted in Table 6.5.

The DIC statistic declines from 2888 in model 4 to 2841.2 in model 5, indicating that random coefficient model contributes to explain variation in the probability of women having a second birth between townships/villages. From the fixed effects of model 5, we see that the predicted average probability of a second birth within six years after a first birth is $e^{1.345}$=3.84 times higher for a woman who had only a daughter than for a woman who had only a son. The significant random effect indicates the odds ratios (ORs) vary between townships/villages.

As demonstrated by Steele (*2008*), in a random coefficient model, the between-group variance is a function of the variance with the random coefficient. When a dichotomous *X* had a random coefficient associated with it, the between-group variance can be obtained by

$$\text{For } X=0,\ \mathrm{Var}\,(u_{0j}+u_{1j}X_{ij})=\sigma^2_{u0} \quad (6.1)$$

$$\text{For } X=1,\ \mathrm{Var}\,(u_{0j}+u_{1j}X_{ij})=\sigma^2_{u0}+2\sigma_{u01}+\sigma^2_{u1} \quad (6.2)$$

Substituting estimates of σ^2_{u0} , σ_{u01} and σ^2_{u1} obtained from model 5, the between-township/ village variances are: 3.702 for women whose first birth was a son, and 3.702+2*(-0.334) + 1.485=4.519 for women whose first birth was a daughter after accounting for effects of all other predictors from different levels. We can therefore conclude that there are larger between-township/village difference in the probability of having a second birth within six years after the first birth for women with a daughter than for women with a son.

We can test the signficance of the added parameters, σ_{u01} and σ^2_{u1}, using a Wald test. The test statistic is 9.320, which approximately chi-squared distributed on 2 d.f. (p = 0.009), which implies that the effect of sex of first birth does vary across townships/villages.

I have also examined the interaction of the effect of sex of first birth with that of FP services at FPSCs and average household annual income (level-2 variables). However, the addition of interaction effects do not explain between-township/village differences in attainment trends, The estimated coefficients (standard errors) of interaction terms (sex of first birth *categories of FP services at FPSCs) are -0.652 (0.377), -0.128(0.349) and -0.576(0.431), respectively. None of them are statistically significant at the 0.05 level. Similarly, none of the interaction terms between sex of first birth and average household annual income in villages are statistically significant. Models with interaction terms are thus omitted here.

Table 6.5: Parameter estimates of logistic regression models from fitting data on second births in provinces dominated by 1-child policy

Predicators (reference category)	Model 1 Coeff.	Model 1 s.e.		Model 2 Coeff.	Model 2 s.e.	Model 3 Coeff.		Model 3 s.e.	Model 4 Coeff.		Model 4 s.e.	Model 5 Coeff.		Model 5 s.e.
Fixed effects														
Intercept term	-0.890	0.275	**	-0.712	0.416	-0.897	*	0.425	1.385	**	0.506	1.814	**	0.437
Individual level (level-1)														
Woman's age at 1st birth (ref: ≤ 21 years old)														
~23				-0.056	0.136	-0.031		0.140	-0.038		0.143	-0.071		0.149
~25				-0.217	0.159	-0.193		0.159	-0.225		0.161	-0.243		0.169
26+				-0.175	0.205	-0.160		0.202	-0.201		0.195	-0.176		0.214
Husband's age at 1st birth (ref: ≤ 22 years old)														
~24				0.047	0.153	0.035		0.156	0.043		0.158	0.042		0.166
~26				-0.153	0.147	-0.154		0.183	-0.134		0.179	-0.152		0.184
27+				-0.112	0.180	-0.119		0.185	-0.095		0.186	-0.109		0.191
Women's education (ref=Primary School or below)														
Middle School or above				-0.402**	0.119	-0.348	**	0.120	-0.333	**	0.121	-0.338	**	0.128
Cohort of 1st birth (ref =1979-84)														
1985-90				-0.597	0.441	-0.734		0.524	-0.659	*	0.298	-0.682	*	0.289
1991-95				-2.149**	0.504	-2.083	**	0.538	-2.157	**	0.300	-2.293	**	0.358
Sex of 1st birth (ref=Boy)														
Girl				1.243**	0.114	1.249	**	0.110	1.256	**	0.112	1.345	**	0.137
Women's sex preference (ref: ≤ -1)														
0				0.670**	0.202	0.612	**	0.217	0.660	**	0.200	0.626	**	0.231
1+				0.374	0.296	0.339		0.310	0.383		0.285	0.343		0.318

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Table 6.5: Continued from previous page

	Model 1		Model 2		Model 3		Model 4		Model 5	
Predictors (reference category)	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Township-village level (level-2)										
Average income at village					-1.047 **	0.269	-1.258 **	0.280	-1.320 **	0.282
FP services at FPSCs (ref=good short, poor long)										
No a FPSC					1.432 **	0.386	1.668 **	0.374	1.892 **	0.469
Good short- & long-term method provision					1.130 **	0.351	1.350 **	0.357	1.466 **	0.385
Poor short-term, moderate long-term method provision					0.298	0.406	0.660	0.424	0.746	0.457
FP services at villages (ref=good quality)										
Moderate					-0.276	0.232	-0.315	0.241	-0.368	0.238
Poor					0.458	0.320	0.554	0.315	0.590	0.341
Province level (level-3)										
GDP per capita (centred log value)							-2.345 **	0.603	-2.918 **	0.502
% of rural population (ref: <60)										
60-70							-3.774 **	0.907	-4.388 **	0.806
>75							-4.431 **	0.858	-5.013 **	0.815
% of minority groups (ref: <3%)										
-9							0.147	0.558	0.101	0.658
Random effects										
Township-village level:										
Constant variance	3.491**	0.450	3.903	0.509**	3.260 **	0.433	3.259 **	0.437	3.702 **	0.592
Variance of sex of 1st birth									1.485 **	0.487
Covariance: sex of 1st birth * Constant									-0.334	0.413
Province level:										
Constant variance	1.363	0.719	0.401	0.395	0.763	0.485	0.041	0.071	0.035	0.066
DIC	3051.2		2907.4		2894.1		2888.0		2841.2	

* p value <0.05, ** p value <0.01.

Using Normal probability plots, where the ranked residuals are plotted against corresponding points on a Normal distribution curve, we can check Normality assumptions for high-level units. As can be seen in Figure 6.6, the plots at township/village-level and province-level are linear, which suggests that the assumptions of Normality at level 2 and level 3 for models 4 and 5 are reasonable.

Figure 6.6: Province- and township/village-level normal plots for the residuals of models 4 and 5

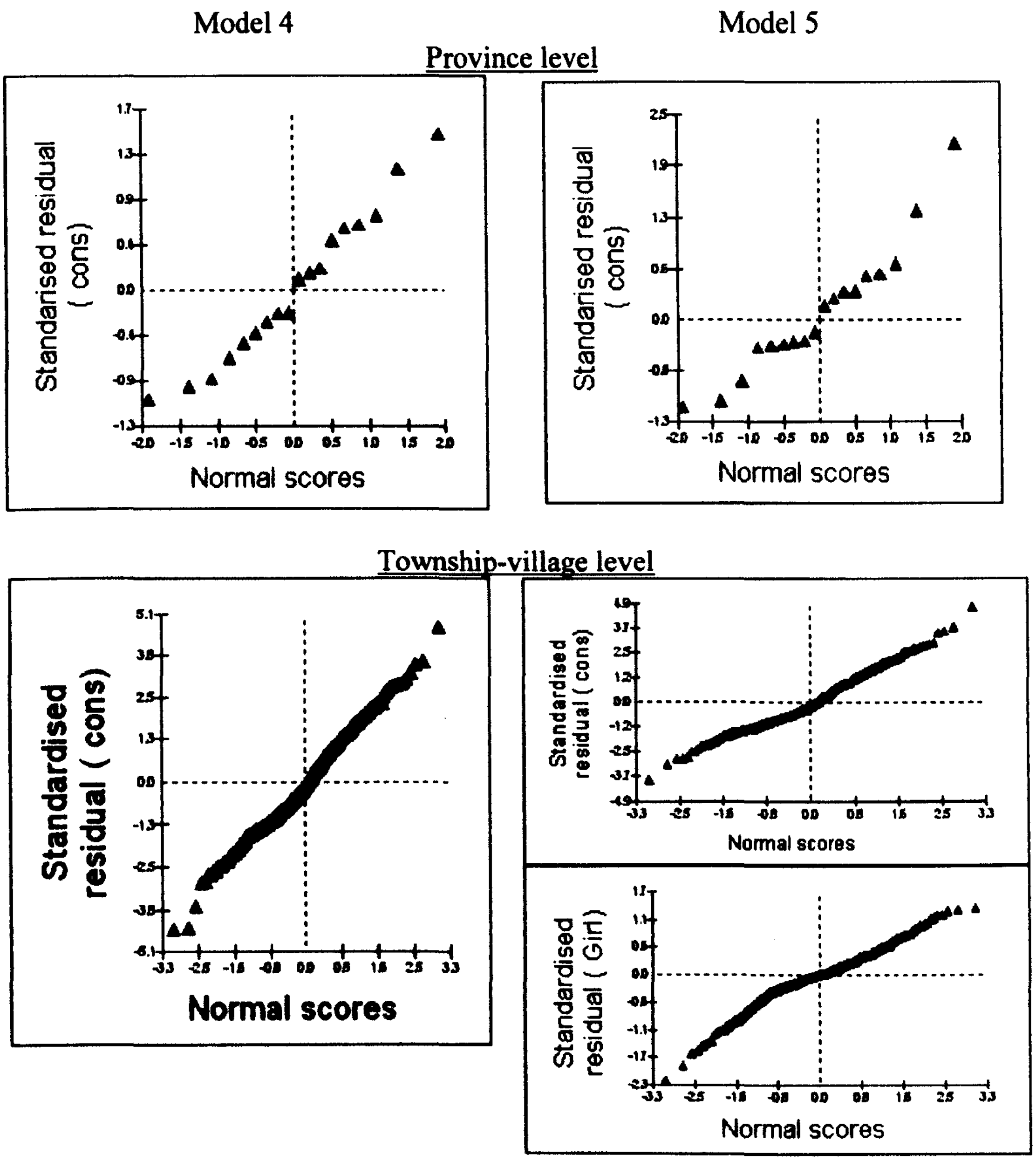
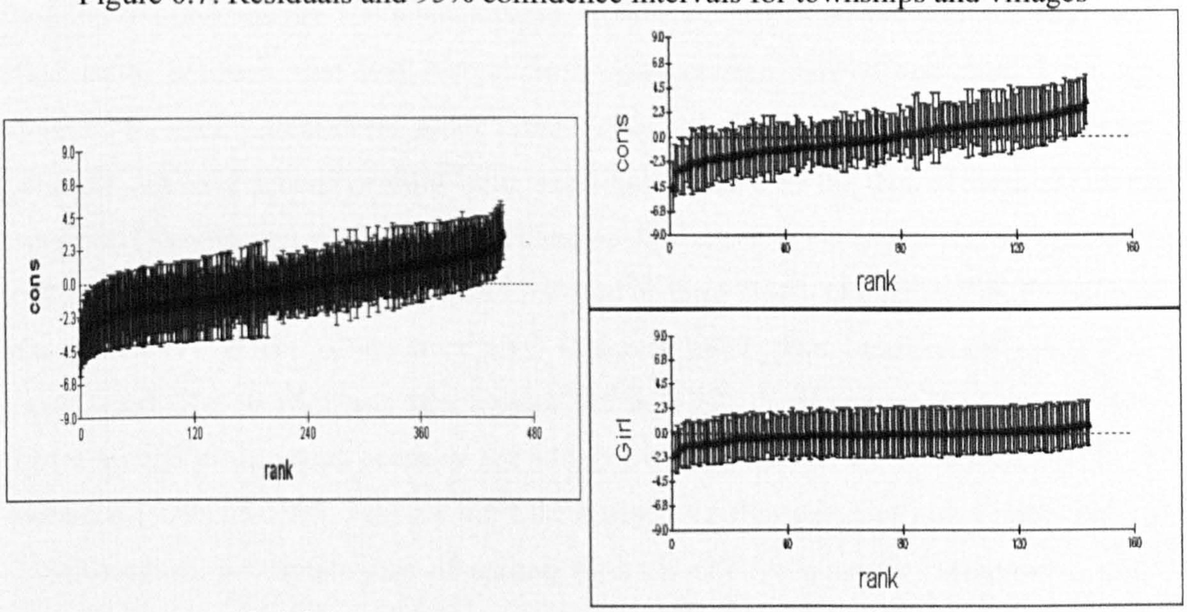


Figure 6.7 contains three 'caterpillar' plots that show township/village-level residual estimates with 95% confidence intervals (CI) for models 4 and 5. Each residual represents the township/village's departure from the overall average predicted by the

fixed parameters in the corresponding model. Townships/villages with less than average probability of a second birth appear below the horizontal line at zero, depicting the average experience. Townships/ villages with higher than average probability appear above it. The 95% CI helps to determine whether a township/village differs significantly from the average. If the confidence interval overlaps zero, we conclude that it does not differ significantly from the average. Conversely where it is not the case, we conclude it does. We can see that, in the three plots, there is a cluster of townships/villages whose mean probability of a second birth within six years after a first birth is significant lower than average. At the other extreme, there is a cluster with above-average probability of a second birth. The residuals at province level are not plotted because level-3 variances of all fitted models were not statistically significant, which means the 95% CI of residuals that represent province departures from overall mean overlap the line at zero.

Figure 6.7: Residuals and 95% confidence intervals for townships and villages



Model 4 Model 5

6.3 Abortion

Even though the Chinese government has always claimed that abortion is not a contraceptive but a back-up method, previous studies showed that the likelihood of abortion is closely related to China's population policy (*Qiao and Suchindran 2006*). However, the causes of abortion can be various. Contraceptive failure, inconsistency with policy requirements and selective abortion due to son preference have been demonstrated as the leading causes of abortion in China (*Che and Cleland 2001; Li et al. 2004; Qiao and Suchindran 2006; Tong et al. 2002*). In this section, I calculate abortion rates before and after the index birth in provinces dominated by 1-child policy and by sex of first birth. Risk factors of abortion after a first birth are also explored.

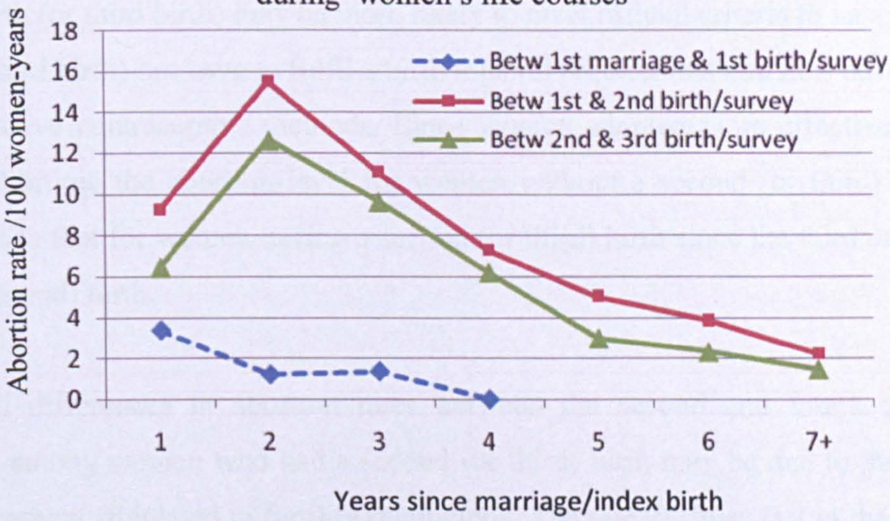
6.3.1 Abortion rate

The 3094 women who had their first birth between 1979 and 1995 in provinces dominated by 1-child policy are included in this analysis. The period of 1979-95 is chosen for consistency with the fertility analysis. Moreover, an abortion may occur several years later after a birth. This period also provides complete abortion information for six years after a first birth and thus avoids selection bias due to incomplete abortion history of women who had a first birth in more recent years. Six-year duration is also long enough to observe abortion trends after birth. The abortion rate is measured by number of abortions per 100 women years. Numbers of abortions between marriage and first birth, between first and second birth and between second and third birth are counted for each year after the index events (marriage, first or second birth). For women who did not have second or third birth, exposure is ended by the date of sterilization or survey (if sterilisation was not used). Otherwise, exposure is measured between dates of two consecutive events (marriage, first, second or third birth). Owing to data limitations, the protective effect of contraceptive methods other than sterilisation cannot be considered. The abortion rate after a second birth is calculated among 1512 women who had a second birth, which accounts for 48.9 per cent of women who had their first birth between 1979 and 1995. I do not limit the analysis of abortion after index births before 1996 because the sample size of second births is relatively small. Furthermore, only about 11.8 per cent of second births were born after 1995.

The overall abortion rates in provinces with a dominant 1-child policy are 2.63 per 100 women-years before the first birth, 6.27 per 100 women-years after the first birth and 5.28 per 100 women-years after the second birth. Figure 6.8 shows the abortion rates and trends during these three specified periods over women's life courses. This figure shows that the abortion rate between marriage and first birth is very low and monotonically declines from 3.35 per 100 women-years in the first year to zero in the fourth year after marriage. The first-year abortion rate after the first birth is about 9 per

100 women-years. It sharply increases to nearly 16 per 100 women-years in the second-year, but rapidly declines in the following three years. During the last few years, abortion rates drop slowly. The abortion trend after a second birth is similar to that after a first birth, but the abortion level is about 2 points lower than that after a first birth for each respective year.

Figure 6.8: Abortion rate (/100 women-years) and trend in three reproductive phases during women's life courses



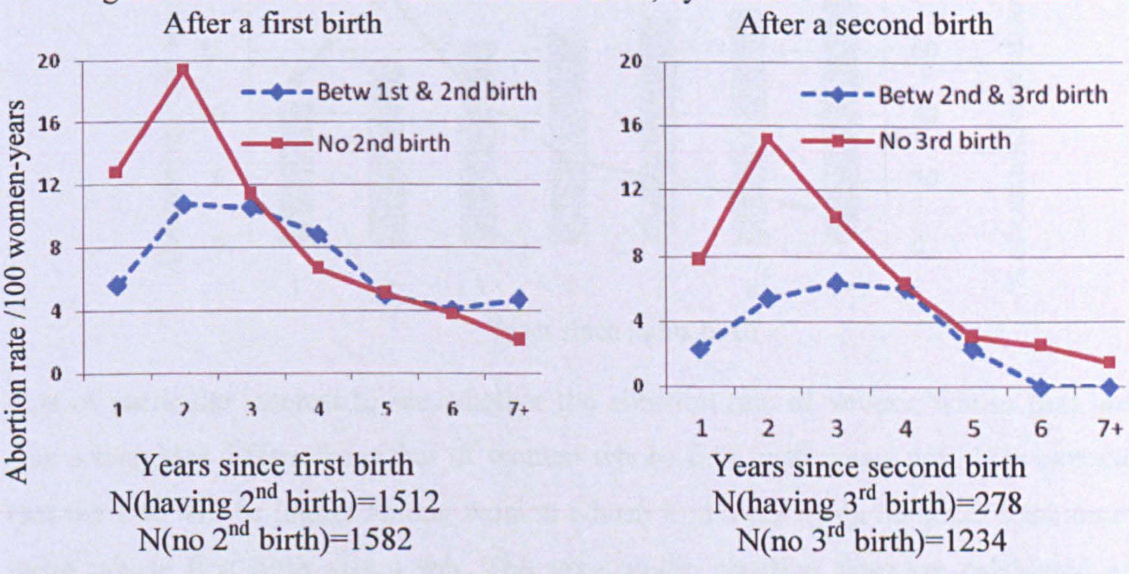
In view of the likelihood that abortion behaviour for women who had a second or third birth may be different from that for women who had only one or two births, I calculate the abortion rates by women's status of next birth after an index birth. The results are shown in Figure 6.9. The left-side graph in Figure 6.9 displays abortion rates and trends after a first birth. This graph shows that the abortion trends during the first two years after a first birth are similar for women having a second birth and those without a second birth, but the abortion level is nearly two times higher for women without a second birth than for those who had it. The two series overlap in the fifth and sixth year with small differences in other years. Another feature that can be seen from the graph is that, among women who had a second birth, the abortion rate declines very slowly between 2nd and 4th years, but moves down fast in the fifth year after a first birth.

The right-hand graph shows the abortion rates and trends after a second birth among women having a third birth and those who did not. The trends of the two series look fairly similar to those in the left-side graph, with slightly lower abortion rates. These results may reflect similar risk factors of abortions before and after a second birth.

The big differences of the first- and second-year abortion rates between women with and those without a further birth may partly be due to their different status of next birth. More pregnancies for women with no further birth must end in an abortion, while those having a further birth tend to carry it to term. Another possible reason that may contribute to this result is that women without a second birth (or a third birth) tended to use less effective contraceptive methods than their counterparts. Those who had a second birth (or third birth) may be more likely to meet official criteria to have a second birth (or third birth) but have to fulfil a birth interval requirement and thus have adopted more effective contraceptive methods. Since women adopted more effective methods after an abortion, the abortion level for women without a second (or third) birth had been close to that for women having a second (or third) birth since the third year after a first (or second) birth.

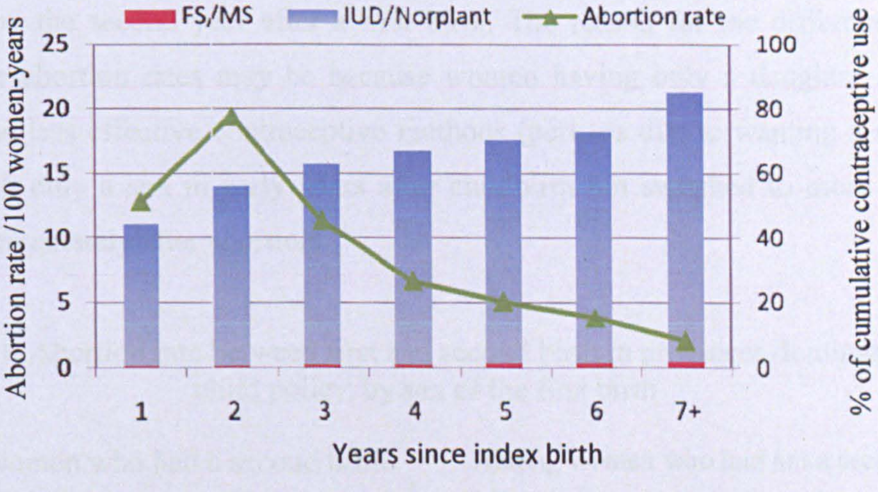
The small differences in abortion rates between the second and fourth year after childbirth among women who had a second (or third) birth may be due to the 3/4-year gap requirement stipulated in fertility regulations. The rate declines fast in the fifth year because many women were sterilized after a second or third birth.

Figure 6.9: Abortion rate after an index birth, by women's status of next birth



Since information only on the last contraceptive method ever used was collected in the 2001 survey, women's contraceptive histories are incomplete and cannot be used to explore association of contraceptive use with abortion. However, I try, here, to examine the relationship of contraceptive use to risk of abortion after a first birth among women without a second birth because the contraceptive use was not interrupted by a next birth and may reveal the process of contraceptive adoption among married women. Figure 6.10 shows cumulative percentage of long-term contraceptive use (sterilization and IUD) and yearly abortion rate since first birth. The cumulative proportion of effective contraceptive methods consistently increases over time, while the abortion rate monotonically declines since the second year after a first birth. However, breastfeeding, abstinence and frequency of intercourse (intercourse is less frequent within 6 months after a birth) in the first year after a first birth may possibly account for the low first-year abortion rate despite low effective contraceptive use. This is also the case for results shown in Figures 6.8 and 6.9. We see contrasting trends in the abortion rates and cumulative percentage of contraceptive use since the second year after a first birth. Increased use of effective contraceptive methods contributed to the decline of abortion among women who had only one child.

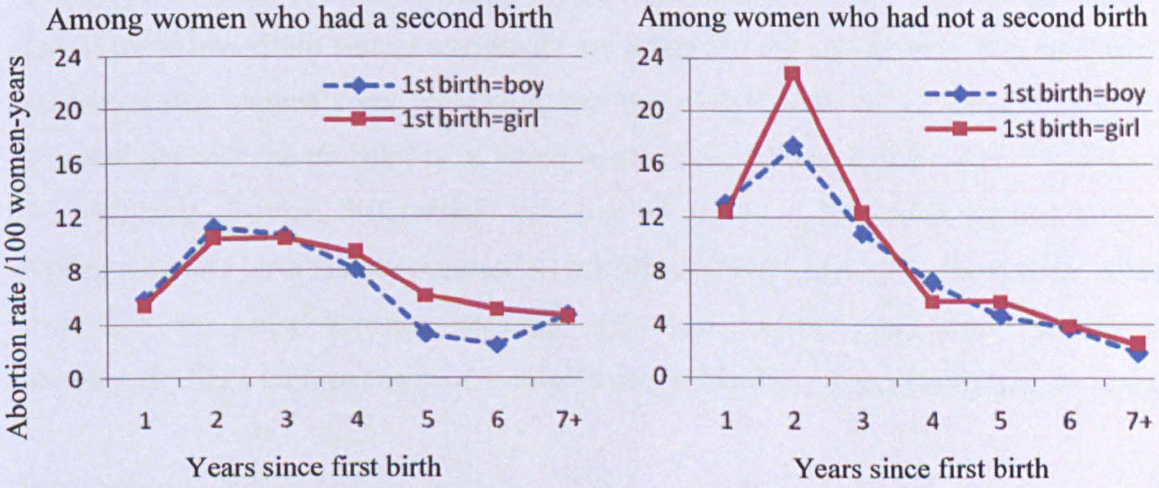
Figure 6.10: Relationship between cumulative percentage of current contraceptive use and abortion rate after a first birth among women who did not have a second birth in provinces dominated by 1-child policy



It is of particular interest to see whether the abortion rate of women whose first birth was a daughter differs from that of women whose first birth was a son. It is expected that the rate will be higher among women whose first birth was a daughter than among those whose first birth was a son. The sex-specific abortion rates are calculated and results are shown in Figure 6.11. The left-side graph plotted abortion rates and trends among women who had a second child by sex of first birth. The two abortion series overlap during the first three years after a first birth and there is a small difference in the fourth year but the fifth- and sixth-year abortion rates are higher among women with a daughter than among women with a son for the first birth. The difference of the two abortion series may reflect the combined effects of the 3/4-year-gap requirement on fertility regulations and culture of son preference. Since a minimum of three-year gap between births is usually enforced by local authorities, the abortion differences between the two groups of women are small during the first three/four years. Starting in the fourth/fifth year, women with only a daughter might be more likely to seek a selective abortion for a son and result in slightly higher abortion level. The two series overlap in the seventh plus year after a first birth, which cannot be explained by women's sex preference and the reason is unclear.

The right-side graph in Figure 6.11 plotted abortion trends by sex of first birth among women without a second child. The two series overlap in first year but the second-year abortion rate is about 5 points higher for women with only a daughter than for women with only a son. The abortion differentials between the two groups of women are very small during the following years. These results indicate that abortion behaviour is largely similar for women having only a daughter and those having only a son with one exception on the second year after a first birth. The reason for the difference of the second-year abortion rates may be because women having only a daughter are more likely to use less effective contraceptive methods (perhaps due to wanting a son) than women with only a son in early years after childbirth but switched to more effective methods immediately after abortion.

Figure 6.11: Abortion rate between first and second birth in provinces dominated by 1-child policy, by sex of the first birth



6.3.2 Risk factors of abortions within 2 years after a first birth

From the above analyses, we see that the overall abortion rates are much higher during the first two years after childbirth than in subsequent years. Moreover, as we can see in Figure 6.9, differences in abortion rates since the third year after the first birth between women who have and do not have a second birth are small. Thus the risk factors of abortion within the first two years after first birth are of particular interest in this study. Risk factors of abortions after a second birth are likely to be similar to those after a first birth and thus not analysed further. Figures 6.9 and 6.11 show that the abortion pattern for women having a second birth differs from that for women without a second birth. It is anticipated that these two groups of women will have different risk factors of abortion and thus need to be investigated separately.

Table 6.6 shows the percentage distribution of abortions within 2 years after a first birth among women who had a second birth. About 13 per cent of the women experienced at least one abortion during such a short period. Of them, 10.6 per cent had one and 1.9 per cent had two or more abortions. The proportions of women with one abortion vary between categories of selected variables, ranging from 3.6 per cent to 15.5 per cent; those women with two or more abortions vary from 0 to 5.5 per cent. Bivariate analyses indicate that the calendar cohort of first birth, husbands' age at first birth, women's education, FP services at FPSCs and all variables at province-level (geographical region, GDP per capita, proportion of rural population and proportion of ethnic minority groups) are significantly associated with the risk of abortions within 24 months after a first birth. However, women's age at first birth, couple's minority status, FP services in villages and average household annual income do not affect the risk of abortion. It is somewhat surprising that women's sex preference and sex of first birth do not show significant associations with the probability of abortion after a first birth. Results shown in Figure 6.11 indicate abortion differentials between the sexes of first birth among women having a second birth mainly occurred in the fifth and sixth year after a first birth, while their first two years' abortion rates are very close. On the other hand, the risk of abortion declines with strength of women's son preference. The non-significant result may be due to small sample sizes for women with daughter preference and those with son preference.

Table 6.6: Percent of abortions within 2 years after a first birth among women having a second birth, by individual, township/village- and province-level factors

Indicators	No. of 1st birth	% of abortion after 1st birth 1	2+	p value
Individual level				
Cohort of 1st birth				
1979-84	624	11.1	3.2	0.043
1985-90	631	10.5	1.1	
1991-95	257	10.1	0.8	
Woman's age at 1st birth				
≤21	441	11.3	1.6	0.442
~23	474	10.8	2.1	
~25	375	12.0	2.4	
26+	222	6.8	1.4	
Husband's age at 1st birth				
≤22	313	10.5	0.3	0.012
~24	457	9.6	2.0	
~26	363	11.6	4.1	
27+	379	11.1	1.1	
Women's education				
≤Primary School	1073	8.7	1.9	<0.001
Middle School +	439	15.5	2.1	
Couple's minority status				
Both Han Chinese	1457	10.9	1.9	0.157
One or both a minority	55	3.6	3.6	
Women's sex preference #				
Daughter	70	11.4	2.9	0.597
No	1349	10.7	2.0	
Son	93	8.6	0.0	
Sex of 1st birth				
Boy	638	11.6	1.9	0.592
Girl	874	10.0	1.9	
Township-village level				
FP services at FPSCs				
No a FPSC	299	13.0	2.3	0.009
Good short-, poor long-term meth. serv.	676	10.1	1.0	
Good long- & short-term meth. serv.	373	9.7	1.6	
Moderate long-, poor short-term method Services	164	11.0	5.5	

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Table 6.6: Continued from previous page

Indicators	No. of 1st birth	% of abortion after 1st birth: 1	2+	p value
FP services at villages				
Good	740	10.4	2.0	0.823
Moderate	524	10.3	1.5	
Poor	248	12.1	2.4	
Average income at villages (Yuan)				
<1200	361	10.8	2.2	0.180
~1900	305	12.1	3.3	
~2800	278	12.2	1.8	
>2800	568	9.0	1.1	
Province level				
Geographical Region				
East	704	9.1	1.0	0.007
West	808	12.0	2.7	
GDP per capita (Yuan)				
<4200	625	13.1	2.2	0.002
~6000	183	8.2	4.4	
>9000	704	9.1	1.0	
% of rural population				
<60	704	9.1	1.0	0.002
~70	625	13.1	2.2	
>75	183	8.2	4.4	
% of minority				
<3	617	8.4	0.8	0.002
~9	895	12.2	2.7	
Total	1512	10.6	1.9	

Women's sex preference= woman's ideal number of son – her ideal number of daughter

Table 6.7 shows the distribution of abortions within 2 years after a first birth among women without a second birth. As can be seen in this table, about 28 per cent of women experienced at least one abortion, which is more than two times higher than the proportion of women who had a second birth. Nearly a quarter of them had one abortion and 3.4 per cent experienced two or more abortions. Proportions of women with a history of one abortion also varied between categories of the selected variables, ranging from 17.6 per cent to 32.0 per cent; those of women with two or more abortions range from 1.0 per cent to 6.3 per cent. Bivariate analyses indicate that calendar cohort of first birth and province-level variables - geographical region, GDP per capita, percentage of rural population and percentage of ethnic minority groups - are significantly associated with the likelihood of abortion within 24 months after a first birth at 0.05 level. Abortion differences between categories of women's education and between levels of average household annual income in villages are significant at the 0.10 level. Women's and their husbands' age at first birth, couple's minority status, women's sex preference and FP services at FPSCs or in villages are not associated with the risk of abortion. Although the second-year abortion rate is slightly higher for women having a daughter than for women having a son, this difference is not statistically significant.

Table 6.7: Percent of abortions within 2 years after a first birth among women without a second birth, by individual, township/village- and province–level factors

Indicators	No. of 1st birth	% of abortion after 1st birth 1	2+	p value
Individual characteristics				
Woman's age at 1st birth				
≤21	410	24.9	4.1	0.499
~23	566	26.9	2.5	
~25	428	23.6	4.0	
26+	178	21.3	2.8	
Husband's age at 1st birth				
≤22	271	24.7	2.6	0.820
~24	601	26.1	2.8	
~26	386	23.8	4.1	
27+	324	23.8	4.0	
Women's education				
≤Primary School	823	22.6	3.0	<0.063
Middle School +	759	27.3	3.7	
Cohort of 1st birth				
1979-84	328	32.0	3.0	<0.001
1985-90	602	26.7	4.2	
1991-95	652	19.5	2.8	
Couple's minority status				
Both Han Chinese	1556	24.9	3.3	0.462
One or both minority	26	23.1	7.7	

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Table 6.7: continued from previous page

Indicators	No. of 1st birth	% of abortion after 1st birth 1	2+	p value
Women's sex preference				
Daughter	174	27.0	4.6	0.462
No	1302	25.0	3.1	
Son	106	19.8	4.7	
Sex of 1st birth				
Boy	982	23.9	3.0	0.259
Girl	600	26.3	4.0	
Township-village level				
FP services at FPSCs				
No a FPSC	191	25.1	5.2	0.466
Good short- but poor long-term meth. Provision	974	25.3	2.6	
Good long- & short-term meth. Provision	190	23.2	4.7	
Moderate long-, poor short-term meth. Provision	227	24.2	4.0	
FP services at villages				
Good	801	24.5	3.2	0.622
Moderate	625	26.2	3.7	
Poor	156	21.2	2.6	
Average income at villages (Yuan)				
<1200	211	26.1	4.7	0.074
~1900	219	19.6	5.0	
~2800	411	24.3	4.1	
>2800	741	26.3	2.0	
Province and township-village levels				
Geographical Region				
East	877	26.3	2.2	0.007
West	705	23.0	4.8	
GDP per capita (Yuan)				
<4200	506	25.1	6.3	<0.001
~6000	199	17.6	1.0	
>9000	877	26.3	2.2	
% of rural population				
<60	877	26.3	2.2	<0.001
~70	506	25.1	6.3	
>75	199	17.6	1.0	
% of minority groups				
<3	792	26.3	2.0	0.002
~9	790	23.4	4.7	
Total	1582	24.8	3.4	

Multilevel Poisson regression is applied to fit the data on abortions within two years after a first birth. The *offset* (set to be equal to the log [base e] of the expected abortion count) used in the Poisson regression model for women having a second birth is log(223*1200*exposure for women within the two years after the first birth/33593) in which: 223 is the total number of abortions within 2 years after a first birth; 33593 is the total months of exposure during the same period; exposure (years) for women within the two years after the first birth is denoted as the number of months that a woman is exposed to risk of abortion within the first two years after her first birth being divided by 12 (months); 1200 (months) represents 100 women-years. For women without a second birth, the *offset* is set to be log(507*1200*exposed period/37735). Factors that were statistically significant in bivariate analyses (at a 0.10 level) are included in multilevel Poisson analyses as predictors.

Table 6.8 presents the results of three-level Poisson regression models from fitting abortion data from women who had a second birth. Model 1 is a null model without any predictor. Model 2 includes variables from the individual level. Model 3 includes indicators from individual and township/village levels. However, once all three level-3 variables are introduced in model, none of their effects are significant. This is clearly due to correlation between the three province-level variables. Thus I introduce provincial level of ethnic minority groups in model 4, proportion of rural population in model 5 and GDP per capita in model 6. Since the fixed effect of GDP per capita is not statistically significant and other results of model 6 are similar to those in models 4 and 5, I do not show model 6 in Table 6.8.

As can be seen from the fixed effects in Table 6.8, the better-educated women are associated with a higher risk of abortion than their less-educated counterparts. Women whose husbands became a father for the first time at ages of 25-26 are more likely to undergo an abortion than the reference category, but the significance is at marginal level (0.10). However, the abortion risk seems not to be associated with calendar year of first birth, FP services at FPSCs and GDP per capita at provincial level after controlling other factors. Moreover, neither the variable representing proportion of ethnic minorities nor that representing proportion of rural population is associated with the risk of abortion within 24 months after a first birth after controlling for other level-1 and level-2 variables.

From the random effects, we can see that, with more variables included in model, the township/village level variance is almost unchanged. The level-2 variance is two times higher than its standard error, indicating that there are important unknown risk factors that are responsible for the variation of abortions between townships/villages. The province-level variance is not statistically significant in all models, suggesting abortion difference between provinces is small. The between-township/village variance is about two times higher than the between-province variance, suggesting abortion variation between high-level units being mainly at township/village level.

Table 6.8: Parameter estimates of three-level Poisson regression models from fitting data on abortions within 2 years after a first birth among women who had a second birth in provinces dominated by 1-child policy

Predictors (reference category)	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Fixed effects										
Intercept term	-7.125**	0.173	-7.363**	0.277	-7.711**	0.394	-7.750**	0.374	-7.655**	0.323
Individual level (level-1)										
Husband's age at 1st birth (ref:≤22 years old)			0.124	0.219	0.152	0.227	0.141	0.212	0.114	0.214
~24			0.418†	0.229	0.443†	0.239	0.412†	0.216	0.397†	0.217
~26			-0.002	0.245	0.046	0.250	0.015	0.223	0.001	0.235
27+										
Women's education (ref: Primary school)										
Middle School+			0.445**	0.153	0.453**	0.153	0.446**	0.151	0.486**	0.151
Cohort of 1st birth (ref: 1979-84)										
1985-90			-0.245	0.167	-0.230	0.169	-0.244	0.165	-0.246	0.164
1991-95			-0.410	0.230	-0.399	0.226	-0.399	0.226	-0.412	0.216
Township-village level (level-2)										
FP services at FPSCs (ref: good short-, poor long-term method provision)										
No a FPSC					191	0.313	-0.148	0.322	0.115	0.275
Good short- & long-term method provision					-0.188	0.312	-0.445	0.303	-0.344	0.288
Poor short-term, moderate long-term method provision					0.333	0.340	0.012	0.325	0.184	0.321
Province level (level-3)										
% of rural population (ref: <60)										
~70									0.668	0.481
>75									0.280	0.541
% of minority groups (ref: <3%)										
-9							0.805	0.620		
Random effects										
Township-village level variance	0.409 *	0.160	0.337*	0.139	0.348*	0.153	0.352*	0.139	0.339*	0.143
Province level variance	0.124	0.223	0.135	0.251	0.154	0.294	0.182	0.706	0.179	0.498
DIC	1246.5		1241.3		1241.3		1240.5		1241.3	

Table 6.9 presents parameter estimates of three-level Poisson regression models from fitting abortion data among women without a second birth. As can be seen from the table, women's education is not associated with the risk of abortion within 2 years after a first birth as it does among women having a second birth. Women whose first birth was born in 1991-95 are significantly less likely to have an abortion than those whose first birth was born in 1979-84. This result may be because effective contraceptive methods were more available during the more recent period; stainless steel ring [one type of IUD] was the most popular IUD in China before 1992, which is less effective than modern IUDs and was removed from national family planning programme in 1993 (*Song 1999*). Province with more than 75 per cent of rural population (Chongqing municipality) had lower risk of abortion (significant at the 0.10 level) than provinces with less than 60 per cent of rural population, indicating that FP services in Chongqing were better than in those where less than 60 per cent of population were rural. However, when GDP per capita or proportion of ethnic minorities is included in model 3, neither of them is significantly associated with the likelihood of abortion. Moreover, the effect of average household annual income in villages on abortion largely disappears when adjusted for other variables.

From the random effects, we can see that, level-2 and level-3 variances are small. The level-2 variance is statistically significant at the 0.10 level in models 2 to 4, indicating that risk of abortion varies between townships/villages.

Random coefficient models that allow effects of risk factors at individual level to vary between townships or between provinces were examined in both groups of women with or without a second birth. None of the random coefficients are statistically significant (results not shown).

In summary, risk factors of abortion within 2 years after a first birth are mainly at individual level. Among women who had a second birth, husbands who had their first birth at ages of 25-26 and women who had middle school or higher education are associated with increased higher risk of abortion than their respective counterparts. On the other hand, risk factors of abortion for women without a second birth include calendar year of first birth and proportion of rural population at province-level, but women's education is not associated with such a risk.. There is a large amount of unexplained level-2 variance for women having a second birth, but the variation is little for women without a second birth.

Table 6.9: Parameter estimates of three-level Poisson regression models from fitting data on abortions within 2 years after a first birth among women who did not have a second birth in provinces dominated by 1-child policy

Predicators (reference category)	Model 1 Coeff.		Model 1 s.e.	Model 2 Coeff.		Model 2 s.e.	Model 3 Coeff.		Model 3 s.e.	Model 4 Coeff.		Model 4 s.e.
Fixed effects												
Intercept term	-7.198	**	0.134	-7.102	**	0.116	-7.060	**	0.170	-6.998	**	0.177
Individual level (level-1)												
Women's education (ref: ≤Primary School)												
Middle School+				0.156		0.094	0.161		0.096	0.160		0.098
Cohort of 1st birth (ref: 1979-84)												
1985-90				-0.076		0.113	-0.085		0.112	-0.083		0.114
1991-95				-0.396	**	0119	-0.408	**	0.118	-0.411	**	0.121
Township-village level (level-2)												
Average income at village							-0.096		0.132	-0.129		0.143
Province level (level-3)												
% of rural population (ref: <60)												
60-70										0.168		0.267
>75										-0.524	†	0.305
Random effects												
Township-village level variance	0.085	*	0.040	0.070	†	0.045	0.065	†	0.043	0.067	†	0.038
Province level variance	0.082		0.128	0.067		0.106	0.088		0.149	0.036		0.104
DIC	2189.4			2180.7			2183.1			2181.4		

† Significant at 0.10 level; * significant at 0.05 level; ** significant at 0.01 level

6.4 Sex ratio at birth

Reducing the imbalanced SRB has been becoming one of the priorities for the Chinese National Population and Family Planning Committee since 2000. As described in Chapter one, China has launched a nationwide campaign for this purpose. However, there is still a long way to go to reach the aim of normalizing SRB throughout the country. As already discussed, the imbalanced SRB in China is mainly due to combined effects of the traditional culture of son preference and strict population policy. It is difficult to reduce SRB to normal solely through measures to eliminate strong son preference, while keeping the population policy unchanged. In this section, I explore levels of SRB and predictors of a male birth in provinces with a dominant 1-child policy. These themes will be also explored in provinces dominated by 1.5-child and 2-child population policies in next two chapters. All results will be compared and used to generate useful recommendations for the country to reduce its imbalanced SRB.

Since SRBs in this study are based on samples of a survey, I calculate 95% confidence intervals (CIs) of the ratios in order to assess whether they are truly imbalanced or caused by chance. Suppose m is the male proportion of all births and N is the number of total births, the 95% CI for m can be obtained from the formula:

$$P_{low} = m - 1.96\sqrt{m(1-m)/N} \quad (6.3)$$

$$P_{up} = m + 1.96\sqrt{m(1-m)/N} \quad (6.4)$$

Thus the 95% CI of SRB can be obtained by:

$$SRB_{low} = P_{low} / (1 - P_{low}) \quad (6.5)$$

$$SRB_{up} = P_{up} / (1 - P_{up}) \quad (6.6)$$

6.4.1 SRB by calendar years and birth order

Table 6.10 shows SRBs of first and second births and their 95% CIs during 1979-2000. The sex ratio of first births was 1.056 (boys per 1 girl) in 1979-84. It increased to 1.079 in 1985-90, and further to 1.175 in 1991-95, but slightly declined to 1.138 in 1996-2000. Nevertheless, all 95% CIs of the four ratios overlap the normal value of SRB (1.06). Since the sample sizes for these ratios are small, it is difficult to draw solid conclusions that they are imbalanced. The overall SRB in 1979-2000 increased from first (1.105) to second births (1.141), but this difference is not statistically significant. As indicated by the 95% CI, the sex ratio of second births in 1991-95 was significantly higher than normal; this is not the case for the ratio in the other periods.

However, even though most of the above 95% CIs cover the normal value, the trends of point estimates of SRBs of first and second births fit well the modifications of population policy and in accordance with the availability of B-ultrasound machines during the 20-year period. In the first phase, 1979-84, China implemented a strict 1-child policy throughout the country. An abnormally high SRB would be expected in this period. However, the SRBs in 1979-84 were largely normal. The most likely reason is difficulty of access to a B-ultrasound scan before mid-1980s. A phase of policy moderation began in 1984. We would expect to see a normal SRB during the following several years. On the contrary, the sex ratios rose slightly in 1985-90. It is noted that B-ultrasound machines became more widely available in China after 1985. As a result of sharp increase in fertility in the late 1980s, there were renewed official demands for stricter implementation of the 1-child rule. Meanwhile, B-ultrasound machines spread rapidly from city to county and from more developed to less developed areas in the 1990s. Consequently, SRBs of the first and second births peaked in 1991-95. After the 1994 Cairo International Conference on Population and Development (ICPD) and 1995 Beijing Fourth World Conference on Women, China's FP strategies shifted from population control and administrative targets to client-centred services. This may have alleviated the effect of strict population policy on SRB. We thus see that the SRB of first and second births declined in 1996-2000.

Table 6.10: Sex ratios of first and second births and their 95% confidence intervals (CI) in provinces dominated by 1-child policy, 1979-2000

Birth years	First birth			Second birth**		
	Boy	Girl	SRB (95% CI)	Boy	Girl	SRB (95%CI)
1979-84	489	463	1.056 (0.930-1.200)	222	229	0.969 (0.805-1.166)
1985-90	640	593	1.079 (0.965-1.207)	390	354	1.102 (0.954-1.273)
1991-95	491	418	1.175 (1.032-1.339)	231	150	1.540 (1.259-1.902)
1996-00	305	268	1.138 (0.966-1.343)	109	101	1.079 (0.823-1.419)
Total	1925	1742	1.105 (1.036-1.179)	952	834	1.141 (1.040-1.253)

** $p < 0.01$

One of my hypotheses is that sex selective abortion is the main cause of SRB imbalance. Selective abortion for a son would be more common for women with only a daughter and result in an abnormally high SRB. In order to examine this hypothesis, I calculate SRB of second births by women's abortion history between first and second birth and by sex of first birth. The outcomes are shown in Table 6.11. A slightly higher sex ratio of second births was observed for women who had an abortion history (1.154) than for those who did not (1.139), but this difference is not statistically significant. Among women with only a daughter, SRB of second births (1.461) is about 7 per cent higher for women having an abortion history than for those having no abortion history (1.362). This differential is also not statistically significant. Although we cannot reach a solid conclusion from the above analyses that women with an abortion history had higher SRB than those without such a history, the results among women whose first birth was a daughter strongly support this judgement. However, the ratios of second births after a female birth were extremely high for both groups of women, even among those who did not report an abortion between the first two births. These findings suggest serious underreporting of selective abortions between first and second births. Sex ratios of second births after a male birth are below 0.9, with 95% CIs overlapping normal ranges (1.02-1.07). It appears that women having a son were less likely to have a selective abortion.

Table 6.11: Sex ratios of second births and 95% confidence intervals (CI) during 1979-2000 in provinces dominated by 1-child policy, by women's abortion history and sex of first births

Abortion between 1st & 2nd birth	First birth=boy			First birth=girl			total		
	Boy	Girl	SRB 95%CI	Boy	Girl	SRB 95%CI	Boy	Girl	SRB 95%CI
No	294	327	0.899 0.767-1.052	478	351	1.362 1.188-1.566	772	678	1.139 1.027-1.263
Yes	69	80	0.863 0.621-1.189	111	76	1.461 1.097-1.976	180	156	1.154 0.932-1.433
Total	363	407	0.892 0.774-1.027	589	427	1.379 1.219-1.565	952	834	1.141 1.040-1.253

6.4.2 Sex ratios of first births in 1980s and in 1990s

Sex ratios of first births in 1980s and in 1990s by province, township, village and individual factors are shown in Table 6.12. The overall ratio in 1980s was normal (1.054). As indicated by their 95% CIs, the ratios among most subgroups of women can be regarded as normal with only one exception, where women who preferred a son had significantly imbalanced SRB of first births.

The overall ratio increased to 1.182 in the 1990s, which is significantly higher than the normal value. As shown in the middle column of Table 6.12, a substantial number of women's categories relate to a distorted sex ratio of first births in the 1990s, i.e. having a first birth at age 24 or older, middle school or higher level of education, having son preference, townships with good provision of short-term but poor provision of long-term contraceptive methods, East region and provinces with less than 3 per cent of ethnic minorities. Bivariate analyses show that sex ratios of first births in 1990s are significantly different between categories of women's education, their sex preference, FP services at FPSCs, average household annual income in villages, proportion of ethnic minority groups and geographical region. Since classifications of GDP per capita and proportion of rural population overlap with those of geographical region, these two variables are not reported in Table 6.12.

The SRBs of first births during the entire period of 1979-99 by categories of women's characteristics and high-level variables are displayed in the right column of Table 6.12. Bivariate analyses indicate the overall SRB during 1979-99 is significantly different between categories of women's sex preference and FP services at FPSCs.

Table 6.12: Sex ratios of first births and 95% confidence intervals (CI) in provinces dominated by 1-child policy in 1980s and 1990s, by province, township, village and individual factors

	SRB in 1980s & 95% CI			SRB in 1990s & 95% CI			Total & 95% CI		
	SRB	lower	upper	SRB	lower	upper	SRB	lower	upper
Woman's age at first birth									
≤23	1.017	0.907	1.142	1.126	0.995	1.277	1.066	0.980	1.161
24+	1.107	0.966	1.270	1.287	<u>1.093</u>	<u>1.521</u>	1.177	1.060	1.308
Husband's age at first birth									
≤24	1.041	0.913	1.188	1.185	1.043	1.348	1.113	1.016	1.220
25+	1.068	0.947	1.205	1.186	1.012	1.393	1.109	1.008	1.221
Woman's education									
≤Primary School	1.078	0.964	1.205	1.082†	0.947	1.237	1.079	0.991	1.176
Middle school+	1.016	0.881	1.172	1.320	<u>1.138</u>	<u>1.535</u>	1.152	1.040	1.278
Couple's minority status									
Both Han Chinese	1.042	0.953	1.139	1.182	1.069	1.309	1.101	1.030	1.178
One or both minority	1.706	0.964	3.346	1.182	0.669	2.151	1.410	0.944	2.172
Women's sex preference**				**			**		
Daughter	0.828	0.608	1.118	0.557	0.376	0.794	0.703	0.554	0.884
No	1.029	0.935	1.132	1.152	1.035	1.283	1.081	1.007	1.161
Son	2.128	<u>1.485</u>	<u>3.221</u>	4.600	<u>3.008</u>	<u>8.290</u>	2.966	<u>2.249</u>	<u>4.089</u>

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	SRB in 1980s, 95% CI			SRB in 1990s, 95% CI			Overall SRB, 95% CI		
	SRB	lower	upper	SRB	lower	upper	SRB	lower	upper
Family Planning services at townships' FPSCs				**			**		
No a FPSC	1.305	1.050	1.632	1.327	1.028	1.729	1.314	1.113	1.557
Good short-, poor long-term method provision	1.034	0.917	1.167	1.317	1.148	1.515	1.149	1.049	1.258
Others	0.970	0.826	1.139	0.947	0.796	1.126	0.960	0.853	1.079
Family Planning services at villages									
Good	1.117	0.986	1.265	1.200	1.041	1.386	1.152	1.049	1.265
Moderate or Poor	0.994	0.877	1.126	1.166	1.016	1.341	1.068	0.974	1.172
Average annual income/family at villages				†					
≤2000	1.098	0.953	1.265	1.048	0.887	1.239	1.077	0.967	1.199
2000+	1.027	0.917	1.149	1.264	1.117	1.432	1.128	1.038	1.227
Geographical region				*					
East	1.064	0.942	1.203	1.319	1.145	1.524	1.166	1.063	1.280
West	1.043	0.919	1.184	1.065	0.927	1.224	1.053	0.959	1.156
% of Minority groups at province level				*					
<3	0.998	0.876	1.137	1.357	1.170	1.579	1.140	1.034	1.258
~9	1.103	0.979	1.243	1.059	0.927	1.211	1.083	0.991	1.184
Total	1.054	0.965	1.151	1.182	1.071	1.307	1.109	1.038	1.184

Chi Square test: † $p < 0.10$, * $p < 0.05$, ** $P < 0.01$;

6.4.2 SRB of second birth in 1980s and 1990s

Table 6.10 shows that the overall SRB of second births was higher than that of first births during 1979-2000. Since two children is the upper limit for the majority of Chinese couples, there is an incentive for female birth of parity two to be prevented to allow for the birth of a son within the regulations. This is the general interpretation of the rise of sex ratio of second births in China. However, as indicated by results shown in Table 6.13, the increase of overall sex ratio of second births is restricted to children born in the 1990s because the sex ratio of second births in the 1980s is normal and slightly lower than that of first births in the 1980s. As explained above, the rise of SRB in the 1990s probably reflects the introduction of responsibility system throughout China and the widespread introduction of ultrasound screening technologies.

Table 6.13 shows that SRBs of second births in 1980s can be largely regarded as normal in all subgroups of women, while the ratios in 1990s were distorted in many categories of women, i.e., women aged 26 or younger and those whose husband was less than 28 years old, women with less education, those who rated as no sex preference or having a daughter, those from townships with good provision of short-term but poor provision of long-term contraceptive methods, or from rich villages with good provision of FP methods, women from the East region with less than 3 per cent of ethnic minorities.

Contrary to results for first births, the ratios of second births in the 1990s in women or their husbands who had a second birth at a younger age and women with less education tend to have a higher sex ratio of second births than their older and better-educated counterparts. There are several reasons that may contribute to these outcomes. Compared with less-educated women, the better-educated ones are more likely to work in government departments or agencies. Government employees are usually under strong pressure to implement the 1-child rather than the 1.5-child or the 2-child policy. They also have economic advantages and better knowledge and access to ultrasound technology. For these reasons, the better-educated women would be more likely to seek selective abortions before first birth. On the contrary, less-educated women are more likely to work as peasant farmers and are subject to more lenient 1.5-child or 2-child policies. Thus the sex of second birth is more likely to be selected. The effect of age at birth is consistent with women's education because better-educated women usually marry later so have their first child at older ages. Sex ratio of second births in 1990s is normal for women with only a son, but increased to 1.560 with 95% CI ranging from 1.291 to 1.923 for women with only a daughter. This result can be attributed to the effect of son preference.

Table 6.13: Sex ratios of second births and 95% confidence intervals (CI) in provinces dominated by 1-child policy in 1980s and in 1990s, by province, township, village and individual factors

	1980s			1990s			Total		
	SRB	95% CI		SRB	95% CI		SRB	95% CI	
Woman's age at 2nd birth									
≤26	1.097	0.930	1.296	1.511	1.224	1.883	1.238†	1.087	1.413
27+	0.970	0.817	1.151	1.196	0.959	1.498	1.049	0.916	1.202
Husband's age at 2nd birth									
≤27	1.101	0.913	1.331	1.466	1.180	1.838	1.244	1.080	1.437
28+	0.991	0.849	1.156	1.248	1.008	1.554	1.071	0.946	1.215
Woman's education									
≤Primary School	1.017	0.888	1.165	1.463	1.218	1.768	1.156	1.037	1.289
Middle School+	1.093	0.852	1.407	1.128	0.855	1.495	1.108	0.921	1.337
Women's sex preference									
Daughter	1.200	0.740	1.990	0.867	0.388	1.849	1.089	0.725	1.647
No	1.025	0.904	1.163	1.357	1.154	1.603	1.139	1.031	1.259
Son	1.000	0.585	1.710	1.667	0.953	3.201	1.261	0.860	1.883
Sex of first birth	**			*			**		
Boy	0.835	0.698	0.994	1.066	0.832	1.367	0.906	0.785	1.045
Girl	1.240	1.055	1.462	1.569	1.291	1.923	1.365	1.205	1.550
FP services at townships' FPSCs				†			†		
No a FPSC	0.867	0.645	1.159	1.016	0.717	1.440	0.926	0.740	1.156
Good short-, poor long-term method provision	1.105	0.934	1.310	1.667	1.307	2.159	1.261	1.098	1.451
Others	1.022	0.832	1.257	1.269	1.000	1.621	1.121	0.959	1.312
Family Planning services at villages									
Good	1.008	0.849	1.196	1.523	1.224	1.916	1.177	1.029	1.349
Moderate or Poor	1.059	0.897	1.250	1.208	0.977	1.500	1.112	0.976	1.269
Average annual income at villages									
≤2000	1.128	0.941	1.356	1.159†	0.929	1.451	1.14	0.991	1.314
2000+	0.968	0.827	1.133	1.555	1.260	1.939	1.146	1.010	1.300
Geographical region				†					
East	0.974	0.822	1.154	1.600	1.261	2.059	1.149	1.001	1.320
West	1.095	0.927	1.296	1.203	0.987	1.473	1.139	1.002	1.296
% of Minority groups				**					
<3	1.034	0.864	1.238	1.793	1.391	2.359	1.239	1.071	1.437
~9	1.033	0.881	1.212	1.154	0.953	1.400	1.081	0.957	1.222
Total	1.034	0.918	1.165	1.351	1.160	1.579	1.143	1.041	1.256

Chi-square test: † $p < 0.10$, * $p < 0.05$, ** $P < 0.01$;

6.4.3 Predictors of sex of first and second births in 1990s

As shown in Tables 6.12 and 6.13, imbalance and variation of SRB between categories of women in provinces with a dominant 1-child policy are more common and serious in the 1990s than in the 1980s. The analysis of predictors of a male child is thus focused on data of the first and second births born in the 1990s. Bivariate analyses indicated women's education and their son preference, FP services at FPSCs, average household income in villages, geographical region and proportion of ethnic minority groups at province-level are significantly associated with the probability of a son as a first birth in the 1990s, while sex of first birth, FP services at FPSCs, average household income in villages, geographical region and proportion of ethnic minority groups are significantly related to the probability of a son as a second birth in the 1990s. Since effects of these factors can be confounded by other variables, I use a three-level logistic regression model to identify independent predictors of sex of first and second birth in the 1990s. This approach can also tell us whether the probability of a male birth varies between townships/villages or between provinces. The Binary dependent response for the logistic regression model is, y_{ijk}, 1 if woman *i* in township/village *j* and province *k* had a boy for the first or second birth, and 0 if she had a daughter. Variables that show significant differences in bivariate analyses are included in the multilevel models. To keep this section succinct, Table 6.14 only shows parameter estimates of the models that include all predictors.

Model estimates from fitting data on sex of first births are shown on the left column in Table 6.14. After controlling potential confounding, women's education is significantly associated with the probability of a male child as a first birth. The odds of a male birth for women who had middle school or above education is $e^{(0.324)}$=1.38 times higher than that for women who had less education, with 95% CI ranging from 1.11 to 1.72. The likelihood of having a boy increases with women's sex preference. Compared with women who had daughter preference, the odds for those having a male birth without sex preference are 2.23 times (95% CI: 1.56 – 3.19) higher and the odds for women who had son preference are 9.94 times (95% CI: 5.50 – 17.96) higher. Women from townships where the provision of long-term contraceptive methods is emphasized are significantly less likely to have a son as a first birth than women from townships without a FPSC. Average household income in villages is not associated with sex of first birth after adjusting potential confounding. In contrast to the result of bivariate analysis, after controlling other factors, West region shows a higher probability of a son as a first child (significant at the 0.10 level) than the East region, indicating son preference in the West region was stronger than in the East region. The proportion of ethnic minority groups shows negative association with the probability of a son.

From the random effects, we can see that level-2 and level-3 variances are small and less than their standard errors, indicating that the probability of a male child as a first birth in the 1990s did not differ between township-villages or between provinces.

Model estimates from fitting sex of second birth in the 1990s are shown in the right column of Table 6.14. After controlling other variables, only sex of first birth shows significant association with probability of a male child as a second birth, which is about 30 per cent lower (OR=0.71, 95% CI: 0.51 – 0.99) for women whose first birth was a boy than those whose first birth was a girl. In other words, women who had only a daughter were more likely to have a son as a second birth than women who had only a son. The level-2 and level-3 variables do not show significant association with sex of second birth, which may be partly due to the small sample size in this analysis. Distortions in SRB of second births are similar across townships/villages and between provinces.

I have also fitted random coefficient models to allow effects of women's education, son preference or sex of first birth to vary across townships/villages and provinces. However, none of the random effects are significant at the 0.05 level, indicating their effects are similar between townships/villages and between provinces.

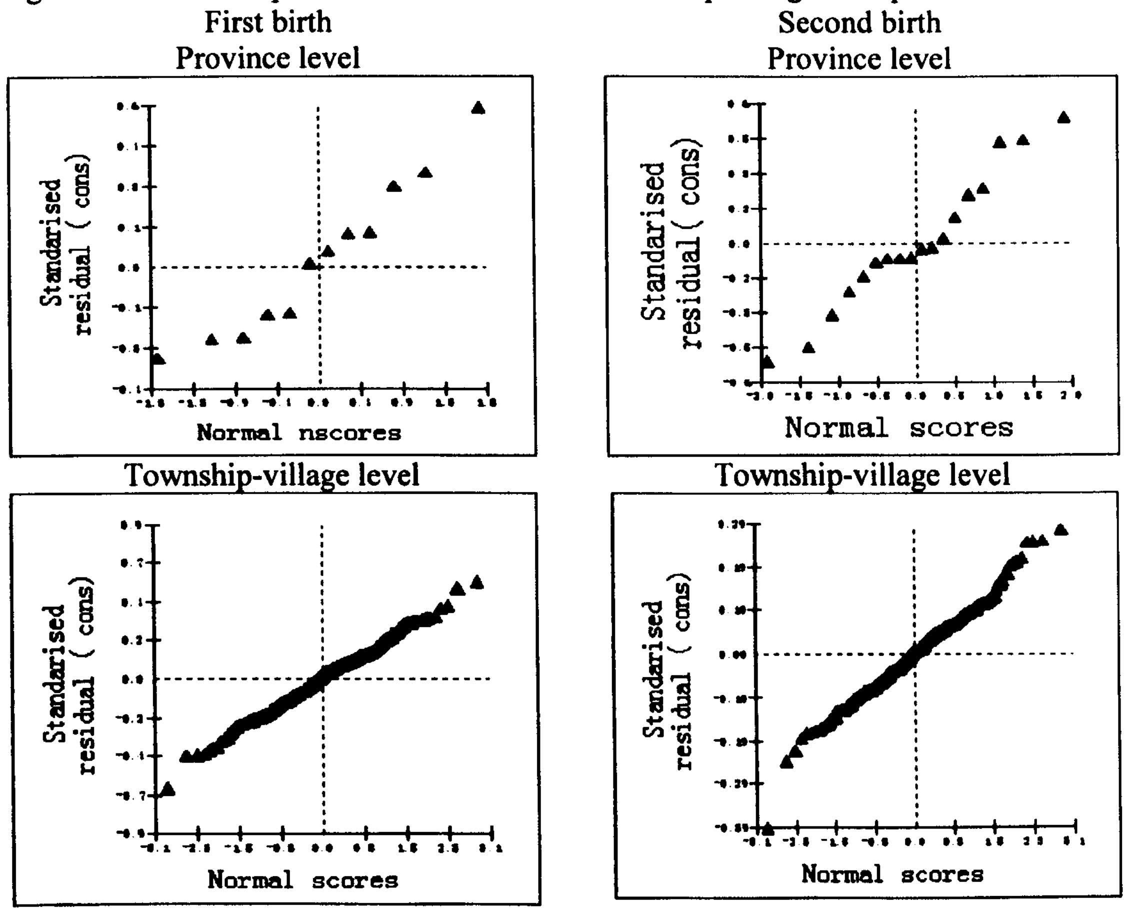
Table 6.14: Parameter estimates of three-level logistic regression models from fitting data on sex of first and second birth in provinces dominated by 1-child policy in the 1990s

Predicators (reference category)	First birth Coeff.	s.e.	Second birth Coeff.	s.e.
Fixed effects				
Intercept term	-0.325	0.351	0.655	0.450
Individual level (level-1)				
Woman's education (ref: ≤Primary school)				
Middle school+	0.324**	0.113		
Women's sex preference (ref: Daughter)				
No	0.802**	0.183		
Son	2.296**	0.302		
Sex of first birth (ref: Girl)				
Boy			-0.347**	0.172
Township-village level (level-2)				
FP services at FPSCs (ref: No a FPSC)				
Good short-, poor long-term meth.	-0.305	0.237	-0.169	0.402
Good short- & long-term meth.	-0.463*	0.222	0.123	0.279
Poor short-, moderate long-term meth.	-0.437†	0.232	-0.329	0.321
Average household income	-0.072	0.137	0.258	0.197
Province level				
Geographical region (ref: east region)				
West	0.491†	0.277	0.809	0.574
% of minority groups (ref: <3%)				
~9	-0.734*	0.316	-1.035	0.659
Random effects				
Township-village-level variance	0.019	0.034	0.010	0.012
Province-level variance	0.034	0.044	0.037	0.059

† p <0.10, * p <0.05, ** P <0.01

Normal plots of the level 2 and 3 residuals are shown in Figure 6.11 to check the normal distribution assumptions at high levels. The plots of level 2 (township/village-level) look fairly linear, which suggests that the assumption of normality is reasonable. The points on normal plots of province-level, though, look not so good as that at township/village level due to small number of level-3 units, are approximately on a straight line and normality assumption is acceptable.

Figure 6.12: Normal plots for the residuals for township/village- and province-level



6.5 Summary of key points

The TFR_{ppr} in provinces dominated by 1-child policy had been far below replacement level since 1986 and fell from 1986 to 2000. The declining trend is mainly attributable to the fall in progression to second birth because progression to first birth, $P_{B\text{-}1}$ was stable and close to 1. Sex-specific progression to second birth shows that women whose first birth was a daughter were more likely to have a second birth than those whose first birth was a son. This result may be attributed to son preference and implementation of 1.5-child policy in some places for women having a daughter. It is noted that $P_{1\text{-}2}$-girl declined faster than $P_{1\text{-}2}$-boy in late 1990s, partially reflecting attenuation of son preference and birth control strategy (encouraging couples to have only one child through incentives to daughter-only families).

The economically less developed provinces with a lower proportion of rural population were associated with a higher probability of a second birth, but the less developed villages and townships which emphasized short-term but not long-term contraceptive methods were associated with a lower probability of a second birth; the less-educated women and those who had a first birth during 1979–84 were significantly more likely to have a second birth than their respective counterparts. Women's sex preference and daughters are positively related to the likelihood of a second birth. It is not surprising that ethnic minorities had a higher probability of a second birth than Han Chinese, but somewhat surprising the birth interval between first and second birth was much longer for Non-Han (55.8 months) than for Han Chinese (32.5 months) and for the first birth cohort 1991-95 (44.8 months) than for the cohort 1985-90 (29.0 months).

Findings in this analysis suggest that abortions might be underreported. However, the abortion trends after first and second births look reasonable: they start at a moderate level in the first year, reach a peak in the second year and decline in the following years after an index birth. the abortion pattern after the first birth for women without a second birth differs from that between first and second births for women having a second birth; the former followed a general trend as above while the latter was lower and relatively stable during early several years after the first birth. These differentials may reflect effects of fertility regulations on birth intervals and timing of effective contraceptive method adoption after the first birth. The slightly higher abortion rates for women having a daughter than for those having a son during the fourth and sixth years after a first birth provides some evidence of sex-selective abortions for women having only a daughter.

The better-educated mothers appeared more likely to have an abortion after their first birth than the less-educated did among women having a second birth, but this association was not seen among those who did not have a second birth. These results may reflect different patterns of effective contraceptive methods between the two groups of women who having a second birth, which the patterns between educational levels of women having only one child are similar. Calendar cohort of the first birth is not associated with risk of abortion among women have a second birth, but among women having only one birth, those whose child was born in 1991-95 had significantly lower risk of an abortion than those whose child was born in 1979-84. These results indicate that risk of abortion among women having a second birth was less affected by FP programme changes in more recent years as it did among women having only one child. Unexpectedly, capacities of FP services at FPSCs and in villages had little effect on the risk of abortion. Neither is the abortion risk between first and second births associated with any province-level predictor among women having a second birth.

Among those without a second birth, abortion risk is higher in provinces with less than 60 per cent of rural population than those with more than 75 per cent of rural population.

The sex ratio of second births was significantly imbalanced in the 1990s. Sex ratios of first births and the sex ratios of second births in other periods were not significantly distorted, which were due partly to small sample sizes in this study. As mentioned before, distortion in SRBs in the early 1990s can largely attributed to the tightening up of population policy and wide availability of B-ultrasound machines during that time.

Several factors were identified to be associated with the distortion in SRBs of first and second births in the 1990s, i.e. women's age at birth, their education and sex preference, sex of existing child, FP services at FPSCs, geographical region and local economic development. However, older mothers with better education tended to have imbalanced SRB of first births, but younger couples and the less-educated mothers tended to have imbalanced SRB of second births. Effects of province, township and village-level factors on imbalance in SRBs of the first and second births are similar: both SRBs in eastern provinces with less than 3 per cent ethnic minorities, townships with poor provision of long-term contraceptive methods and the richer villages were abnormally high, while the ratios in other provinces, townships and villages could be regarded as normal.

Multilevel multivariate analyses indicate that probabilities of a second birth and risk of abortions varied between townships but were similar between provinces. The likelihood of a son as a second birth was largely similar between townships or between provinces.

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[1] A **Hukou** or ***huji*** refers to the system of residency permits. A household registration record officially identifies a person as a resident of an area and includes identifying information such the name of the person, date of birth, the names of parents, and name of spouse, if married. http://en.wikipedia.org/wiki/Hukou_system#cite_note-10, accessed on 10 July 2010

Chapter 7: Fertility, Abortion and Sex Ratio at Birth in Provinces Dominated by One and a half-Child Policy

7.1 Introduction

Since it encountered very strong resistance by peasants, the 1-child policy was modified to allow a second birth for couples with only one daughter (1.5-child policy) in rural areas in most provinces in 1984. There is little doubt that such a modification made the original idea of the 1-child policy, implemented for one generation to achieve government's population target, impossible. Yet few studies have examined how far the specific 1.5-child policy impacted fertility level and relevant reproductive outcomes in areas where the policy dominated. This is partly due to the difficulty of measuring population policy in a province where it is implemented. Using the numerical indicator of policy fertility obtained by Gu and co-workers (*2007b*), provinces in mainland China can be classified into three classes – 1-child, 1.5-child and 2-child policies. Of them, the 1.5-child policy is implemented in 19 out of 31 provinces and autonomous regions that are mainly located in the Central region of China. In this chapter, I will assess fertility level, progression to second birth, abortion rate and sex ratio at birth in provinces (SRB) with a dominant 1.5-child policy. Relevant factors that affect the probability of a second birth, abortion risk after a first birth and sex of second birth will be also explored.

The main hypotheses in this chapter are that the fertility level and progression to second birth will be higher in provinces dominated by 1.5-child policy than in provinces dominated by 1-child policy; the ratio of progression to second birth among women who have only one daughter will be higher than that among women who have only one son; the abortion rate before second birth will be high and sex ratio of second and third births will be distorted.

This chapter is arranged to report parity progression ratios (PPRs), total fertility rate based on PPRs (TFR_{ppr}) and predictors of progression to second birth in Section 7.2, followed by exploring the abortion rate and trend during different phases over women's life course and risk factors of abortion in Section 7.3. Section 7.4 assesses the sex ratio of the first and second births during different time periods and by women's and institutional characteristics and geographical region, provincial socio-economic development indicators. Section 7.5 provides a summary of this chapter.

7.2 Fertility level and birth interval between first and second births

7.2.1 PPR and TFR_{ppr}

The trends in PPR and in TFR_{ppr} during 1986-2000 are shown in Table 7.1 and Figure 7.1. As expected, P_{B-M}, the progression ratio from woman's own birth to first marriage, was virtually constant over the entire period and close to 1. Progression ratios from marriage to first birth, P_{M-1}, dropped to very slightly lower levels than those from the woman's own birth to her first marriage, ranging from 0.98 to 0.99 with a slight dip in 1989.

The progression from first to second birth, P_{1-2} followed a quite different trajectory. The ratio was high in 1986, with 88 per cent of women with a first birth continuing to a second. It dropped to 52 per cent in 2000 with several fluctuations during the period. The series of P_{2-3} followed a very similar trend as that of P_{1-2}. But the estimated value of P_{2-3} is about 0.4 points lower than estimate of P_{1-2} in each corresponding calendar year. Progressions to births of orders three or higher to fourth or higher gradually fell between 1986 and 1989, but moved between 0.1 and 0.2 after 1990.

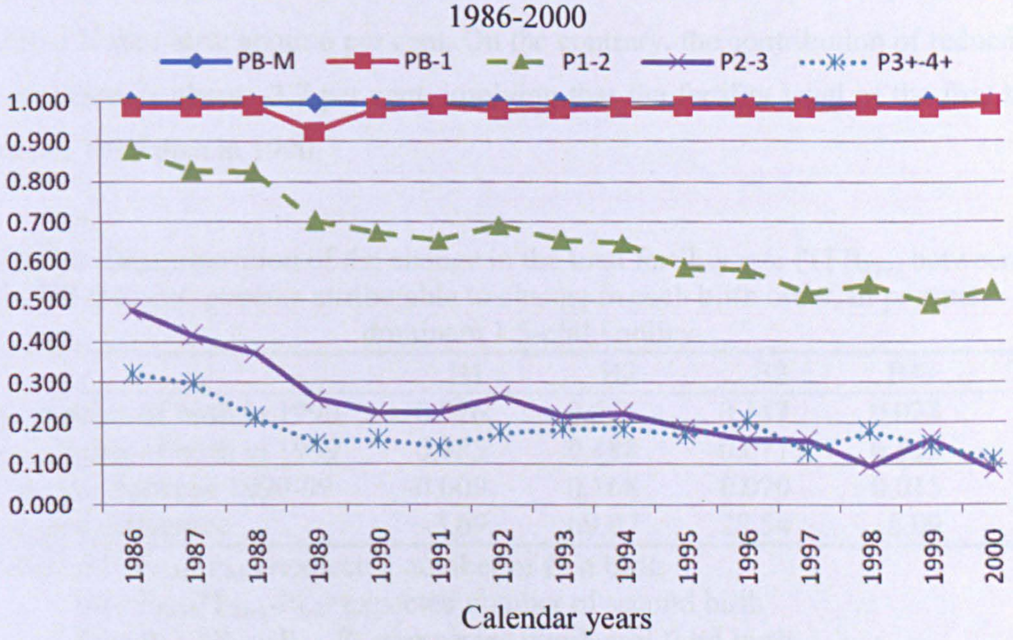
The far right column in Table 7.1 shows the TFR_{ppr} in provinces dominated by the 1.5-child policy and the values are plotted in Figure 7.2. As we can see from Table 7.1 and Figure 7.2, TFR_{ppr} in these provinces was above replacement level before 1988, but sharply declined to 1.77 in 1989, which can be due largely to tightening up of the population policy in that year. The rate rebounded to 1.81 in 1990 and moved downwards to 1.79 in 1991 due to further tightening of population policy in this year. However, there was a strong rebound in 1992. Starting in 1993, the TFR_{ppr} followed a gentle downward trend to the end of the period. Since 1995, the TFR_{ppr} had steadily dropped from 1.68 to 1.56 in 2000, which means TFR_{ppr} moving within the range of policy fertility in provinces dominated by the 1.5-child policy (1.4 – 1.7) since 1995. As can be seen in Figure 7.2, the series of TFR_{ppr} is almost parallel with that of P_{1-2} and P_{2-3}, providing remarkably consistent indication of the trends of fertility level and progressions to second and third births during 1986 and 2000.

Table 7.1: Period parity progressions and total fertility rates (TFR_{ppr}) in provinces dominated by 1.5-child policy: 1986-2000

Year	Progression					TFR_{ppr}
	P_{B-M}	P_{M-1}	P_{1-2}	P_{2-3}	$P_{3^+-4^+}$	
1986	1.000	0.986	0.879	0.477	0.320	2.46
1987	0.999	0.986	0.827	0.415	0.296	2.28
1988	0.998	0.988	0.824	0.371	0.213	2.18
1989	0.997	0.925	0.703	0.260	0.151	1.77
1990	0.995	0.981	0.672	0.224	0.159	1.81
1991	0.992	0.991	0.654	0.224	0.141	1.79
1992	0.999	0.979	0.692	0.264	0.175	1.87
1993	1.000	0.982	0.654	0.217	0.184	1.80
1994	0.987	0.985	0.646	0.223	0.187	1.77
1995	0.992	0.987	0.584	0.186	0.168	1.68
1996	0.999	0.985	0.580	0.158	0.203	1.67
1997	0.999	0.984	0.519	0.155	0.129	1.58
1998	0.995	0.990	0.543	0.095	0.179	1.58
1999	1.000	0.985	0.495	0.158	0.143	1.56
2000	0.997	0.992	0.530	0.085	0.113	1.56

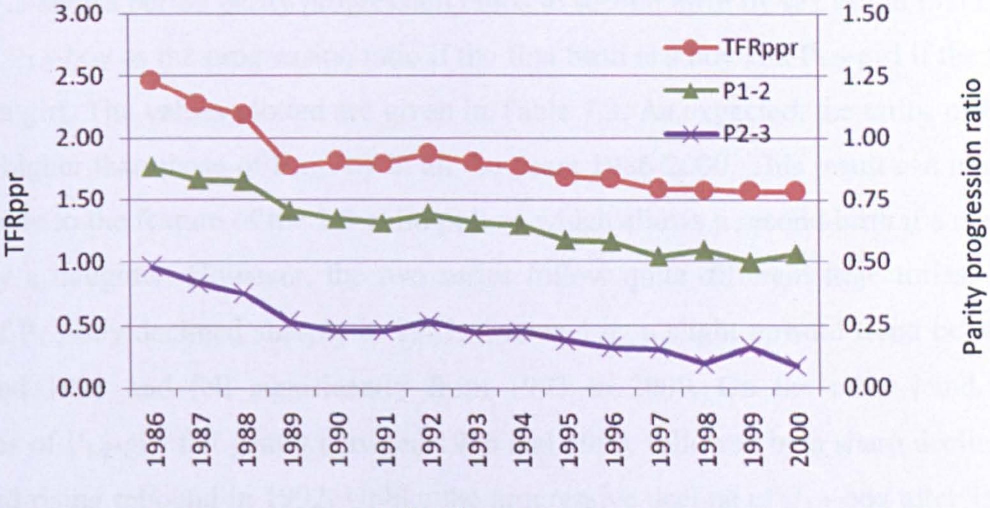
Notes: P_{B-M}, P_{M-1}, P_{1-2}, P_{2-3} and $P_3{}^+{}_{-4}{}^+$ are defined as progression from woman's own birth to her first marriage, first marriage to first birth, first to second birth, second to third birth, and third and higher order to fourth and higher order birth, respectively.

Figure 7.1: Period parity progression ratios in provinces dominated by 1.5-child policy: 1986-2000



Notes: P_{B-M}, P_{M-1}, P_{1-2}, P_{2-3} and $P_3{}^+{}_{-4}{}^+$: same as in Table 6.1

Figure 7.2: Total fertility rates based on parity progression ratios (TFR_{ppr}) and progression to second birth (P_{1-2}) and progression to third birth (P_{2-3}) in provinces dominated by 1.5-child policy: 1986-2000



Calendar years

An illustration of the decomposition of the changes in the TFR_{ppr} between 1990 and 1999 into components attributable to change in each birth order is shown in Table 7.2. The average number of births fell from 1990 to 1999 by 0.244 per woman, of which the second birth contributes 69 per cent of the total reduction, the third 28 per cent and the fourth or higher birth about 6 per cent. On the contrary, the contribution of reduction for the first birth is about –3.7 per cent, implying that the fertility level of the first birth is higher in 1999 than in 1990.

Table 7.2: Decomposition of the change in the total fertility rate (TFR_{ppr}) between 1990 and 1999 into components attributable to change in each birth order, in provinces with a dominant 1.5-child policy

	B1	B2	B3	B4+	TFR_{ppr}
Exp. number of birth in 1990	0.976	0.656	0.147	0.028	1.806
Exp. number of birth in 1999	0.985	0.488	0.077	0.013	1.563
Difference between 1990-99	-0.009	0.168	0.070	0.015	0.244
% of total difference	-3.69	69.07	28.54	6.09	100

Notes: $B1=P_{B-M}*P_{M-1}$=expected number of first birth
$B2= P_{B-M}*P_{M-1}*P_{1-2}$=expected number of second birth
$B3= P_{B-M}*P_{M-1}*P_{1-2}*P_{2-3}$=expected number of third birth
$B_4^+= P_{B-M}*P_{M-1}*P_{1-2}*P_{2-3}*P_{3-4}^{+}/(1-P_{3-4}^{+})$ =expected number of forth or higher order birth

7.2.2 Decomposition of progression to second birth by sex of first birth

Figure 7.3 shows period parity progression ratios to second birth by sex of the first birth, denoted $P_{1\text{-}2}$-boy as the progression ratio if the first birth is a boy and $P_{1\text{-}2}$-girl if the first birth is a girl. The values plotted are given in Table 7.3. As expected, the ratios of $P_{1\text{-}2}$-girl are higher than those of $P_{1\text{-}2}$-boy in all the years 1986-2000. This result can mainly attributable to the feature of the 1.5-child policy, which allows a second birth if a couple has only a daughter. However, the two series follow quite different trajectories. The ratios of $P_{1\text{-}2}$-boy declined sharply in 1989, followed by a slight upward trend between 1990 and 1993 and fell significantly from 1993 to 2000. On the other hand, the estimates of $P_{1\text{-}2}$-girl fall gently between 1986 and 1990, followed by a sharp decline in 1991 and rising rebound in 1992. Unlike the progressive decline of $P_{1\text{-}2}$-boy after 1993, the series of $P_{1\text{-}2}$-girl dropped very gently during 1990s, with some erratic movements in the early 1990s.

Figure 7.3: Sex-specific progression from first to second birth ($P_{1\text{-}2}$) in provinces with a dominant 1.5-child policy in 1986-2000, by sex of the first birth

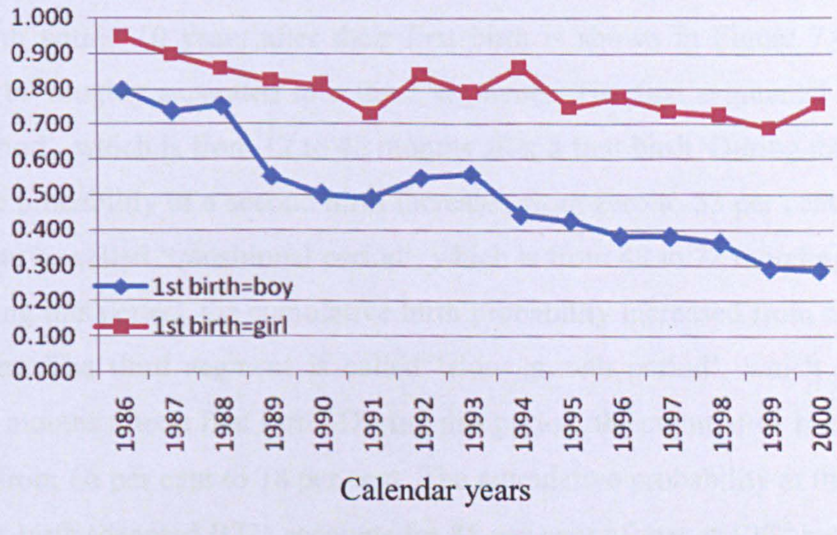


Table 7.3: Progression to second birth ($P_{1\text{-}2}$) in provinces with a dominant 1.5-child policy, by sex of first birth and calendar years

Year	1986	1987	1988	1989	1990	1991	1992	1993
1st birth=boy	0.798	0.737	0.753	0.552	0.502	0.490	0.548	0.558
1st birth=girl	0.946	0.898	0.857	0.825	0.813	0.728	0.839	0.791

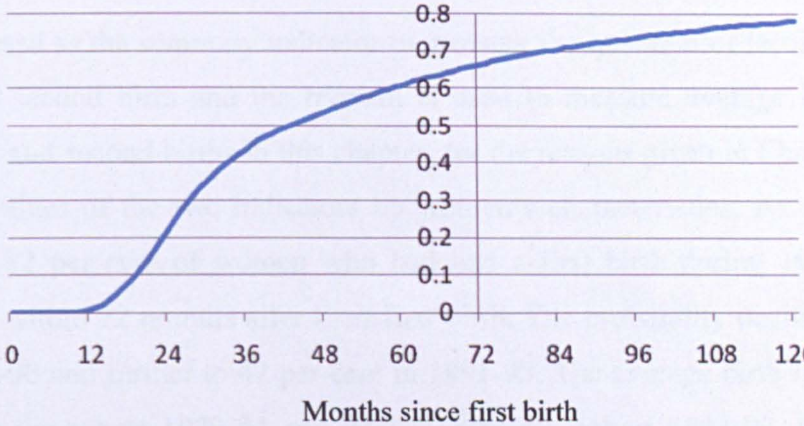
Year	1994	1995	1996	1997	1998	1999	2000
1st birth=boy	0.444	0.427	0.383	0.383	0.364	0.291	0.285
1st birth=girl	0.859	0.748	0.776	0.736	0.726	0.690	0.757

Looking closely at the estimates of $P_{1\text{-}2}$-girl and $P_{1\text{-}2}$-boy, most women having only one daughter went on to have a second birth during 1986-2000. On the contrary, $P_{1\text{-}2}$-boy has been below 0.5 since 1994, indicating that less than 50 per cent of women whose first birth was a son progressed to a second birth after 1994. The gap between the two series was relatively small for the years 1986-1988, i.e. 95.7 per cent of women having only one daughter continued a second birth in 1988, compared with 75.3 per cent of women who had only a son. This gap widened in most of the following years. By the end of these two series, $P_{1\text{-}2}$-girl is about 0.757, compared with 0.285 for $P_{1\text{-}2}$-boy. The gap between $P_{1\text{-}2}$-girl and $P_{1\text{-}2}$-boy increased from 0.204 in 1988 to 0.472 in 2000. Clearly, the decline of overall $P_{1\text{-}2}$ in provinces with a dominant 1.5-child policy during 1986-2000 is due mainly to decline of $P_{1\text{-}2}$-boy.

7.2.3 Cumulative probability of a second birth within 10 years after a first birth

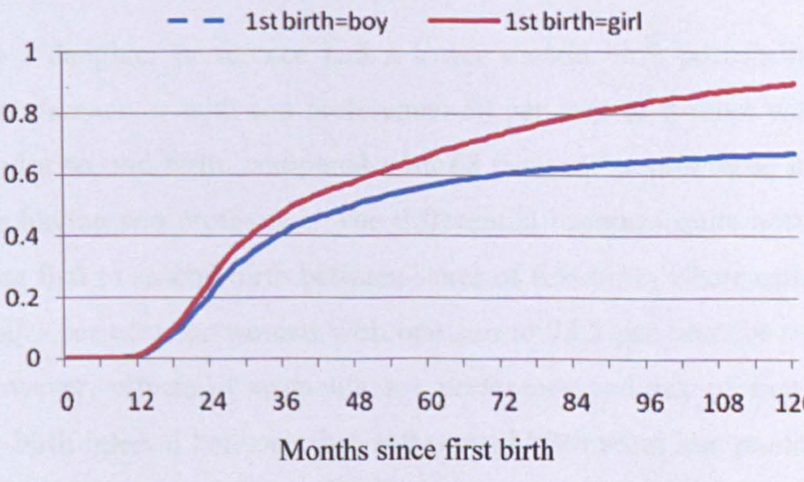
As in Chapter 6, the probability of a second birth is calculated among women who gave their first birth between 1979 and 1995 (N=12711). The cumulative probability of a second birth within 10 years after their first birth is shown in Figure 7.4. This birth curve can be roughly separated into three segments. The first segment I call a 'rapid growth period', which is from 12 to 48 months after a first birth. During this period, the cumulative probability of a second birth increases from zero to 53 per cent. The second segment can be called 'transitional period', which is from 48 to 72 months after the first birth. During this period, the cumulative birth probability increased from 53 per cent to 66 per cent. The third segment is called 'slow growth period', which refers to the remaining months after a first birth. During this period, the cumulative birth probability increased from 66 per cent to 78 per cent. The cumulative probability at the 72nd month after a first birth (denoted B72) accounts for 85 per cent of that at 120th month (denoted B120) and 94 per cent of that at 84th month after a first birth (B84). Compared with cumulative probability of a second birth in provinces with a dominant 1-child policy, estimates of B72, B84 and B120 are 21 per cent, 26 per cent and 30 per cent higher in provinces with a dominant 1.5-child policy, indicating a great contribution to the level of a second birth by the 1.5-child population policy.

Figure 7.4: Probability of second birth among women who had one child (1979-95) in provinces dominated by 1.5-child policy.



Since rural couples with only one daughter are usually permitted to have a second child in provinces dominated by 1.5-child policy, sex of the first born is thus a strong predictor of a second birth. The probability of a second birth is plotted by the sex of the first birth in Figure 7.5. As can be seen from this figure, the birth curve for women whose first birth was a daughter is higher than that for those whose first birth was a son during almost the entire observation period. The estimates of B72 and B120 for women whose first birth was a son are 60.3 per cent and 67.1 per cent, respectively, compared with 73.5 per cent and 89.7 per cent for women whose first birth was a daughter. However, it is noted that nearly two thirds of women having a son had a second birth within 10 years after a first birth. The unexpected high level of a second birth may imply that unapproved second births were common in provinces with a dominant 1.5-child policy.

Figure 7.5: Probability of second birth among women who had a first birth (1991-95) in provinces dominated by 1.5-child policy, by sex of first birth



7.2.4 Cumulative probability of a second birth at the 72nd month after a first birth and average birth interval between first and second births

B72 is also used as the summary indicator to measure the quantum of fertility transition from first to second birth and the trimean is used to measure average birth interval between first and second births in this chapter, for the reasons given in Chapter 6. Table 7.4 reports values of the two indicators by women's characteristics. As shown in the table, about 82 per cent of women who had had a first birth during 1979-84 had a second birth within 72 months after their first birth. The probability declined to 71 per cent in 1985-90 and further to 42 per cent in 1991-95. The average birth intervals were 29.5 months for cohort 1979-84 and 27.3 months for cohort 1985-90. However, the interval increased to 40.8 months for cohort 1991-95.

The estimates of B72 between categories of women's age at first birth range from 62.6 per cent to 72.7 per cent. Those between categories of their husbands' age at first birth vary from 61.9 per cent to 70.2 per cent. The effects of couples' age on the length of the birth interval are less pronounced, as their birth intervals ranged from 28 months to 31 months.

Clearly, women with middle school or higher education had significant lower fertility than those with less education. This differential emerges in the transition from first to second birth which was 59 per cent for the more educated compared with 72 per cent for those with primary or lower education. However, the effect of education on birth interval is small, with the trimeans varying from 29.8 months for the less-educated women to 31.8 months for those better-educated.

Women with a daughter preference had a lower second birth probability than those without sex preference or with son preference: 50 per cent of women with a daughter preference had a second birth, compared with 68 per cent among those having no sex preference or having son preference. The differential becomes quite noticeable in the transition from first to second birth between sexes of first birth, where estimates of B72 range from 60.3 per cent for women with one son to 73.5 per cent for those with one daughter. However, effects of women's sex preference and sex of first birth on the length of the birth interval between first and second birth seem less pronounced, about 2.5 months difference between categories of women's son preference and less than 1 month between sexes of first birth. The values of B72 and trimeans are very similar for Han Chinese and ethnic minorities, indicating similar reproductive behaviours between Han and ethnic minorities in provinces with a dominant 1.5-child policy.

Table 7.4: Summary measures for birth intervals between first (1979-95) and second birth in provinces dominated by 1.5-child policy, by individual characteristics

Category of women's characteristics		N at start	B72	Trimean (months)
Calendar cohort of first birth				
	1979-84	4110	0.824 **	29.5
	1985-90	5107	0.713	27.3
	1991-95	3494	0.422	40.8
Women's age at first birth				
	≤20	3364	0.727 **	28.3
	~22	4044	0.654	30.0
	~24	3308	0.626	31.5
	≥25	1995	0.671	31.5
Husband's age at first birth				
	≤21	2810	0.702 **	28.0
	~23	4094	0.619	30.3
	~25	2979	0.675	31.0
	26+	2828	0.701	30.8
Women's education				
	≤Primary School	7843	0.719 **	29.8
	Middle School +	4868	0.588	31.8
Couple's minority status				
	Both Han Chinese	11538	0.668	30.0
	One or both minority	1173	0.680	30.3
Woman's sex preference				
	Daughter	510	0.502 **	30.1
	No	10730	0.675	30.3
	Son	1471	0.683	27.8
Sex of first birth				
	Boy	6417	0.603 **	29.8
	Girl	6294	0.735	30.5

Woman's son preference= ideal number of boy – ideal number of girl
* P value <0.05, ** P value <0.01 (test the difference of cumulative probability of 2nd birth within 72 months after 1st birth between categories of each indicator.)

Table 7.5 reports estimates of B72 and birth intervals by categories of selected institutional and provincial geographic and socio-economic indicators. As shown in the table, probabilities of a second birth within 6 years after a first birth in townships vary from 55.7 per cent to 72.2 per cent, with the lowest level in townships without a FPSC and highest level in townships with good provision of short- and long-term contraceptive methods. Estimates of B72 declined with the quality of FP services in villages. The probabilities of a second birth in villages with poor, moderate and good FP services were 78.7 per cent, 66.3 per cent and 65.4 per cent, respectively. Probability of a second birth also decreased with average household income in villages: 72.7 per cent in villages with lowest average household income, 66.3 - 71.8 per cent in villages where the average household income being at middle-level and 55.2 per cent in villages with highest average household income. Differences in average birth intervals between townships and between villages were small, ranging from 28.5 months to 31.0 months.

The probability of a second birth follows a geographic gradient, increasing from 57.1 per cent in the East region to 69.0 per cent in the Central region and further to 81.7 per cent in the West region. It generally declines with the level of GDP per capita: 79 per cent in provinces where GDP per capita was less than 4200 Yuan, 67 per cent in provinces where GDP per capita was between 4000 and 6000 Yuan and 46 per cent in provinces where the GDP per capita was between 6000 and 9000 Yuan. However, the probability remarkably rose to 67 per cent in provinces where the GDP per capita was greater than 9000 Yuan. The difference of average birth intervals was small between geographical regions. Birth interval was shortest in the least developed provinces (28.8 months) and longest in provinces where the GDP per capita was between 6000 and 9000 Yuan (33.0 months) with a rising trend as the probability of a second birth declined.

Estimates of B72 rose (from 59.1% to 75.2%) with the proportion of rural population. It slightly declined to 70.6 per cent in provinces with more than 75 per cent of rural population. The average birth interval ranged from 28.5 months in provinces with 70-75 per cent of rural population to 33 months in provinces with 60-70 per cent of rural population. No clear relationship between birth interval length and the proportion of rural population can be discerned.

In provinces characterised as having no son preference, 47.1 per cent of women had a second birth within 6 years after a first birth. The proportion increases to 68.1 per cent in provinces with weak son preference and further to 85 per cent in provinces with strong son preference. The birth interval declines with strength of son preference, from 34.0 months to 30.8 months and further to 26.8 months. The probability of a second birth is lowest (65%) in provinces with moderate level of ethnic minority groups but highest (67.8%) in provinces with lowest level of minority groups. Birth intervals of the three categories of provinces range from 28.5 months to 30.8 months.

Table 7.5: Summary measures for birth intervals between first (1979-95) and second births in provinces dominated by 1.5-child policy, by township/village- and province level indicators

Indicators	N at start	B72	Trimean (months)
Township-village level			
Family planning services at township FPSCs		**	
No a FPSC	481	0.557	30.8
Good short-, poor long-term meth. provision	6451	0.630	30.3
Good long- & short-term meth. provision	5036	0.722	29.8
Moderate long-, poor short-term meth. provision	943	0.698	30.8
Family planning services at villages		**	
Good	6725	0.654	30.5
Moderate	4902	0.663	30.0
Poor	1084	0.787	28.5
Average annual income / family in villages (Yuan)		**	
<1200	2965	0.727	28.5
~1900	3410	0.718	30.8
~2800	3557	0.663	31.0
2800+	2779	0.552	30.5
Provincial level			
Geographical region		**	
East	4702	0.571	30.0
Central	5732	0.690	30.0
West	2277	0.817	28.5
GDP per capita (Yuan)		**	
<4200	1864	0.79	28.8
~6000	5767	0.67	30.8
~9000	3432	0.46	33.8
>9000	1648	0.67	29.3
% of rural population		**	
<60	3804	0.591	30.8
~70	2456	0.608	33.0
~75	4506	0.752	28.5
75+	1945	0.706	31.3
% of ethnic minority groups		*	
<3	7026	0.678	30.8
~9	2850	0.650	30.0
9+	2835	0.664	28.5
Strength of son preference		**	
No	2658	0.471	34.0
Weak	7677	0.681	30.8
Strong	2376	0.850	26.8

Notes: see Table 7.4

7.2.5 Predictors of a second birth

Chi-square tests indicate that all the variables shown in Tables 7.4 and 7.5 are significantly associated with the likelihood of a second birth within 6 years after the first birth except for couple's minority status. Three-level logistic regression models are used to explore the independent effects of these variables on the probability of a second birth and to identify whether effects of level-1 (individual women) variables vary between provinces and between townships/villages.

The binary response of the multilevel logistic regression model is 1 (y_{ijk}) for woman i in township/village j and province k who had a second birth within 6 years after the first birth, and 0 if she did not have. Results of multilevel analyses are shown in Table 7.6. Models 1 to 5 in Table 7.6 are random intercept models that allow the overall probability of a second birth to vary between townships/villages and across provinces. Model 1 fits just the overall mean of the data (null model) and models 2-5 include different combinations of variables of level-1, -2 and -3. Model 6 allows the effects of women's education and sex of first birth to vary between townships/villages and across provinces.

As can be seen from the table, the fixed effects of these models are very consistent: women's education, calendar cohort of first birth, sex of first birth, women's sex preference, average household annual income in villages, proportion of rural population, strength of son preference, geographical region and GDP per capita in a province are significantly associated with the odds of a second birth within 6 years after a first birth.

The better-educated women and those whose first child was born in more recent years were significantly less likely to have a second birth than their respective counterparts. The odds of a second birth for women whose first child was a daughter is about $e^{(1.034)}$=2.81 times greater than that for women whose first child was a son, with 95% confidence interval (CI) ranging from 2.53 to 3.13. Compared with women having daughter preference, those having no sex preference were significantly less likely to have a second birth, with a log-odds about 0.44. However, the difference of probabilities of a second birth between women having daughter preference and those having son preference is not statistically significant after adjusting for township/village-level variables.

Average household annual income in villages shows a significant association with probability of a second birth, where women from richer villages were less likely to have a second child. Similar is the association of GDP per capita with the likelihood of a second birth. The effect of economic indicator at province-level (GDP per capita) on the probability of a second birth (odd ratio, OR, = $e^{(-2.051)}$ = 0.13, 95% CI = 0.07-0.25) seems greater than that of economic indicator at village-level (average household income in villages) (OR=$e^{(-0.4)}$=0.67, 95% CI=0.57-0.79). Women in Central (OR=3.22, 95% CI=1.85-5.58) and West (OR=8.56, 95% CI=3.99-18.35) regions are significantly more likely to have a second birth than those in the East region. These results are consistent with that of GDP per capita because the East region is the most developed and the West region is the least developed region. Son preference at province-level shows a very strong relationship to the likelihood of a second birth, with ORs being 65 ($e^{4.181}$) in provinces with weak son preference and 72 ($e^{4.280}$) in provinces with strong son preference in model 4 and being 13 ($e^{2.613}$) in the former group of provinces and 43 ($e^{3.762}$) in the latter group of provinces in model 5. The smaller ORs in model 5 than in model 4 may be because the relationship of strength of son preference to probability of a second birth is partially explained by GDP per capita in a province.

The negative coefficients for the three categories of proportion of rural population indicate provinces with more than 60 per cent of rural population had significantly lower probabilities of a second birth than provinces with less than 60 per cent of rural population did. The effects of rural population seem less strong in model 5 than in model 4, which may be due to correlation between GDP per capita and proportion of rural population. After controlling for potential confounding, proportion of ethnic minority groups shows no association with the probability of a second birth, indicating that Han Chinese and ethnic minorities have a similar probability of a second birth in provinces dominated by 1.5-child policy.

Comparing the random effects between null model (model 1) and model 2, the overall unexplained variance declined from 1.235+3.394=4.629 for the null model to 1.275+2.091=3.366 for model 2, but the between-township/village variance slightly increased. Thus the reduction of overall high-level variance is mainly contributed by decline of between-province variance. The overall variance further falls from model 2 to 1.243+1.929= 3.172 for model 3 and 1.256+0.479=1.735 for model 4 (model 5 is similar to model 4), indicating that level-2, and particularly level-3 variables, partly explain variations of probabilities of a second birth between townships/villages and between provinces. Specifically, the four province-level variables explain about three-fourths of the province-level variation in model 3. Nevertheless, the level-2 and level-3 variances are still significantly greater than zero using the Wald test. This implies that there are still unknown predictors that resulted in variations of the probabilities of a second birth between provinces and, particularly, between townships/villages.

In model 6, I allow the effect of women's education on the probability of a second birth to vary between townships/villages and effect of sex of first birth on the probability to vary between townships/villages and between provinces. As can be seen in the far right column of Table 7.7, the fixed effects of women's education and sex of first birth in the random coefficient model are still statistically significant. The odds of a second birth is 2.96 times higher for women whose first birth was a daughter than for those whose first birth was a son. Moreover, the random effects indicate that effect of sex of first birth varies between townships/villages and between provinces. Although the average effect of women's education shows that the better-educated women were less likely to have a second birth, the effect was also different between provinces, indicating women's education having positive effect on the likelihood in some provinces but negative effect in some other provinces.

Using equations 6.1 and 6.2, we can calculate that the between-township/village variances are 1.6 for women whose first birth was a son and 1.6+2*(-0.438) + 0.522=1.248 for women whose first birth was a daughter. Similarly, we obtain the between-province variances of 1.282 for women whose first birth was a son, and 1.282+2*(-0.464)+0.302=0.656 for women whose first birth was a daughter. Moreover, the between-province variances are 1.282 for women with primary school or lower education and 1.282+2*(-0.394) + 0.255=0.749 for those with middle school or higher education. It can be concluded, therefore, that there are larger variations in the probability of a second birth between high-level units for women whose first birth was a son than for women whose first birth was a daughter. There is also larger variation of the likelihood of a second birth between provinces for women with primary school or less education than for those with middle school or higher education.

The DIC statistics indicate that the three-level logistic model is slightly improved when higher-level variables are included in the model. Random coefficient models that allow effects of other level-1 variables to vary between townships/villages or between provinces are also fitted. None of their random coefficients are significant at the level of 0.05. Hence, their effects do not vary between high-level units.

Table 7.6: Parameter estimates of 3-level logistic regression models from fitting data on second birth in provinces dominated by 1.5-child policy

Predicators (reference category)	Model 1 Coeff.	Model 1 s.e.	Model 2 Coeff.	Model 2 s.e.	Model 3 Coeff.	Model 3 s.e.	Model 4 Coeff.	Model 4 s.e.	Model 5 Coeff.	Model 5 s.e.	Model 6 Coeff.	Model 6 s.e.
Fixed effects												
Intercept term	1.060	0.271**	1.309	0.329**	1.577	0.293**	-0.622	0.306*	0.750	0.299*	1.169	0.254**
Individual level (level-1)												
Woman's age at 1st birth (ref: ≤21 years old)												
~23			-0.070	0.077	-0.068	0.073	-0.065	0.073	-0.059	0.072	-0.050	0.080
~25			-0.122	0.083	-0.115	0.085	-0.102	0.078	-0.103	0.082	-0.085	0.088
26+			-0.066	0.100	-0.054	0.098	-0.041	0.098	-0.041	0.095	-0.021	0.103
Husband's age at 1st birth (ref:≤22 years old)												
~24			-0.101	0.075	-0.086	0.074	-0.098	0.070	-0.093	0.075	-0.096	0.079
~26			-0.045	0.086	-0.030	0.087	-0.044	0.082	-0.038	0.090	-0.039	0.091
27+			-0.086	0.090	-0.077	0.088	-0.095	0.090	-0.084	0.094	-0.079	0.097
Women's education (ref: ≤Primary School)												
Middle School+			-0.254	0.059**	-0.211	0.056**	-0.213	0.058**	-0.212	0.055**	**-0.237**	**0.091***
Calendar cohort of first birth (ref: 1979-84)												
1985-90			-0.684	0.346*	-0.972	0.330**	-0.912	0.227**	-1.039	0.301**	-1.265	0.201**
1991-95			-2.510	0.422**	-2.837	0.312**	-2.887	0.202**	-3.005	0.322**	-3.156	0.234**
Sex of 1st birth (ref: Boy)												
Girl			1.037	0.054**	1.034	0.055**	1.035	0.058**	1.036	0.056**	**1.086**	**0.087****
Woman's son preference (ref: Daughter)												
No			0.539	0.125**	0.432	0.148*	0.430	0.137**	0.449	0.128**	0.440	0.114**
Son			0.292	0.153†	0.179	0.170	0.167	0.161	0.192	0.150	0.191	0.144
Township-village level (level-2)												
Average income at village					-0.418	0.077**	-0.409	0.078**	-0.400	0.084**	-0.424	0.085**
FP services at FPSCs (ref: good short, poor long)												
No a FPSC					0.057	0.226	0.056	0.212	0.059	0.208	-0.018	0.233
Good short- & long-term method provision					0.129	0.099	0.110	0.098	0.099	0.095	0.089	0.101
Poor short-term, moderate long-term method provision					0.091	0.168	0.110	0.161	0.110	0.166	0.088	0.165
FP services at villages (ref: Good)												
Moderate					0.072	0.091	0.088	0.090	0.093	0.088	0.096	0.092
Poor					0.158	0.165	0.094	0.152	0.077	0.163	0.067	0.168

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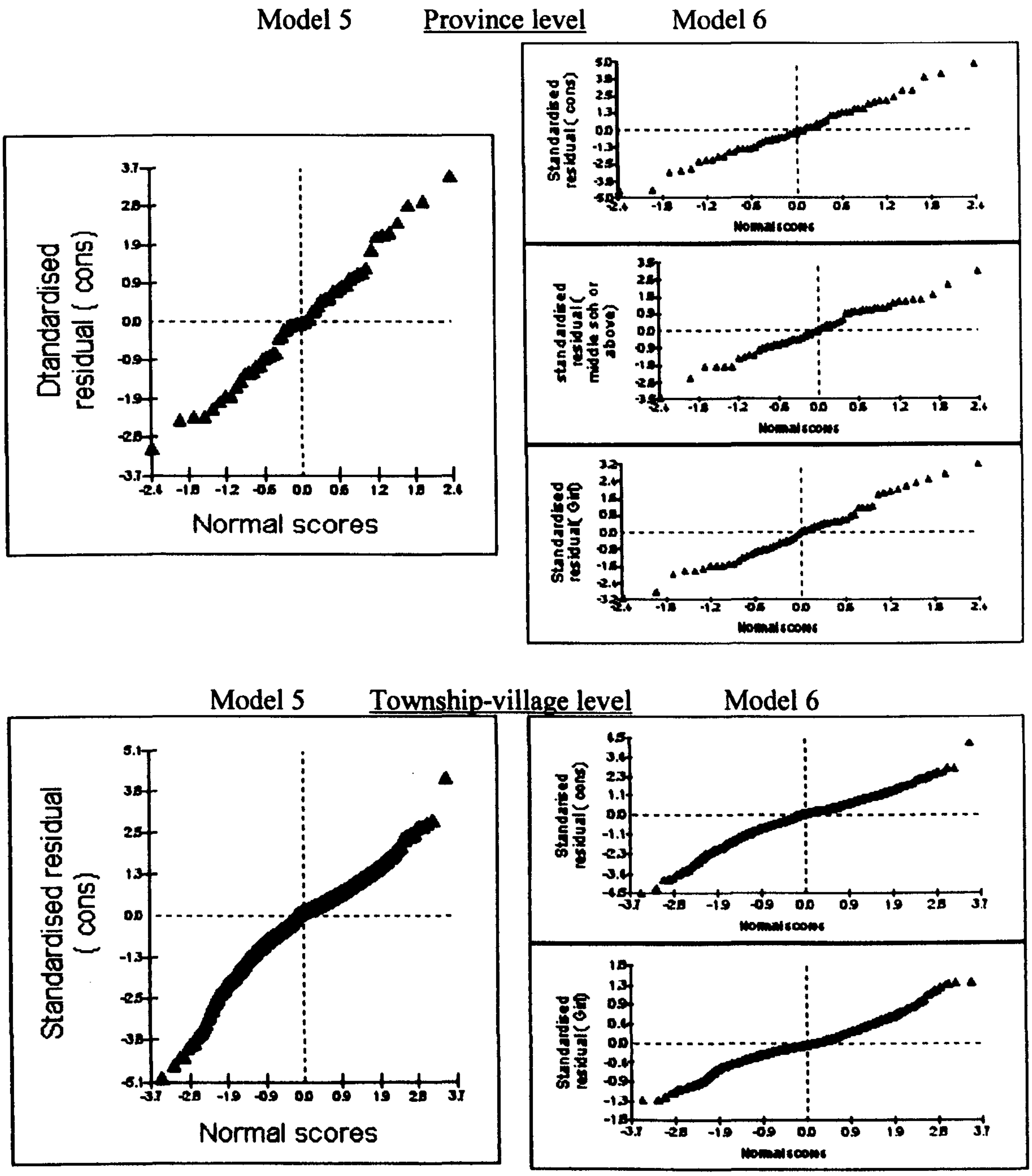
Table 7.6: continued from previous page

Predicators (reference category)	Model 1 Coeff.	s.e.	Model 2 Coeff.	s.e.	Model 3 Coeff.	s.e.	Model 4 Coeff.	s.e.	Model 5 Coeff.	s.e.	Model 6 Coeff.	s.e.
Province level (level-3)												
Geographical region (ref: East region)												
Central							1.168	0.281**				
West							2.147	0.389**				
GDP per capita (centred log value)									-2.051	0.340**	-2.001	0.291**
% of rural population (ref: <60)												
~70							-3.229	0.507**	-2.114	0.409**	-2.844	0.360**
~75							-2.573	0.365**	-2.061	0.323**	-2.356	0.321**
75+							-3.573	0.459**	-1.896	0.418**	-2.874	0.366**
% of ethnic minority groups (ref: <3%)												
~9							0.148	0.293	0.030	0.319	-0.146	0.216
9+							-0.387	0.450	-0.298	0.270	-0.369	0.225
Strength of son preference (ref: No son preference)												
Weak							4.181	0.450**	2.613	0.294**	2.968	0.341**
Strong							4.280	0.387**	3.762	0.367**	3.491	0.388**
Random effects												
Township-village level variance												
Intercept term	1.235	0.101**	1.275	0.105**	1.243	0.106**	1.256	0.109**	1.240	0.100**	1.600	0.164**
Sex of 1st birth											0.522	0.148**
Covariance (intercept-sex)											-0.438	0.141**
Province level variance												
Intercept term	3.394	0.695**	2.091	0.434**	1.929	0.415**	0.479	0.137**	0.553	0.152**	1.282	0.279**
Sex of 1st birth											0.302	0.089**
Woman's education											0.255	0.087**
Covariance: intercept-sex											-0.464	0.141**
Covariance: sex of 1st birth-woman's education											0.014	0.060
Covariance: woman's education-intercept											-0.394	0.129**
DIC	11280.3		10866.4		10858.2		10853.5		10853.6		10725.8	

*p<0.05, **P<0.01.

Normality assumptions for high-level units are checked using normal probability plots (see Figure 7.6). The plots of both level-2 and level-3 residuals look fairly linear, indicating the assumptions of normality at level-2 and level-3 are reasonable.

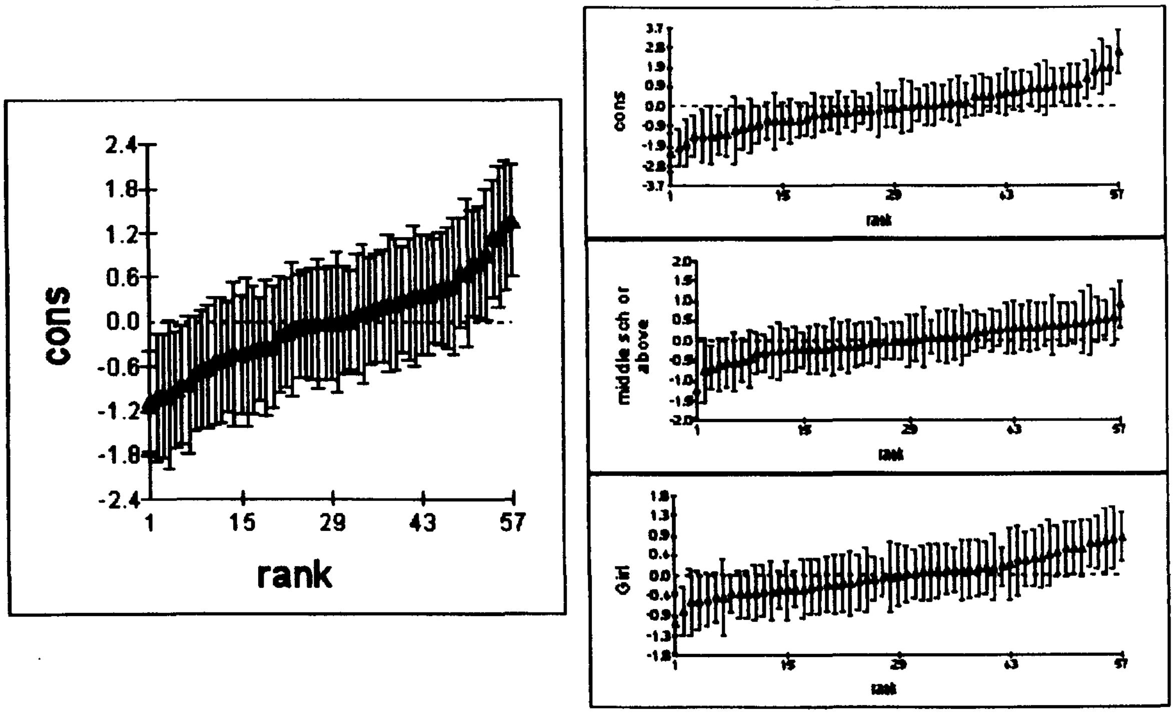
Figure 7.6: Normal plots of standardised level-2 (township-village) and level-3 (province) residuals × normal scores of models 5 and 6



High-level residuals with 95% CIs for models 5 and 6 are displayed graphically in Figure 7.7. Several provinces and some townships/villages have 95% CIs of residuals that do not overlap the line at zero, which suggests their mean probability of a second birth within six years after a first birth is significantly lower or higher than average.

Figure 7.7: Residuals and 95 per cent confidence intervals by rank of provinces

Model 4 Model 5



Predictors of a second birth by sex of the first birth

The central feature of the 1.5-child policy is that parents with only one daughter can officially be approved to have a second child. However, as can be seen in Table 7.5, 60 per cent of women whose first birth was a son had a second child. This result is somewhat surprising because couples whose first child was a son are normally not allowed a second child. I, therefore, separate the data of second births by sex of first birth and to see whether predictors of a second birth are different between women whose first was a son and those whose first was a daughter.

Table 7.7 presents the distributions of probabilities of a second birth within six years after a first birth by sex of first birth and categories of women's characteristics and selected high-level indicators. As can be seen in the table, the probabilities of a second birth among women with a son ranged from 37.1 per cent to 81.0 per cent, while among those having only a daughter, the proportions ranged from 51.0 per cent to 89.0 per cent.

For each category of each variable, the likelihood of a second birth is higher among women whose first birth was a daughter than among those whose first birth was a son. Chi-square tests indicate that most women's characteristics and selected high-level indicators are associated with the likelihood of a second birth among both groups of women except for couple's ethnic minority status and proportion of ethnic minority groups in a province. Among women with only a son, those whose first child was born in more recent years were less likely to have a second child. The youngest or oldest couples tended to have higher probabilities of a second birth. This is the case no matter what sex of the first birth. The probability of a second birth drops with women's education, village's FP service quality and average household income but rises with women's son preference and strength of son preference at province-level. The probability of a second birth also follows a geographical pattern increasing from East to Central and further to West regions. Provinces with higher GDP per capita are associated with lower probability of a second birth except the category with extreme high GDP per capita. On the contrary, provinces with a greater proportion of rural population are associated with higher probability of a second birth except the category with an extremely high proportion of rural population. The patterns of a second birth look similar for both groups of women having only a son and having only a daughter.

Table 7.7: Percentage of a second birth within six years after a first birth (1979-95) in provinces dominated by 1.5-child policy, by sex of first birth and individual, township/village- and province-level indicators

Indicators	First birth=boy			First birth=girl		
	No.	% of 2nd birth	P value	No.	% of 2nd birth	P value
Individual level						
Calendar cohort of first birth						
1979-84	2098	76.9	0.000	2012	88.8	0.000
1985-90	2566	65.3		2541	78.0	
1991-95	1753	33.9		1741	51.3	
Women's age at 1st birth						
≤21	1752	68.9	0.000	1612	77.5	0.000
~23	2010	58.2		2034	73.2	
~25	1654	56.0		1654	70.0	
26+	1001	57.9		994	77.1	
Husband's age at 1st birth						
≤22	1468	64.2	0.000	1342	77.6	0.000
~24	2070	55.9		2024	69.0	
~26	1467	59.5		1512	75.6	
27+	1412	64.6		1416	76.3	
Women's education						
≤Primary School	3982	66.2	0.000	3861	78.5	0.000
Middle School+	2435	51.2		2433	67.0	
Couple's status of ethnic minority						
Both Han	5839	60.4	0.422	5699	74.0	0.844
One or both minority	578	62.1		595	74.5	
Women's sex preference						
Daughter	210	50.5	0.002	300	51.0	0.000
No	5239	61.4		5491	74.0	
Son	968	58.2		503	88.1	
Township-village level						
Family planning services at township FPSCs						
No a FPSC	257	51.8	0.000	224	61.2	0.000
Good short-term, poor long-term method provision	3120	56.6		3131	70.0	
Good long- & short-term method provision	2564	65.5		2472	80.0	
Moderate long-term, poor short-term method provision	476	64.3		467	75.8	
Family planning services in villages						
Good	3331	58.8	0.000	3394	72.6	0.000
Moderate	2527	59.6		2375	74.1	
Poor	559	75.1		525	83.4	
Average household annual income in villages (Yuan)						
<1200	1505	67.4	0.000	1460	79.3	0.000
~1900	1690	66.5		1720	77.8	
~2800	1802	59.0		1755	74.4	
2800+	1420	48.0		1359	63.1	

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Table 7.7: continued from previous page

Indicators	First birth=boy No.	% of 2nd birth	P value	First birth=girl No.	% of 2nd birth	P value
Provincial level						
Geographical region						
East	2389	49.8	0.000	2313	65.6	0.000
Central	2911	62.9		2821	75.8	
West	1117	77.3		1160	86.6	
GDP per capita (Yuan)						
4200	922	78.6	0.000	942	87.5	0.000
~6000	2909	65.4		2858	77.4	
~9000	1735	40.9		1697	59.8	
>9000	851	64.3		797	76.5	
% of rural population						
<60	1962	51.1	0.000	1842	68.2	0.000
~70	1189	53.6		1267	68.7	
~75	2306	69.6		2200	81.4	
75+	960	66.7		985	75.5	
% of ethnic minority groups						
<3	3517	61.8	0.047	3509	74.6	0.286
~9	1435	58.2		1415	72.4	
9+	1465	59.7		1370	74.4	
Strength of son preference						
No	1364	37.1	0.000	1294	58.7	0.000
Weak	3871	62.5		3806	74.6	
Strong	1182	81.0		1194	89.0	
Total	6417	60.5		6294	74.1	

Three-level logistic regression models are used to explore predictors of a second birth for both groups of women. Parameter estimates of comprehensive models are displayed in Table 7.8. Model 1 (M1) and model 2 (M2) in Table 7.8 fit data of second births within six years after a first birth among women whose first birth was a son. M1 is a random intercept model, assuming fixed effects of predictors across provinces as well as townships/villages. M2 allows effect of women's education to vary between provinces (random coefficient model). Model 3 (M3) and model 4 (M4) fit data on second births within six years after a first birth among women whose first birth was a daughter. M3 is a random intercept model and M4 is a random coefficient model, allowing the educational effect to vary between provinces.

Results from the fixed part of models 1 and 2 clearly show that, among women whose first birth was a son, the older and better-educated women and those who preferred a son were significantly less likely to have a second birth than their respective counterparts. Women whose son was born in 1985-90 or in 1991-95 were associated with a significantly lower probability of a second birth than those whose son born in 1979-84, with ORs being 0.39 and 0.04 respectively. Estimated coefficients of the main effects also show that the more developed villages and provinces as well as those with less than 60 per cent of rural population were significantly less likely to have a second birth than their respective counterparts. Expectedly, strength of son preference in a province shows a positive relationship to the probability of a second birth. However, when removing strength of son preference from model 1, coefficients of the three categories of rural population become positive and two of them are more than two times their standard error, indicating that provinces with more rural population are more likely to have a second birth. The conflicting results between models with or without the predictor of son preference at province-level suggest that the effect of proportion of rural population on the likelihood of a second birth is confounded by strength of son preference. Provinces with less than 60 per cent of rural population seem to have less strong son preference than others.

Models 1 and 2 show that the effect of women's son preference on the probability of a second birth is opposite to that of son preference at province-level: women's son preference was associated with a significantly lower probability but son preference at province-level was associated with a significantly higher probability of a second birth. It is worth noticing that these results are obtained from women whose first birth was a son. Since women had achieved the deserved sex of a child, they would have a less strong motive for a second birth than women without a son preference. However, women who preferred daughters (the reference group) would be more likely to have a second birth if their first birth was a son, even if they would not be approved to have a second child. On the other hand, strength of son preference is measured at provincial level. It reflects a general social norm in a province rather than a perspective of individual woman. The effect of son preference at province-level indicates that the strong social norm of son preference results in a higher probability of a second birth. Thus the opposing results are reasonable.

Comparing coefficients between models 1 and 2 shows that, the fixed effects of level-1 and level-2 predictors are close, but the absolute values of coefficients for categories of rural population and strength of son preference in model 2 are considerably greater than those in model 1. Clearly, these results are due to allowing the effect of women's education to vary between provinces, which may be more likely to reflect their true effects on likelihood of a second birth at province-level.

Using equations 6.1 and 6.2, we show that, for women with middle school or higher education, the between-province variance is 0.796; for women with primary school or less education, the between-province variance is 0.796+2*0.115+0.241 = 1.267. Therefore, there is larger between-province difference in the probability of a second birth for the less-educated women than for the better-educated ones.

The reduction of unexplained province-level variance from 0.971 in model 1 to 0.796 in model 2 indicates that part of the differential in the probability of a second birth between provinces can be explained by differential effects of women's education in different provinces. However, the unexplained province-level variance and township/village-level variance in the random coefficient model are still statistically significant, indicating that unmeasured factors contribute to variation of a second birth between provinces and particularly between townships/villages.

Table 7.8: Parameter estimates of three-level logistic regression models from fitting data on second births in provinces dominated by 1.5-child policy, by sex of first birth

Predicators	First birth=boy				First birth=girl			
	Model 1		Model 2		Model 3		Model 4	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Fixed effects								
Intercept term	1.065	0.455*	1.233	0.439**	0.932	0.270**	0.927	0.343*
Individual level (level-1)								
Woman's age at 1st birth (ref: ≤21 years old)								
22~23	-0.221	0.103*	-0.227	0.112	0.135	0.111	0.116	0.102
~25	-0.271	0.119*	-0.279	0.125*	0.122	0.122	0.085	0.110
26+	-0.509	0.140**	-0.521	0.151**	0.498	0.147**	0.461	0.139**
Husband's age at 1st birth (ref: ≤22 years old)								
23~24	-0.067	0.107	-0.053	0.109	-0.251	0.111*	-0.198	0.108
~26	-0.063	0.125	-0.044	0.134	-0.124	0.130	-0.076	0.121
27+	0.032	0.133	0.046	0.144	-0.327	0.142*	-0.271	0.134*
Women's education (ref: Middle School+)								
≤Primary School	0.271	0.088**	<u>0.247</u>	<u>0.125*</u>	0.252	0.087**	<u>0.263</u>	<u>0.106*</u>
Calendar cohort of first birth (ref: 1979-84)								
1985-90	-0.940	0.321**	-0.992	0.352**	-0.932	0.213**	-1.037	0.245**
1991-95	-3.230	0.344**	-3.176	0.371**	-2.830	0.272**	-3.058	0.286**
Woman's sex preference (ref: Daughter)								
No	-0.223	0.217	-0.241	0.196	0.885	0.159**	0.940	0.185**
Son	-0.699	0.243**	-0.730	0.216**	1.290	0.234**	1.360	0.250**
Township-village level (level 2)								
Average income in vill.	-0.527	0.109**	-0.521	0.112**	-0.340	0.099**	-0.327	0.100**
FP services at FPSCs (ref: good short, poor long)								
No a FPSC	0.193	0.295	0.169	0.299	-0.174	0.258	-0.203	0.255
Good short- & long-term method provision	-0.111	0.138	-0.125	0.131	0.360	0.122**	0.369	0.123**
Poor short-term, moderate long-term method provision	0.212	0.226	0.207	0.211	0.064	0.196	0.089	0.202
FP services at villages (ref: good quality)								
Moderate	0.015	0.122	0.024	0.115	0.201	0.108	0.195	0.107
Poor	0.076	0.218	0.086	0.219	0.103	0.209	0.111	0.201
Province level (level3)								
GDP per capita	-2.335	0.533**	-2.992	0.509**	-1.709	0.385**	-1.804	0.355**
% of rural population (ref: <60)								
60~70	-2.039	0.808*	-3.841	0.837**	-1.791	0.620**	-1.947	0.508**
~75	-2.017	0.625**	-3.407	0.553**	-1.691	0.529**	-1.832	0.462**
75+	-1.682	0.840*	-3.450	0.785**	-1.542	0.613*	-1.914	0.505**
% of ethnic minority groups (ref: <3%)								
3~9	0.195	0.455	-0.034	0.452				
9+	-0.330	0.435	-0.523	0.392				

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Table 7.6: continued from previous page

Predicators	First birth=boy				First birth=girl			
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Strength of son preference (ref.=no son preference)								
Weak	2.905	0.583**	4.436	0.596**	2.083	0.506**	2.299	0.476**
Strong	4.373	0.524**	5.079	0.403**	3.103	0.372**	3.230	0.383**
Random effects								
Township-village level: Intercept term	1.780	0.194**	1.767	0.195**	1.129	0.136**	1.094	0.156**
Province level : Intercept term	0.971	0.269**	0.796	0.240**	0.380	0.132**	0.186	0.076*
Variance of woman's education			0.241	0.124†			0.238	0.100*
Covariance: level-3 intercept - education			0.115	0.128			0.107	0.063

† p <0.10, * p<0.05, ** p<0.01

Models 3 and 4 fit data on second births among women whose first birth was a daughter. From the fixed effects of the two models, we can find that the estimated coefficients for women's age at first birth are positive rather than negative as they are in models 1 and 2. Women having a daughter at 26 or older were significantly more likely to have a second birth than those having a daughter at 21 or younger. We can also see that the effects of women's son preference are positive rather than negative as they are shown in models 1 and 2. That is to say, women who preferred sons but had a daughter were significantly more likely to have a second birth. The stronger a woman's son preference, the higher is the probability of a second birth. Comparing the effect of women's sex preference in models 1/2 with that in models 3/4, we can conclude that the probability of a second birth is affected not only by women's sex preference but also by the sex of their first child. Women who preferred daughters, but had a son and those who preferred sons but had a daughter may be more likely to have a second birth in order to achieve the desired sex of offspring.

Husbands' age at first birth shows a negative association with the likelihood of a second birth if their first birth was a daughter, particularly the oldest fathers. This result may be because the youngest fathers were more likely to come from traditional families with stronger son preference. This interpretation is based on the consideration that the youngest fathers were married below 23 years old, the official requirement on men's minimum marriage age that is embedded in China's Marriage Law. Traditionally in many rural areas, a marriage starts at the date of the marriage ceremony rather than the date of registration in government marriage offices. Effect of husbands' age at first birth on the likelihood of a second birth is not significant if the first birth was a son. This result provides an indirect support for the above interpretation.

Results consistently show that better-educated women and those whose first child was born in more recent years were significantly less likely to have a second birth. This is because the less-educated women may be subject to a more lenient population policy and be more likely to have an unapproved birth than the better-educated ones. Since population policy was intensified in 1991 and the following years, it is expected that the probability of a second birth would fall in more recent years. A growing preference for a smaller family size in more recent years may also partly contribute to the decreased probability of a second birth.

The probability of a second birth declines with village average household income and provincial GDP per capita no matter the sex of the first birth. These results are consistent with the general agreement that economic development would reduce the overall fertility level. However, effects of the two economic factors seem smaller among women whose first birth was a daughter than among those whose first birth was a son.

Quality of FP services in villages show little effect on the likelihood of a second birth among either group of women. Nevertheless, FP services at FPSCs have a positive impact on the likelihood among women whose first birth was a daughter; good provision of long-term contraceptive methods at FPSCs are associated with a significantly higher probability of a second birth than poor provision of long-term contraceptive methods. However, this finding may reflect the likelihood that long-term contraceptive methods are particularly emphasized in townships where women with only a daughter had a high probability of a second birth. This effect is not observed among women whose first birth was a son.

Effects of rural population and strength of son preference on the likelihood of a second birth are in the same direction for women whose first birth was a son and those whose first birth was a daughter, but their effects seem weaker among women with only a daughter than among those with only a son.

The unexplained variance is greater at level-2 than at level-3 in models 3 and 4. The unexplained high-level variances slightly reduce in the random coefficient model. Particularly, the province-level variance reduces by nearly a half in model 4, suggesting that substantial variation of the likelihood of a second birth between provinces was due to different effects of women's education across provinces. The between-province variance is smaller for women with middle school or higher education (0.186) than for those with primary school or lower education (0.186+ 2*0.238+0.107=0.769).

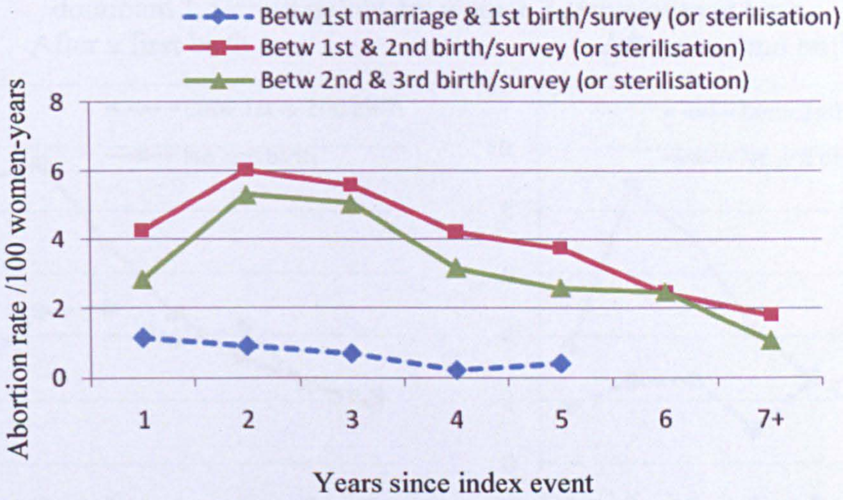
7.3 Abortion

The analysis strategy for abortion in this chapter is similar to that used in Chapter 6, i.e. focusing on women whose first child was born in 1979-95, estimating abortion rates in three key phases during women's life course, exploring risk factors of abortion within 2 years after a first birth, etc. The reasons for this strategy were given in the previous chapter. The abortion rate is measured by number of abortion per 100-women years and protective effect of contraception, other than sterilisation, on abortion is ignored. A total of 12711 women had at least one child during 1979-95. Of them, 9784 (77.0%) had a second birth and 3010 (23.7%) had a third birth.

7.3.1 Abortion rate

The overall abortion rates between marriage and first birth, after a first birth and after a second birth are 1.01, 3.95 and 3.17 per 100 women-years, respectively. Only 160 out of 12711 (1.2%) women reported an abortion between marriage and first birth. The number of women who had a history of abortion after the first birth is 1750, which accounts for 13.8 per cent of women who had at least one birth. Five hundred and seventy-five women had an abortion history after a second birth, which accounts for 5.9 per cent of women who had a second birth.

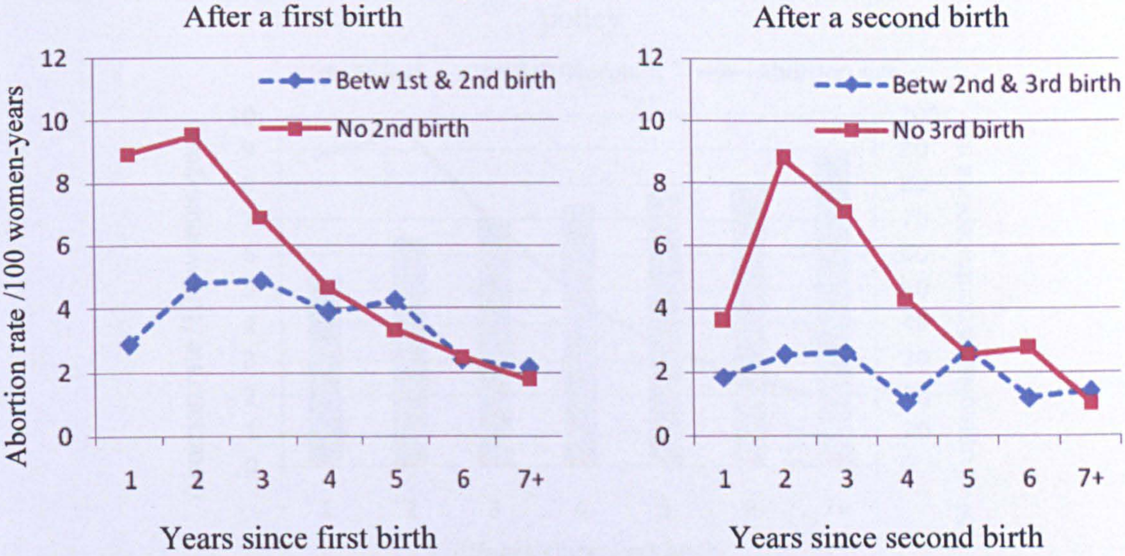
Figure 7.8: Abortion rates and trends during women's different reproductive periods



The abortion rates and trends in different phases during women's life course are presented in Figure 7.8. The rates between marriage and first birth range from about 1 abortion per 100 women-years in the first year to 0.22 abortions per 100 women-years in the fourth year after a marriage. The rates after a first birth are much higher. They steadily decline in the second year to the seventh plus year after a first birth from 6.02 to 1.81 abortions per 100 women-years. Abortion levels after a second birth are about one abortion lower than those after a first birth in most years except in year 6. The two abortion series follow similar trends after the index birth.

The abortion rates after a birth can be decomposed by women's status of next birth. Figure 7.9 shows the two components of abortion rates after the first (left graph) and after the second (right graph) birth. For women who had a second birth, abortion rates after the first birth range from 2.87 to 4.86 per 100 women-years. For those without a second birth, the rates are 8.91, 9.49 and 6.90 per 100 women-years for the first three years after the first birth. It declines to 4.65 and further to 3.33 per 100 women-years in the fourth and fifth year, which is close to that of women having a second birth.

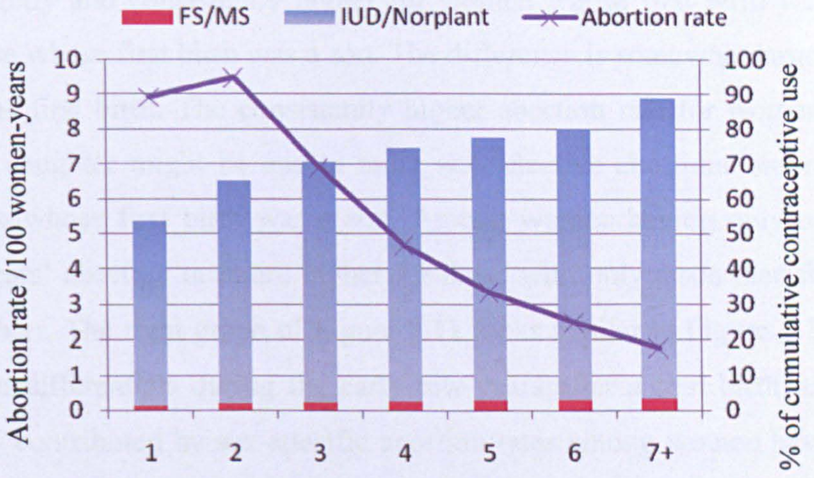
Figure 7.9: Abortion rates and trends after first or second birth in provinces with a dominant 1.5-child policy, by women's status of next birth



For women having a third birth, abortion rates after a second birth fluctuate around 2 abortions per 100 women-years. For women without a third birth, the first-year abortion rate after a second birth is 3.60 per 100 women-years. It rises sharply to 8.80 per 100 women-years in the second year, but declines rapidly to 7.11, 4.26 and 2.55 per 100 women-years in the third, fourth and fifth year. The two abortion series overlap in the fifth and seventh plus year after a second birth.

Figure 7.10 shows the relationship between abortion rate and cumulative contraceptive use in the years after a first birth among women who had only one child. As discussed in Chapter 6, the first-year abortion rate after a birth is lower than in the second year, despite low contraceptive use, because of the protective effects of breastfeeding, abstinence and low frequency of sex intercourse. The abortion rate peaks in the second year after a first birth and then steadily declines as cumulative contraceptive use consistently increases. The increasing use of effective contraceptive methods may explain the decline trend of abortion over time.

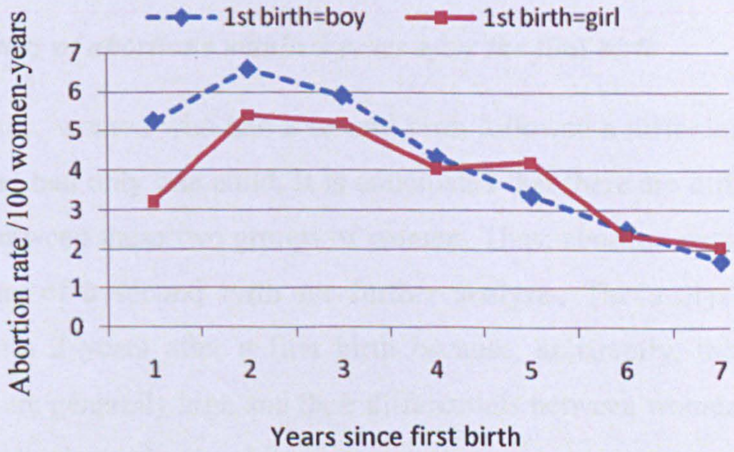
Figure 7.10: Relationship between cumulative contraceptive use and abortion rate after a first birth among women having only one child in provinces dominated by 1.5-child policy



Notes: FS=female sterilization, MS=male sterilization, IUD=Intrauterine Device

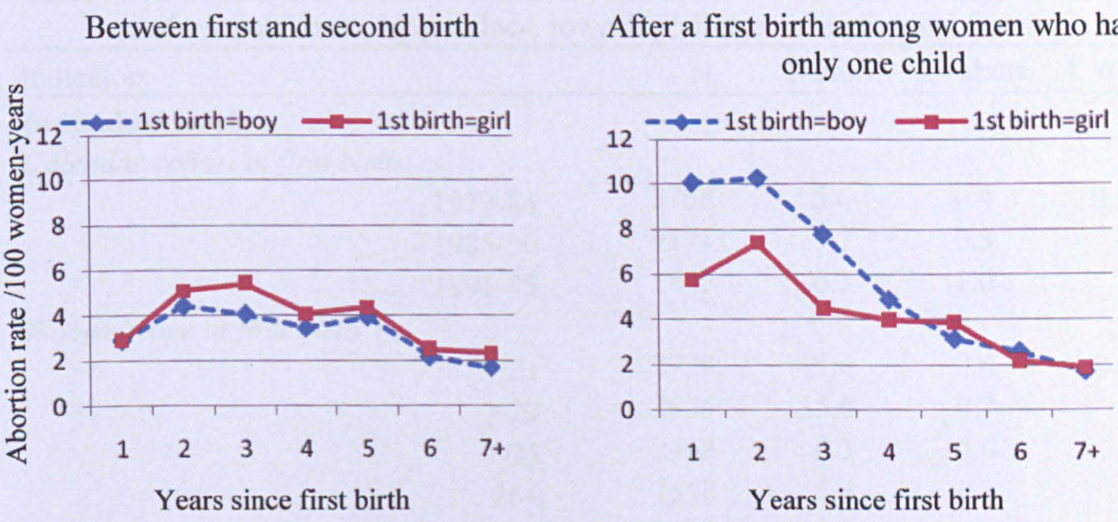
Figure 7.11 shows the decomposition of abortions after the first birth by sex of first child. The two abortion trends over time look similar, but the first three years' rates are slightly higher for women whose first birth was a son than for those whose first birth was a daughter. This result is unlikely to reflect contraceptive failure because there is no reason for women having only a daughter to adopt more effective contraceptive methods. Thus the explanation for this result may be that women whose first birth was a daughter are more likely to carry a pregnancy to term during the early few years after a first birth and thus have lower risk of abortion than those with a son.

Figure 7.11: Abortion rates and trends after a first birth among women who had at least one child in provinces dominated by 1.5-child policy, by sex of first birth



Abortion data after the first birth are further decomposed by status of a second birth (Figure 7.12). Among women having a second birth, abortion rates after the first birth are very slightly and consistently higher for women whose first birth was a daughter than for those whose first birth was a son. The difference is somewhat larger in the third year after the first birth. The consistently higher abortion rate for women whose first birth was a daughter might be due to more sex-selective abortions among them than among those whose first birth was a son. Among women having only one child, the early few years' abortion rates are higher for those with only a son than for those with only a daughter. The right graph of Figure 7.11 looks similar to Figure 7.10, indicating that abortion differentials during the early few years after a first birth in Figure 7.10 were mainly contributed by sex-specific abortion rates among women having only one child. However, these women reported only one birth. The possibility that women with only one daughter might underreport their second birth should be borne in mind.

Figure 7.12: Abortion rate and trends after a first birth in provinces dominated by 1.5-child policy, by sex of first birth and women's status of a second birth



7.3.2 Risk factors of abortions within 2 years after the first birth

As we have seen, women who had a second birth followed a different abortion pattern from those who had only one child. It is anticipated that there are different risk factors of abortions between these two groups of women. Thus, abortion data are separated by woman's status of a second birth for further analysis. The analysis is focused on abortions within 2 years after a first birth because, apparently, the first two-year's abortion rates are generally high and their differentials between women having a second birth and those having only one child are greatest.

Risk factors of abortions among women having a second birth

Table 7.9 reports distributions of abortions within 2 years after the first birth among women having a second birth by categories of women's characteristics and high-level variables. About 6.4 per cent of the women experienced at least one abortion during such a short period. Of them, 5.8 per cent had one abortion and 0.6 per cent experienced two or more abortions. The proportion of women with one abortion ranges from 2.2 per cent to 11.0 per cent between categories of the selected variables, while the proportion of women with two or more abortions varies from 0.2 per cent to 1.4 per cent. Chi-square tests show that calendar year of first birth, husbands' age at first birth, women's education and sex of first birth are significantly associated with the risk of abortion. For the high-level variables, village's FP services and average household annual income and all the five selected province-level variables relate to the risk of abortion. Moreover, the abortion risk increases with average household income but declines with the proportion of rural population and the strength of son preference at province-level.

Table 7.9: Percentage of abortions within 2 years after the first birth among women who had a second birth, by province, township/village and individual factors

Indicators		N	1 abort.	2+ abort.	P value
Individual level					
Calendar cohort of first birth					
	1979-84	3768	5.6	0.4	0.032
	1985-90	4171	5.7	0.5	
	1991-95	1845	6.3	1.0	
Women's age at first birth					
	≤21	2728	5.6	0.6	0.531
	~23	3085	5.6	0.7	
	~25	2453	6.3	0.6	
	26+	1518	5.4	0.3	
Husband's age at first birth					
	≤22	2229	4.8	0.8	0.031
	~24	3003	6.2	0.5	
	~26	2304	6.6	0.7	
	27+	2248	5.2	0.3	
Women's education					
	≤Primary School	6406	5.1	0.6	<0.001
	Middle School +	3378	7.0	0.6	
Couple's minority status					
	Both Han Chinese	8877	5.8	0.5	0.389
	One or both minority	907	5.4	0.9	

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Table 7.9: continued from previous page

Indicators		N	1 abort.	2+ abort.	P value
Woman's son preference	Daughter	321	7.5	0.6	0.242
	No	8379	5.9	0.6	
	Son	1084	4.4	0.6	
Sex of 1st birth	Boy	4264	5.1	0.7	0.010
	Girl	5520	6.3	0.5	
FP services at FPSCs					
	No a FPSC	325	6.5	0.6	0.281
Good short-term, poor long-term meth. prov.		4631	6.2	0.5	
Good long- & short-term method prov.		4069	5.2	0.6	
Moderate long-, poor short-term method provision		759	5.5	0.9	
Family planning services at villages					
	Good	5066	6.0	0.4	<0.001
	Moderate	3774	6.1	0.9	
	Poor	944	3.1	0.2	
Average annual income at villages					
	<1200	2687	3.8	0.5	<0.001
	~1900	2611	4.8	0.7	
	~2800	2692	5.9	0.5	
	2800+	1794	9.9	0.7	
Geographical region	East	3309	8.1	0.6	<0.001
	Central	4475	5.3	0.6	
	West	2000	2.8	0.4	
GDP per capita					
	<4200	1668	2.2	0.3	<0.001
	~6000	4599	5.4	0.7	
	~9000	2246	8.5	0.6	
	9000+	1271	6.8	0.6	
% of rural population	<60	2614	8.9	1.0	<0.001
	~70	1831	6.1	0.3	
	~75	3757	4.4	0.5	
	75+	1582	3.3	0.4	
% of ethnic minority groups					
	<3	5472	5.1	0.4	<0.001
	~9	2169	7.7	0.7	
	9+	2143	5.6	0.9	
Strength of son preference					
	No	1586	11.9	1.4	<0.001
	Weak	6092	4.8	0.5	
	Strong	2106	3.8	0.2	
Total		9784	5.8	0.6	

Multilevel Poisson regression is used to explore independent effects of the above factors on the risk of abortion. The average abortion rate within 2 years after a first birth for women having a second birth is (687/216467)*1200=3.758 per 100 women-years. Thus the *offset* in Poisson regression model is set to be $Log_e^{(3.758*\text{exposed years to risk of abortion within the first two years after a first birth})}$. Variables that are significant at the 0.10 level in bivariate analysis are included in multilevel models. Results of these models are presented in Table 7.10. As usual, Model 1 is a null model without any predictor. Model 2 includes individual level (level-1) fixed effects. Model 3 includes fixed effects of level-1 and level-2 variables. Model 4 and 5 includes predictors from all three levels. The difference between models 4 and 5 is that GDP per capita is introduced in model 4 but geographical region is introduced in model 5. This is because GDP per capita is highly correlated to geographical region. Preliminary analysis included both variables in one model but neither showed a significant effect on abortion risk. However, they do show significant effect in models 4 and 5. I also fitted random coefficient models that allowed effects of level-1 variables to vary between townships/villages and between provinces. Since none of them is significant at the 0.10 level, the random coefficient model is, thus, not preferred.

DIC statistics decline from 4536 in model 1 to 4514 in model 2 and further to 4509-4510 in model 3, 4 and 5, indicating the models are slightly improved with the introduction of level-2 and level-3 variables. We see that level-2 variance slightly declines from 0.642 in model 2 to 0.608 in model 3, indicating that the two level-2 variables explain some of the variation in the risk of abortion between townships/villages. However, when level-3 variables are included, the level-3 variance declines from 0.370 in model 3 to about 0.16 in models 4 and 5 and the level-3 variance is no longer statistically significant, indicating variation in the risk of abortion between provinces can be explained by the four level-3 variables in models 4 and 5. Nevertheless, the level-2 variance is still statistically significant, indicating the inclusion of level-2 and level-3 variables is insufficient to explain abortion differences between townships/villages. Moreover, the unexplained level-2 variance is more than three times greater than the variance between provinces, suggesting there more variation of abortion between townships/ villages than between provinces.

From the fixed effects of model 3, 4 and 5, we can see that abortion risk within 2 years after the first birth is significantly higher for women having a first child in 1991-95 than for women having a first child in 1979-84, while the risk for women having a first child in 1985-90 is similar to that of reference group. One explanation for this result is that the implementation of a minimum birth interval requirement (usually 3 to 4 years) is stricter in more recent years, with the consequence that more pregnancies ended in abortion in more recent years because they did not meet the spacing requirement.

At township-village level, average household income in villages is associated with an increased risk of abortion. This may be because women from higher household income villages were more likely to use condoms and other less effective contraceptive methods than women in the less developed villages.

At province level, the economic factor, GDP per capita, is associated with increased risk of abortion (statistically significant at the 0.10 level). I would expect a similar explanation for this result as that of the village economic factor. Compared with East region, abortion risk in West region is significantly lower. It is noted that East region is more developed than West region. Explanation of this result can be similar to that of GDP per capita. Provinces with strong son preference are associated with a significantly lower risk of abortion than those without son preference. This association is not seen in provinces with weak son preference. This may be because provinces with stronger son preference tend to have a second birth earlier, which would reduce the risk of abortion during the early years after a first birth. Proportions of ethnic minority population and rural population are not associated with increased risk of abortion after controlling for other variables. These results are perhaps due partly to the short duration of abortion measurement in this analysis. The subtle differences of abortion risk between subgroups of population could not be identified.

After controlling for other variables, husband's age at first birth, woman's education, sex of first birth and FP services in villages are not associated with risk of abortion within 2 years after the first birth among women who had a second birth.

Table 7.10: Parameter estimates of three-level Poisson regression models from fitting data on abortions between first and second birth in provinces dominated by 1.5-child policy

Predictors	Model 1		Model 2		Model 3		Model 4		Model 5	
(reference category)	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Fixed effects										
Intercept term	-7.580	0.140**	-7.606	0.189**	-7.619	0190**	-7.249	0.455**	-6.857	0.325**
Individual level (level-1)										
Husband's age at 1st birth (ref:≤22 years old)										
23-24			-0.035	0.111	-0.046	0.111	-0.052	0.112	-0.047	0.111
25-26			0.111	0.112	0.095	0.119	0.093	0.120	0.097	0.117
27+			-0.204	0.125	-0.215	0.130	-0.219	0.131	-0.219	0.127
Women's education (ref: Primary School+)										
>=Middle School			0.085	0.086	0.050	0.084	0.039	0.085	0.041	0.086
Calendar cohort of first birth (ref.=1979-84)										
1985-90			0.116	0.095	0.127	0.092	0.133	0.093	0.135	0.091
1991-95			0.500	0.111**	0.515	0.110**	0.537	0.112**	0.534	0.110**
Sex of first birth (ref: Boy)										
Girl			-0.141	0.083	-0.141	0.082	-0.157	0.083	-0.154	0.083
Township-village level (level-2)										
FP services at village (ref: Good)										
Moderate					0.140	0.120	0.128	0.122	0.134	0.120
Poor					-0.211	0.252	-0.105	0.250	-0.123	0.251
Average annual income per family at villages					0.443	0.109**	0.412	0.117**	0.417	0.112**
Province level (level-3)										
GDP per capita (centred log value)							1.007	0.552 †		
Geographical region (ref=East)										
Central									-0.429	0.259
West									-0.905	0.360*

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Table 7.10: continued from previous page

Predictors (reference category)	Model 1 Coeff.	Model 1 s.e.	Model 2 Coeff.	Model 2 s.e.	Model 3 Coeff.	Model 3 s.e.	Model 4 Coeff.	Model 4 s.e.	Model 5 Coeff.	Model 5 s.e.
% of rural population (ref: <60)										
60-70							0.241	0.929	0.162	0.603
-70							0.485	0.738	0.131	0.458
>75							0.077	0.957	0.059	0.589
% of ethnic minority groups (ref: <3%)										
-9							0.070	0.372	0.129	0.339
>9							0.372	0.362	0.520	0.374
Strength of son preference (ref: no son preference)										
Weak							-0.759	0.706	-0.778	0.548
Strong							-1.295	0.482**	-1.095	0.395**
Random effects										
Township-village level variance										
Intercept term	0.642	0.111**	0.642	0.107*	0.608	0.110**	0.611	0.111**	0.610	0.108**
Province level variance										
Intercept term	0.406	0.179**	0.478	0.209**	0.370	0.169**	0.164	0.249	0.157	0.125
DIC	4536.2		4514.4		4509.0		4510.8		4509.1	

† P<0.10, * P<0.05, ** P<0.01

Risk factors of abortions among women without a second birth

Among the 2927 women who had only one child, about 16 per cent experienced at least one abortion within 2 years after their first birth, which is more than two times higher than that among women having a second birth. About 14.1 per cent of the women had one abortion and 2.0 per cent experienced two or more. The proportion of women with one abortion varies from 7.1 per cent to 22.8 per cent between categories of women's characteristics and high-level variables. The proportion of women with two or more abortions ranges from 0.7 per cent to 3.8 per cent. Detailed distributions of abortions for women with different characteristics are presented in Table 7.11.

Table 7.11: Percent of abortions within 2 years after a first birth among women who did not have a second birth, by province-, township/village and individual factors

Indicators		N	1 abort.	2+ abort.	P value
Calendar cohort of first birth					
	1979-84	342	17.0	3.8	<0.001
	1985-90	936	19.1	2.8	
	1991-95	1649	10.6	1.3	
Women's age at first birth					
	≤21	636	14.8	2.5	0.440
	~23	959	14.6	2.0	
	~25	855	14.7	1.8	
	26+	477	10.9	2.1	
Husband's age at first birth					
	≤22	581	13.8	2.2	0.109
	~24	1091	15.0	2.0	
	~26	675	16.0	1.6	
	27+	580	10.3	2.4	
Women's education					
	≤Primary School	1437	13.3	1.9	0.441
	Middle School +	1490	14.8	2.1	
Couple's minority status					
	Both Han Chinese	2661	14.5	2.0	0.090
	One or both minority	266	10.2	3.0	
Woman's sex preference					
	Daughter	189	22.8	2.6	0.001
	No	2351	14.0	2.1	
	Son	387	10.6	1.3	
Sex of first birth					
	Boy	2153	15.0	2.5	<0.001
	Girl	774	11.4	0.8	

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Table 7.11: Continued from previous page

Indicators	N	1 abort.	2+ abort.	P value
Indicators at township-village level				
FP services at FPSCs				
No a FPSC	156	16.7	3.8	0.009
Good short-term, poor long-term meth.	1620	15.0	2.2	
Good long- & short-term meth.	967	13.4	1.2	
Moderate long-, poor short-term meth.	184	7.1	3.3	
Family planning services at villages				
Good	1659	15.5	2.2	0.060
Moderate	1128	11.9	2.0	
Poor	140	15.0	0.7	
Indicators at township-village level				
Average annual income at villages (Yuan)				
<1200	572	12.1	1.2	<0.001
~1900	678	11.8	1.9	
~2800	810	12.5	2.0	
2800+	867	18.7	2.8	
Provincial level				
Geographical region				
East	1393	15.5	2.4	0.176
Central	1257	12.7	1.8	
West	277	13.0	1.4	
GDP per capita (Yuan)				
<4200	196	7.1	1.5	<0.001
~6000	1168	13.4	1.8	
~9000	1186	13.8	2.0	
9000+	377	20.7	3.2	
% of rural population				
<60	1190	18.2	2.5	<0.001
~70	625	13.0	2.2	
~75	749	12.0	1.7	
75+	363	6.6	0.8	
% of ethnic minority groups				
<3	1554	13.4	2.1	0.586
~9	681	14.0	1.8	
9+	692	15.8	2.3	
Strength of son preference				
No	1072	18.3	2.6	<0.001
Weak	1585	11.0	1.7	
Strong	270	15.2	1.9	
Total	2927	14.1	2.0	

Bivariate analyses indicate that calendar year of first birth, women's sex preference, sex of first birth, FP services at FPSCs, average household income in villages, and GDP per capita, proportion of rural population, proportion of ethnic minority groups and strength of son preference in a province are significantly related to the risk of abortion after the first birth among women having only one child, while effects of couple's minority status and FP services in villages are significant at the 0.10 level.

All the variables that are significant at the 0.10 level in bivariate analysis are introduced in multilevel Poisson regression analysis to explore their independent effect on the risk of abortion. The *offset* for Poisson regression is set to be $\text{Log}_e^{(9.204 * \text{exposed years to abortion risk within the first two years after the first birth})}$. Analysis results are reported in Table 7.12. Similarly as before, model 1 is null model including no explanatory variables. Model 2 includes level-1 variables. Level-2 variables are added in model 3. However, when all the three level-3 variables - GDP per capita, proportion of rural population and strength of son preference - are introduced in one model, none of them shows a relationship to the risk of abortion, which may be due to collinearity between them. They are thus introduced in the model one by one. As shown in models 4 and 5, the fixed effects for rural population and strength of son preference are significant at the 0.05 level. Since the effect of GDP per capita is not significant, parameter estimates of model 6 are thus not presented.

The fixed effects in models 2, 3, 4 and 5 are rather consistent. Women's sex preference, calendar cohort of first birth and sex of the first birth are significantly associated with risk of abortion within 2 years after a first birth. Women without sex preference or having son preference and those having only a daughter are significantly less likely to have an abortion than those with daughter preference. As mentioned above, this result might be due to underreporting of a second birth among them. Women whose first birth was born in 1991-95 were significantly less likely to have an abortion than those whose first birth was born in 1979-84. One explanation for this result is that women had adopted more effective contraceptive methods in most recent years. Women having a daughter were significantly less likely to have an abortion than those having a son, suggesting that the former group of women tended to have shorter birth interval resulting in lower risk of abortion. Couple's minority status shows no association with the risk of abortion, indicating that risk of abortion is similar for Han Chinese and ethnic minorities in provinces with a dominant 1.5-child policy.

After controlling for other variables, FP services at FPSCs and in villages are not related to the risk of abortion. However, average household income in villages is related. This result is similar to that among women having a second birth. The coefficients of economic effects among women without a second child are about a half of those among women having a second birth (as shown in Table 7.10), indicating that economic effect at village-level on risk of abortion is greater among the latter group of women than among the former group of women.

Model 4 shows that the risk of abortion is significantly lower in a province with more than 75 per cent of rural population than in a province with less than 60 per cent of rural population. One possible explanation of this result is underreporting of second births in provinces with the highest level of rural population, but this reason is rather unconvincing. Another reason may be due to different contraceptive patterns between the two groups of provinces. Provinces with an extremely high proportion of rural population are more likely to emphasize effective long-term contraceptive methods. Women are usually persuaded to use an IUD three to six months after their first birth, while the persuasion-education model is less strong in provinces with a lower proportion of rural population, resulting in more contraceptive failures. Provinces with weak son preference are associated with a significantly lower risk of abortion. This result can partly be attributed to the effect of the proportion of rural population, because the category of weak son preference contains only two provinces (Henan and Gansu provinces) where more than 75 per cent of total population is rural. The linkage of abortion risk with calendar year of first birth, couple's minority status and economic development at province-level among women having only one child seems less pronounced.

The unexplained level-2 variances in more complex models 2, 3, 4 and 5 are close to statistically significant that in the null model, indicating that the included variables are not good atinsufficient to explaining variation of abortion between townships/villages and thus some risk factors that are responsible for the variation between townships/villages remain unknown. The level-3 variance is slightly reduced when higher-level variables are included in models 3 to 5, but not statistically significant, indicating that variation of abortion risk between provinces is small.

Comparing results shown in Tables 7.10 and 7.12, we see that the abortion risk within 2 years after the first birth among women having a second birth is associated with calendar year of first birth, economic factors at village- and province-levels, geographical region and strength of son preference. However, among women having only one child, risk factors also include women's sex preference and sex of first birth; the effect of strength of son preference at province-level is confounded by proportion of rural population; the effect of economic factors at province-level is less pronounced.

Table 7.12: Parameter estimates of three-level Poisson regression models from fitting data on abortions within 2 years after a first birth among women who did not have a second birth in provinces dominated by 1.5-child policy

Predictors (reference category)	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Fixed effects										
Intercept term	-7.397	0.114**	-6.620	0.195**	-6.716	0.209**	-6.507	0.225**	-6.492	0.213**
Individual level (level-1)										
Woman's sex preference (ref: Daughter)										
No			-0.403	0.146**	-0.348	0.148**	-0.339	0,157*	-0.349	0.158*
son			-0.759	0.202**	-0.693	0.205**	-0.688	0.216**	-0.698	0.209**
Calendar cohort of first birth (ref:1979-84)										
1985-90			0.072	0.132	0.106	0.129	0.105	0.131	0.107	0.129
1991-95			-0.436	0.137**	-0.391	0.136**	-0.382	0.137**	-0.377	0.137
Couple's minority status (ref: Both Han Chinese)										
One or both minority			-0.100	0.187	-0.058	0.187	-0.121	0.194	-0.107	0.188
Sex of first birth (ref: Boy)										
Girl			-0.389	0.117**	-0.392	0.118**	-0.388	0.117**	-0.400	0.117**
Township-village level (level-2)										
FP services at FPSCs (ref: good both short- & long-term methods)										
No a FPSC					0.276	0.239	0.250	0.247	0.252	0.244
Good short-, poor long-term method provision					-0.014	0.133	-0.008	0.133	-0.018	0.128
Poor short-, moderate long-term method provision					-0.020	0.254	-0.045	0.257	-0.026	0.248
FP services at village (ref=Good)										
Moderate					-0.184	0.120	-0.185	0.122	-0.165	0.120
Poor					0.084	0.271	0.119	0.259	0.116	0.260
Average household annual income in villages					0.250	0.120*	0.227	0.112*	0.219	0.110*

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Table 7.12: continued from previous page

Predictors (reference category)	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Province level (level-3)										
% of rural population (ref: <60)										
60-70							-0.359	0.225		
-70							-0.200	0.185		
>75							-0.960	0.303**		
Strength of son preference (ref: no son preference)										
Weak									-0.394	0.178**
Strong									-0.093	0.253
Random effects										
Township-village level variance	0.345	0.089**	0.228	0.079**	0.295	0.078**	0.320	0.106*	0.290	0.086**
Province level variance	0.140	0.085†	0.097	0.069	0.075	0.061	0.033	0.040	0.050	0.050
DIC	2834.3		2801.9		2803.0		2798.9		2802.4	

† P<0.10, * P<0.05, ** P<0.01

7.4 Sex ratio at birth

7.4.1 SRB by calendar years and birth order

Table 7.13 reports sex ratios of first, second and third births in provinces with a dominant of 1.5-child policy in 1979-2000. The overall SRBs of the first three births in 1979-2000 were 1.025, 1.320 and 1.321 respectively. The ratio for first births was normal, but those of second and third births were significantly imbalanced. These results can be largely attributed to the 1.5-child policy because women could have a second birth if the first child was a daughter but a third birth was normally not approved. It is noticeable that the ratios of second and third births steadily increased over time and the changes of FP strategy in late 1990s did not avert the rising trend as they did in provinces dominated by 1-child policy.

Table 7.13: Sex ratios of first and second births and 95% confidence intervals (CI) in provinces dominated by 1.5-child policy: 1979-2000

Birth Cohort	First birth			Second birth**			Third birth**		
	Boy	Girl	SRB 95%CI	Boy	Girl	SRB 95%CI	Boy	Girl	SRB 95%CI
1979-84	2098	2012	1.043	1465	1278	1.146	605	523	1.157
		0.981-1.109			1.064-1.236			1.029-1.301	
1985-90	2566	2541	1.010	2409	2033	1.185	1020	804	1.269
		0.956-1.067			1.117-1.257			1.157-1.392	
1991-95	1753	1741	1.007	1325	866	1.530	457	279	1.638
		0.942-1.076			1.405-1.668			1.415-1.907	
1996-00	1489	1418	1.050	1083	584	1.854	164	94	1.745
		0.976-1.129			1.679-2.054			1.364-2.272	
total	7906	7712	1.025	6282	4761	1.320	2246	1700	1.321
		0.993-1.058			1.271-1.370			1.241-1.408	

** P<0.01

The sex ratio of second births in 1979-2000 is decomposed by abortion history between first and second birth and sex of first birth. The results are displayed in Table 7.14. As can be seen in this table, women with an abortion history had a higher sex ratio of second births than women without an abortion history. This is the case no matter what the sex of first birth. These findings imply that women who had an abortion history between their first birth and second birth might be more likely to undertake a sex-selective abortion for a son than those without such a history. Nevertheless, the ratio differentials are not statistically significant perhaps because the differentials are too small to be detected with sample sizes as in this study. Another explanation for this result is misclassification of women without an abortion due to underreporting of sex-selective abortion. This is very likely to happen because selective abortion is forbidden in China. The sex ratio of second births among women having a daughter but no abortion history was as high as 1.555. As it is implausible to attribute this result entirely to underreporting of female births, selective abortion must have played an important role. The overall sex ratio for women whose first birth was a son is 1.061, significantly lower than that for women whose first birth was a daughter (1.581). This difference suggests strong son preference and a high level of selective abortion in provinces dominated by 1.5-child policy.

Table 7.14: Sex ratio of second births and 95% confidence intervals (CI) in provinces with a dominant 1.5-cihld policy, by women's abortion history and sex of first birth

Abortion between 1st & 2nd birth	First birth=boy			First birth=girl			Total		
	Boy	Girl	SRB 95%CI	Boy	Girl	SRB 95%CI	Boy	Girl	SRB 95%CI
No	2325	2199	1.057 0.997-1.121	3330	2141	1.555 1.474-1.643	5655	4340	1.303 1.253-1.356
Yes	219	198	1.106 0.913-1.343	408	223	1.830 1.559-2.163	627	421	1.489 1.318-1.688
Total	2544	2397	1.061 1.004-1.122	3738	2364	1.581 1.502-1.665	6282	4761	1.319 1.271-1.370

7.4.2 Sex ratios of second births in 1980s and 1990s

Since sex ratios of first births in the 1980s and 1990s are normal (detailed numbers of births are presented in Appendix D) and preliminary analyses show no sensible differentials between women's characteristics and other factors, this section focuses on sex ratios of second births. As can be seen in Table 7.15, the overall sex ratio of second births was 1.146 in the 1980s, with 95% CI ranging from 1.091 to 1.204. The ratios in the 1980s for several categories of women, i.e., women who had a second birth at ages of 27-28, those having less education, Han couples and women having son preference or without sex preference, were also significantly imbalanced. The overall ratio of second births increased by 37 per cent to 1.575 in 1990s, with 95% CI 1.481-1.676. The ratios are imbalanced for almost all categories of women, indicating selective abortion for a son was very common in provinces dominated by 1.5-child regardless of women's characteristics.

Bivariate analyses show that the sex ratio of second births in 1980s is significantly different between woman's sex preference and between sexes of first birth. The ratio of second births in 1990s was significantly higher for the less-educated women (1.653) and women whose first birth was a daughter (2.066) than for women with better education (1.452) and those having a son (1.077). It was also significantly higher (1.538-1.733) in townships with good provision of short-term contraceptive methods than in townships without a FPSC or with poor provision of short-term methods (1.173-1.188). SRB of second births varied between villages, being relatively lower in the least or most developed villages.

As for the province level factors, the ratio in 1990s declined with levels of economic development and so as to the geographical region (decline from West to Central and further to East region). The sex ratio of second births was slightly higher in provinces with weak son preference than in those with strong preference, but the difference is not statistically significant.

The sex ratios of second births during the entire period of 1979-99 are presented in the right column of Table 7.15. Bivariate analyses show that women's sex preference, sex of first birth, FP services at FPSCs, average household annual income in villages, GDP per capita, proportion of rural population and ethnic minority groups are significantly associated with sex ratio of second births in 1979-99.

Table 7.15: Sex ratios of the second births in 1980s and 1990s and their 95% confidence intervals (CI) in provinces dominated by 1.5-child policy, by province, township, village and individual factors

	SRB in 1980s & 95%CI			SRB in 1990s & 95%CI			Total & 95%CI		
	SRB	lower	upper	SRB	lower	upper	SRB	lower	upper
Woman's age at birth									
≤24	1.101	1.014	1.196	1.524	1.360	1.712	1.232	1.153	1.318
25-26	1.119	1.017	1.231	1.766	1.550	2.022	1.313	1.216	1.419
27-28	1.244	1.115	1.388	1.494	1.298	1.726	1.332	1.222	1.453
29+	1.17	1.044	1.314	1.545	1.385	1.728	1.354	1.251	1.467
Husband's age at birth									
≤25	1.200	1.095	1.315	1.516	1.346	1.712	1.308	1.217	1.407
26-27	1.114	1.005	1.234	1.635	1.435	1.872	1.288	1.189	1.397
28-29	1.157	1.036	1.293	1.797	1.560	2.081	1.369	1.255	1.494
30+	1.112	1.015	1.220	1.471	1.324	1.638	1.255	1.172	1.346
Woman's education				*					
≤Primary School	1.137	1.073	1.205	1.653	1.530	1.789	1.302	1.243	1.364
Second School+	1.170	1.068	1.283	1.452	1.315	1.607	1.292	1.208	1.383
Couple's minority status									
Both Han Chinese	1.146	1.089	1.207	1.588	1.489	1.695	1.302	1.251	1.355
One or both minority	1.143	0.968	1.353	1.459	1.204	1.781	1.269	1.119	1.442
Woman's son preference				**			**		
Daughter	0.714**	0.541	0.932	0.655	0.459	0.912	0.690	0.556	0.850
No	1.138	1.079	1.200	1.602	1.499	1.713	1.303	1.251	1.359
Son	1.380	1.197	1.596	1.816	1.507	2.212	1.527	1.363	1.715
Sex of first birth				**			**		
Boy	1.041**	0.971	1.117	1.077	0.979	1.184	1.053	0.996	1.114
Girl	1.257	1.174	1.347	2.066	1.904	2.247	1.552	1.473	1.636
Family Planning services at FPSCs				**			*		
No a FPSC	1.019	0.779	1.333	1.188	0.853	1.669	1.082	0.879	1.334
Good short-, poor long-term methods	1.204	1.122	1.293	1.538	1.404	1.687	1.321	1.249	1.397
Good short-, long-term methods	1.110	1.028	1.199	1.733	1.580	1.906	1.334	1.257	1.415
Poor short-, moderate long-term methods	1.055	0.889	1.254	1.196	0.963	1.492	1.107	0.968	1.268
Family Planning services at villages									
Good	1.169	1.092	1.252	1.602	1.472	1.746	1.325	1.257	1.398
Moderate or poor	1.122	1.046	1.204	1.546	1.415	1.691	1.271	1.203	1.343
Average household annual income in villages				**			*		
≤1200	1.107	1.008	1.217	1.429	1.276	1.603	1.230	1.144	1.323
-1900	1.152	1.047	1.269	1.966	1.743	2.229	1.423	1.320	1.535
-2800	1.141	1.041	1.251	1.647	1.462	1.862	1.309	1.218	1.409
>2800	1.203	1.075	1.349	1.262	1.096	1.455	1.226	1.122	1.340

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Table 7.15: continued from previous page

	SRB in 1980s & 95%CI			SRB in 1990s & 95%CI			Total & 95%CI		
	SRB	lower	upper	SRB	lower	upper	SRB	lower	upper
Central	1.120	1.043	1.203	1.658	1.512	1.822	1.300	1.228	1.375
West	1.137	1.013	1.277	1.677	1.476	1.912	1.355	1.245	1.478
GDP per capita (Yuan)				* ##			#		
<4200	1.137	1.005	1.289	1.832	1.590	2.123	1.401	1.276	1.540
-6000	1.135	1.056	1.219	1.617	1.479	1.771	1.305	1.234	1.380
-9000	1.199	1.089	1.322	1.441	1.254	1.662	1.273	1.176	1.379
>9000	1.093	0.951	1.259	1.355	1.162	1.585	1.205	1.087	1.337
% of rural population							*		
<60	1.049†	0.955	1.153	1.441	1.285	1.619	1.192	1.109	1.282
-70	1.274	1.138	1.428	1.531	1.328	1.772	1.368	1.252	1.496
-75	1.142	1.056	1.236	1.643	1.486	1.822	1.312	1.233	1.396
>75	1.188	1.048	1.349	1.718	1.481	2.005	1.386	1.260	1.528
% of ethnic minority groups							†		
<3	1.182	1.107	1.264	1.606	1.483	1.742	1.341	1.274	1.412
-9	1.045	0.944	1.156	1.551	1.354	1.783	1.204	1.110	1.306
>9	1.170	1.054	1.300	1.514	1.327	1.733	1.292	1.191	1.404
Strength of son preference									
No	1.071	0.952	1.205	1.521	1.304	1.783	1.218	1.110	1.338
Weak	1.211	1.138	1.289	1.616	1.494	1.750	1.355	1.291	1.423
Strong	1.029	0.924	1.146	1.507	1.331	1.713	1.211	1.116	1.314
Total	1.146	1.091	1.204	1.575	1.481	1.676	1.299	1.250	1.350

*P<0.05, ** P<0.01;

7.4.3 Predictors of sex of second birth in the 1990s

Unlike Chapter 6 that explored determinants of sex of child for both first and second births in the 1990s, investigation of predictors of sex in this chapter is focused on the second birth. This is mainly because the overall sex ratio of first births in 1979-99 was normal but the sex ratio of second births was highly distorted, particularly in the 1990s. Binary response of the three-level logistic regression models is 1 (y_{ijk}) for woman *i* in township/village *j* and province *k* who had a son as a second birth in the 1990s, and 0 if she had a daughter.

Table 7.16 presents parameter estimates of the multilevel logistic models. Model 1 is a null three-level model, which includes no explanatory variables. Level-1 variables are introduced in model 2. Level-2 variables are added in model 3 and GDP per capita in a province is included in model 4. Model 5 is a random coefficient model that allows effect of sex of first birth to vary between townships/villages and across provinces.

Random coefficient models that allowed other level-1 variables to vary across high level units are also fitted but none is statistically significant. Hence, they are not reported.

The DIC diagnostics shown at the bottom of Table 7.16, indicate that the null model is greatly improved when level-1 explanatory variables are included in the model. The DIC statistic reduces from 5549.7 in model 2 to 5505.6 in model 3 and further to 5499 in model 4, indicating that the most comprehensive model (model 4) is better than the other two. However, as indicated by the DIC statistic, model 4 can be further improved by allowing effect of sex of first birth to vary across high-level units (model 5). I mainly describe results of models 4 and 5 in this section because fixed effects of models 2, 3, 4 and 5 are very consistent but models 4 and 5 are the most comprehensive and allow comparison of both fixed and random effects.

In model 4, women's education, their sex preference and sex of first birth are significantly associated with the probability of a son as a second birth. The positive coefficient on women's education indicates that women with primary school or less education were more likely to have a son than their better-educated counterparts. There is also a positive relationship between woman's son preference and the likelihood of a son as a second birth. The stronger women's son preference is associated with a higher probability of a male birth as a second birth. On the contrary, the negative coefficient for sex of first birth indicates that a woman whose first birth was a son is significantly less likely to have a male child as a second birth than women whose first birth was a daughter.

Average household annual income in villages is used as a categorical variable rather than continuous variable in models. This is because, as shown in Table 7.16, sex ratio of second births does not follow a linear relationship with household income. Preliminary analysis introducing average household annual income as a continuous variable shows that village household income was not related to the sex of second birth. However, as shown in model 4, compared with women from villages with the highest average household income, those from villages where the household income was at middle-level were significantly more likely to have a male child as a second birth. The negative coefficients for categories of FP services at FPSCs indicate that the reference category – townships with good services of both long- and short-term contraceptive methods –

tended to have a higher probability of a boy as a second birth. Thus those townships were under greater pressure of not only birth control but also normalizing SRB than others.

GDP per capita at provincial level shows a marginal association with the likelihood of a boy as a second birth, with the more developed provinces being slightly less likely to have a male birth. This result agrees with the general view that son preference is less strong in more developed areas than in less developed ones. Since geographical region is correlated to GDP per capita in a province, it is not included in model 4, but introduced in another one (not shown). Parameter estimates for Central and West region in the model are 0.108 and 0.211 with standard errors of 0.133 and 0.126 respectively. The estimated coefficient for West region is significant at level of 0.10, indicating the West region tended to have more male births at parity two than the East region did.

From the random effects, we see that the overall unexplained variance reduces from 0.132+0.037=0.169 in model 1 to 0.002+0.046 = 0.048 in model 2, suggesting the individual variables succeed in explaining most of the high-level unexplained variance in model 1. When level-2 variables are introduced in model 3, the overall unexplained variance (particularly the province-level variance) is further reduced to 0.026. Neither the township/village-level variance nor the province-level variance is statistically significant. When GDP per capita in a province is introduced in model 4, level-3 variance slightly declines from 0.026 in model 3 to 0.023 in model 4. However, the level-2 variance slightly rises to 0.053. The standard error for level-2 variance is also increased. Thus although we see greater township-village variance in model 4, there is also bigger between-township/village variation. The unexplained level-2 variance is not statistically significant.

Having fitted model 4, in which the main effects of all explanatory variables were estimated, we can further question the variability of the effects of individual variables between townships/villages or across provinces. For instance, we can assess whether the effect of sex of first birth varies between provinces or between villages, by allowing parameter estimates of sex of first birth to vary across high-level units using a random coefficient model. Parameter estimates of the random coefficient model are shown in model 5.

Since the fixed effects in model 5 are very similar to those in model 4, with the single exception that GDP per capita is no longer significant at the level of 0.10, the discussion is focused on the random effect of model 5. This model shows that the log-odds for sex of first birth varied between $-0.724 \pm \sqrt{0.439}$ at level-2 and varied between $-0.724 \pm \sqrt{0.224}$ at level-3. The covariance between the intercept and the slope for sex of first birth at township/village-level is -0.369. The covariance between intercept and the slope for sex of first birth at province- level is -0.132. The random effect covariances are all negative, indicating that a township/village or a province with high probability of a son as a first birth tends to have a low probability of a son as a second birth. The estimated correlation at level-2 is -0.930 and that at level-3 is -0.884, both of which are significantly different from zero.

The variances between townships/villages are then related to sex of first birth according to the function $0.359+2*(-0.369)*1 +0.439=0.060$ (for first birth=son) and 0.359 (for first birth=daughter) respectively. The corresponding variances between provinces are $0.099+2*(-0.132) + 0.224=0.059$ (for first birth = son) and 0.099 (for first birth = daughter) respectively. Clearly, the between-township/village-variance and between-province variance are greater for women whose first birth was a daughter than for those whose first birth was a son.

Table 7.16: parameter estimates of three-level logistic regression models from fitting data on sex as a second birth in 1990s in provinces dominated by 1.5-child policy

	Model 1		Model 2		Model 3		Model 4		Model 5	
Predictors (ref. cat.)	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Fixed effects										
Intercept term	0.455	0.050**	-0.290	0166	-0.409	0.189*	-0.362	0.223	-0.375	0.226
Individual level (level-1)										
Women's education (ref: Middle school+)										
Primary School-			0.147	0.067*	0.145	0.067*	0.139	0.069*	0.150	0.075*
Woman's son preference (ref: Daughter)										
No			0.927	0.161**	0.941	0.179**	0.934	0.204**	0.974	0.189**
Son			1.175	0.188**	1.141	0.107**	1.153	0.223**	1.199	0.213**
Sex of first birth (ref: Girl)										
Son			-0.699	0.067**	-0.706	0.066**	-0.727	0.066**	-0.724	0.111**
Township-village level (level-2)										
Average household annual income at village (ref: >2800 Yuan)										
<1200					0.097	0.108	0.020	0.119	0.029	0.120
~1900					0.392	0.107**	0.333	0.229**	0.331	0.112**
~2800					0.284	0.103**	0.234	0.107*	0.239	0.107*
FP services at FPSCs (ref: good provision of short- & long-term methods)										
No a FPSC					-0.336	0.184†	-0.325	0.192	-0.313	0.206
Good short- but poor long-term method provision					-0.094	0.074	-0.083	0.078	-0.077	0.083
Poor short-, moderate long-term method provision					-0.399	0.127**	-0.402	0.135**	-0.387	0.142**
Province level (level-3)										
GDP per capita							-0.200	0.117+	-0.137	0.112

Continues to next page

Table 7.16: continued from previous page

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Random effects										
Township-village level variance										
Intercept term	0.132	0.060*	0.002	0.001	0.002	0.001	0.053	0.031	0.359	0.128**
Sex of first birth									0.439	0.143**
Covariance: intercept term – sex of first birth									-0.369	0.114**
Province level variance										
Intercept term	0.037	0.025	0.046	0.026+	0.026	0.017	0.023	0.019	0.099	0.043*
Sex of first birth									0.224	0.097*
Covariance: intercept term – sex of first birth									-0.132	0.058*
DIC	5676.5		5549.7		5505.6		5499.0		5453.5	

† p <0.10, * p<0.05, ** p<0.01

Residual plots of the level-2 and level-3 residuals are used for model diagnostics to check the suitability of the chosen logit specification for these data. As shown in Figure 7.13, the relationship between ranked residuals and normal scores is fairly linear, suggesting that the assumptions of normality at level 2 and level 3 are reasonable for models 4 and 5. Moreover, province-level residuals and their 95% confidence interval are plotted in Figure 7.14 for model 4 and in Figure 7.15 for model 5. As shown in Figure 7.14, the 95% confidence intervals of all provinces cross the line at zero, indicating that none of the provincial residuals significantly depart from the overall mean in model 4. This result corresponds to level-3 intercept variance, which suggests no significant variation between provinces. Nevertheless, as can be seen in Figure 7.15, the 95% CI of several provinces do not overlap zero, indicating these provinces having significantly higher or lower probability of a male child as a second birth than the average when allowing effect of sex of first birth to vary across provinces.

Figure 7.13: Normal plots for residuals at township/village- and province-level in models 4 &5

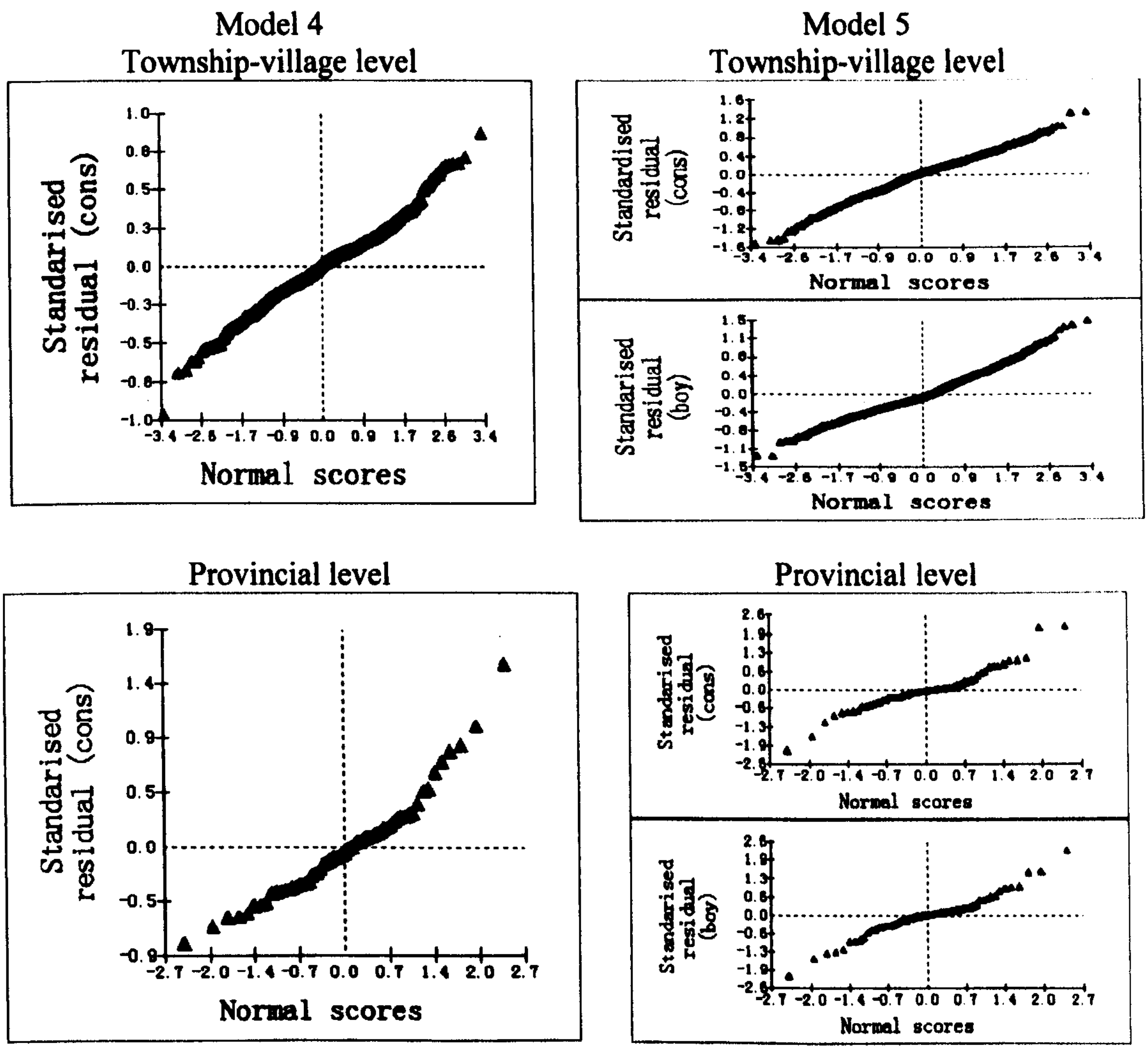


Figure 7.14: Residuals and 95% confidence intervals for provinces in Model 4

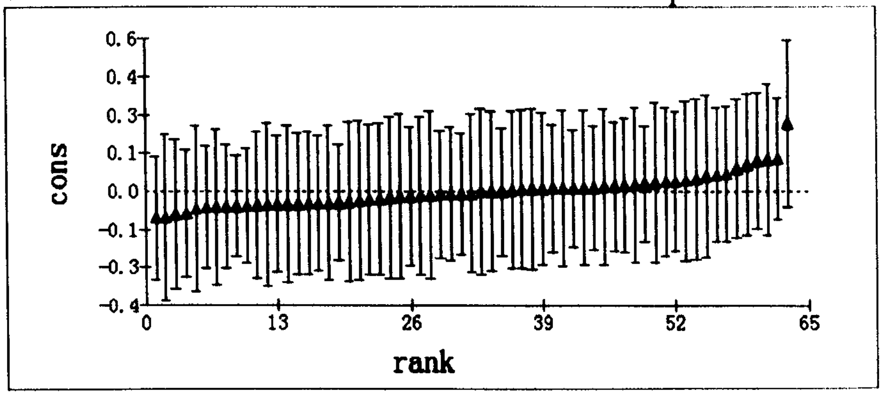
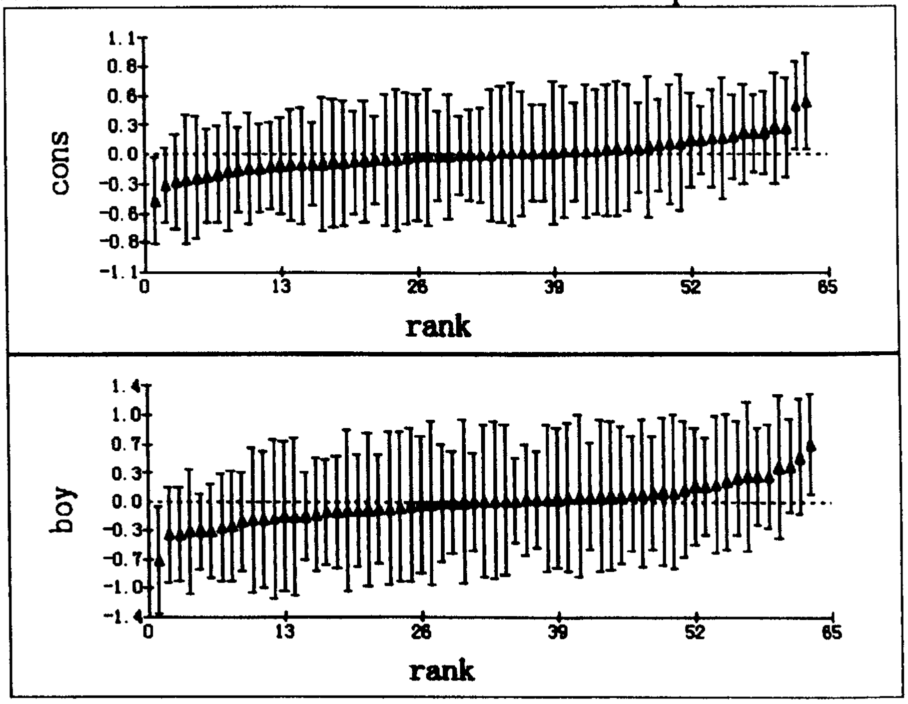


Figure 7.15: Residuals and 95% confidence intervals for provinces in Model 5:



7.5 Summary of key points

TFR_{ppr} in provinces dominated by 1.5-child policy was above replacement level before 1990. It sharply declined in the 1990s to an average of 1.56 children per couple in 2000. Similarly as in provinces dominated by 1-child policy, the decline of total fertility rate is mainly attributed to the decrease in progression to second birth, which reduced by 40 per cent between 1986 (0.879) and 2000 (0.530). Furthermore, $P_{1\text{-}2}$-boy was lower but fell faster than that of $P_{1\text{-}2}$-girl during the observation period. These results reflect the feature of 1.5-child policy (allow a second birth if the first birth is a daughter) on one hand, and tightening up a second birth for women having a son in the 1990s on the other hand.

The probability of a second birth varies between categories of women's characteristics and other factors. The better-educated women, those whose first birth was born in more recent years or was a son and those with daughter preference were significantly less likely to have a second birth than their respective counterparts. Nevertheless, a woman with son preference was significantly less likely to have a second birth if she had a son, but more likely to do so if she had a daughter. Moreover, women having a son at older age were significantly more likely, but those having a daughter at older ages were less likely to have a second birth than the youngest group of mothers.

The relationship of FP services at FPSCs to the probability of a second birth was negative among women having a son, but the likelihood of a second birth among women whose first birth was a daughter was significantly higher in townships which emphasized both long-term and short-term contraceptives than in townships which only emphasized short-term methods. Effects of other high-level factors, i.e. average household income in village, GDP per capita, proportion of rural population and strength of son preference, on the likelihood of a second birth are in the same direction between the two groups of women, but their effects appear stronger among those whose first birth was a son than those whose first birth was a daughter, indicating greater fertility variations between high-level units among women having a son. In other words, fertility behaviour was more similar between areas among women having a daughter.

Abortion levels between marriage and first birth, after a first birth and after a second birth were lower in provinces with a dominant of 1.5 child policy than in provinces with a dominant 1-child policy. This differential can be mainly attributable to the difference of their population policies because pregnancies in 1.5-child provinces were more likely to be carried to term rather than terminated as in 1-child provinces. Nonetheless, their abortion patterns appear very similar: low and relatively stable during early few years after a first birth among women having a second birth; reaching a peak in the second year and progressively declining in the following years after a first birth among women having only one child.

The risk factors of an abortion after a first birth among women having only one child include daughter preference, the first birth being born in 1979-84, having a boy, living in more developed villages, and in provinces with less than 60 per cent of rural population and those without son preference culture. Abortion between first and second births was associated with calendar years of first birth, economic development of villages and provinces and son preference culture.

As couples having a daughter are normally allowed to have a second child, the sex ratio of first births was normal in provinces dominated by 1.5-child policy. This is not the case for the second and third births. SRBs of second and third births particularly increased in the 1990s, partly reflecting stricter implementation of the 1.5-child policy in this period. The significantly distorted SRBs of second and third births suggest that sex-selective abortion was common in provinces dominated by 1.5-child policy. The sex-specific SRBs of second births provided some evidences of underreporting of selective abortion, particularly among women having a daughter.

Imbalance in SRB of second births in the 1990s appeared universal among women in provinces dominated by 1.5-child policy, but was particularly pronounced among the less-educated women with son preference, those having a daughter, from villages with middle-level economic development or from townships where emphasized both long- and short-term contraceptive methods.

Multilevel analyses imply that likelihood of a second birth and abortion risk varied between townships and across provinces in provinces dominated by 1.5-child policy. This is not the case for the likelihood of a son as a second birth.

Chapter 8: Fertility, Abortion and Sex Ratio at Birth in Provinces Dominated by Two-Child Policy

8.1 Introduction

A 2-child policy in China refers to allowing two children per couple under no restrictions. Although some couples may be allowed to have three or more children, in the context of China, the proportion of such parents are very small. Meanwhile, the 2- and more–child policies are mainly carried out among ethnic minorities. In many provinces, a second birth is usually allowed for a couple if either husband or wife belongs to an ethnic minority. As I mentioned in Chapter 1, ethnic minorities account only for about 8 per cent of China's total population and most of them live in West, Northwest and Southwest regions (a broad concept of 'West region') of China, such as Ningxia, Qinghai, Xinjiang, Tibet and Yunnan provinces / autonomous regions. Compared with East and Central regions, The West region is less developed with low population density (see Map 4.5 in Chapter 4).

A total of six provinces and autonomous regions were classified into the category of 2-child policy, namely Yunnan, Qinghai, Ningxia, Hainan, Xinjiang and Tibet. The main hypotheses for this chapter are that progression to second births among women in these provinces will be high but the abortion rate will be low. Sex ratio of first and second birth will be within normal range. The arrangement of this chapter is similar to that in Chapters 6 and 7: Section 8.2 reports parity progression ratios (PPRs), total fertility rates based on PPRs (TFR_{ppr}), and predictors of a second birth, Section 8.3 introduces abortion rates and relevant risk factors, and Section 8.4 assesses sex ratios of first and second births. The last section provides summary of this chapter.

8.2 Fertility level and birth interval between first and second births

8.2.1 PPR and TFR_{ppr}

As can be seen in Table 8.1 and Figure 8.1, progression ratios from woman's own birth to first marriage ($P_{B\text{-}M}$) and from marriage to first birth ($P_{M\text{-}1}$) are close to one and were stable during late 1980s and early 1990s. They slightly declined in the late 1990s, i.e. $P_{M\text{-}1}$ was 0.922 in 1996 and 0.934 in 1998; $P_{M\text{-}1}$ dipped to 0.929 in 1999. A distinguishing feature of PPRs in provinces with a dominant of 2-child policy is that progression ratios from first to second birth, $P_{1\text{-}2}$, kept at a high level. As can be seen in

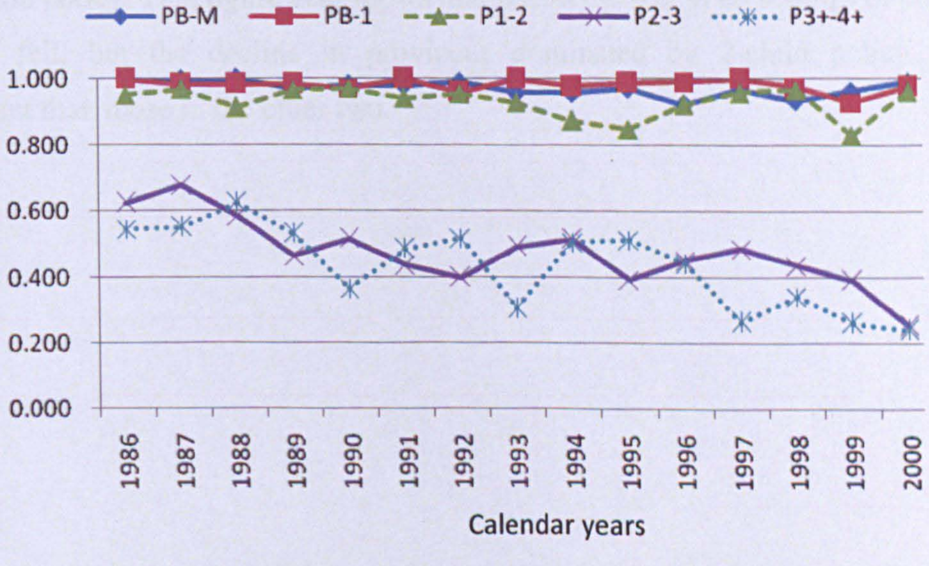
Table 8.1, P_{1-2} ranged from 0.91 to 0.97 in most years between 1986 and 2000 with slight declines in 1994, 1995 and 1998, bringing the level down to 0.83-0.88. Progression ratios to third birth order dropped sharply from 0.62 in 1986 to 0.25 in 2000 with several small movements during this period. As shown in Figure 8.1, progression ratios of fourth or higher orders, $P_3^+{-}_4^+$, are unstable during the observation period, which is due to a small number of women reaching higher parities. Nevertheless, $P_3^+{-}_4^+$ also followed a declining trend during 1986 - 2000.

Table 8.1: Period parity progressions and total fertility rates (TFR_{ppr}) in provinces dominated by 2-child policy, 1986-2000

	Progression					TFR_{ppr}
Year	P_{B-M}	P_{M-1}	P_{1-2}	P_{2-3}	$P_3^+{-}_4^+$	
1986	1.000	1.000	0.951	0.625	0.545	3.26
1987	0.997	0.985	0.970	0.677	0.552	3.37
1988	1.000	0.985	0.914	0.585	0.625	3.29
1989	0.973	0.985	0.967	0.463	0.531	2.80
1990	0.981	0.971	0.971	0.516	0.366	2.63
1991	0.981	1.000	0.941	0.435	0.485	2.68
1992	0.991	0.962	0.956	0.399	0.519	2.62
1993	0.960	1.000	0.931	0.493	0.306	2.49
1994	0.960	0.978	0.875	0.515	0.506	2.62
1995	0.974	0.989	0.850	0.393	0.515	2.45
1996	0.922	0.990	0.923	0.452	0.443	2.44
1997	0.966	1.000	0.959	0.486	0.266	2.51
1998	0.934	0.976	0.967	0.436	0.342	2.38
1999	0.964	0.929	0.831	0.391	0.261	2.03
2000	0.991	0.978	0.962	0.254	0.243	2.19

Notes: same as in Table 6.1

Figure 8.1: Period parity progression ratios for provinces dominated by 2-child policy: 1986-2000



Estimates of TFR_{ppr} between 1986 and 2000 are plotted in Figure 8.2, together with corresponding values of P_{1-2} and P_{2-3}. The estimates of TFR_{ppr} were between 3.25 and 3.37 during 1986 and 1988. It sharply dropped by about 0.5 children per women in 1989, indicating that the tightening up of population policy in 1989 had significant impact on fertility in provinces dominated by a 2-child policy. As can be seen in Figure 8.2, the decline of the total fertility rate in 1989 is largely attributed to P_{2-3} rather than P_{1-2} because P_{1-2} slightly increased from 1988 to 1989. TFR_{ppr} fluctuated around 2.5 births per couple during 1990 and 1998 and dropped slightly below 2.20 in the last two years before the survey.

Figure 8.2: Total fertility rates (TFR_{ppr}), progression to second birth (P_{1-2}) and progression to third birth (P_{2-3}) in provinces dominated by 2-child policy: 1986-2000

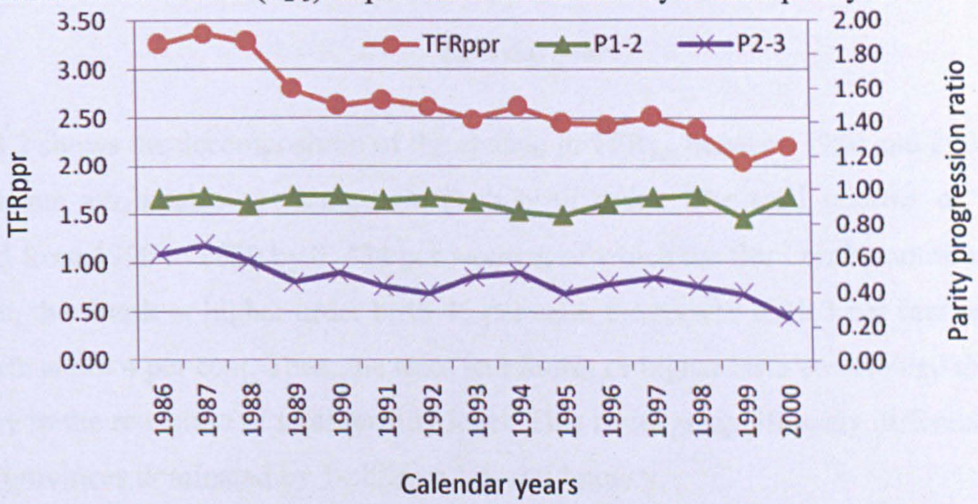


Figure 8.3 shows trends in TFR_{pprs} of provinces dominated by the three population policies together. Clearly, the fertility level is higher in provinces with a more lenient population policy. This figure also shows that fertility levels in all settings of population policies fell, but the decline in provinces dominated by 2-child policy is more significant than those in the other two.

Figure 8.3: Total fertility rate (TFR_{ppr}) in settings of different population policies, 1986-2000

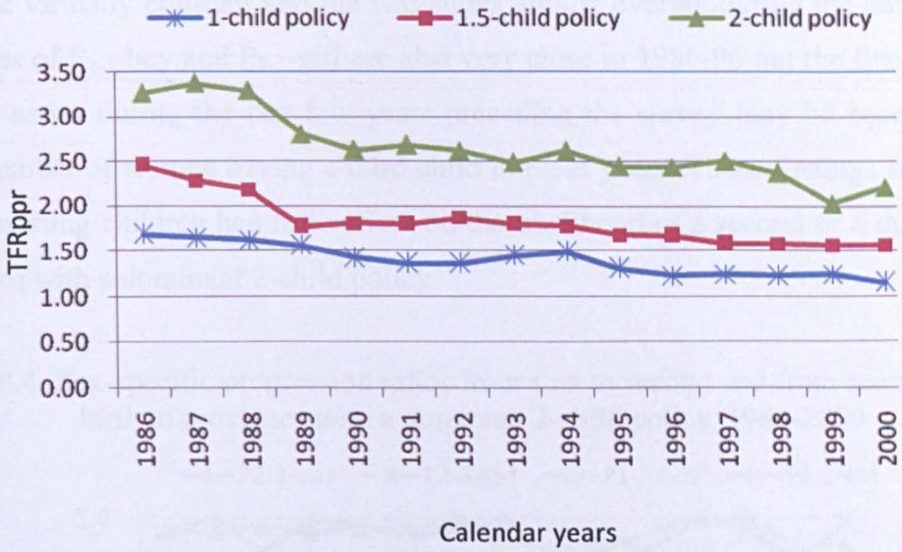


Table 8.2 shows the decomposition of the change in TFR_{ppr} between 1990 and 2000 into components attributable to changes in each birth order. The total number of births reduced from 1990 to 2000 by 0. 434 per women, of which the third birth contributes 55 per cent, the fourth or higher order birth 46 per cent, the second birth 3 per cent and the first birth about 4 per cent. Thus, the third and fourth or higher birth contributed the vast majority to the reduction of total fertility level. This result is significantly different from that in provinces dominated by 1-child or 1.5-child policy.

Table 8.2: Decomposition of the change in the total fertility rate (TFR_{ppr}) between 1990 and 2000 into components attributable to change in each birth order, in provinces with a dominant 2-child policy

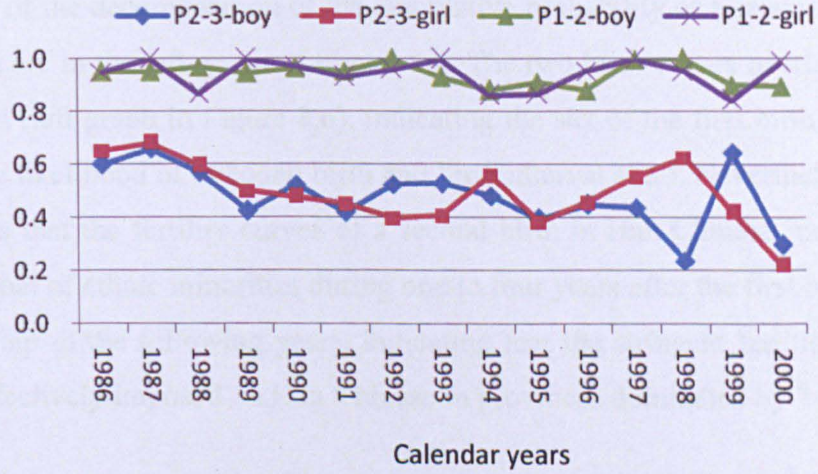
	B1	B2	B3	B4+	TFR_{ppr}
Exp. number of birth in 1990	0.952	0.924	0.477	0.275	2.628
Exp. number of birth in 2000	0.969	0.912	0.237	0.076	2.194
Difference between 1990-2000	-0.017	0.012	0.240	0.199	0.434
% of total difference	-3.96	2.80	55.34	45.85	100

Notes: B1=$P_{B\text{-}M}*P_{M\text{-}1}$=expected number of first birth; B2= $P_{B\text{-}M}*P_{M\text{-}1}*P_{1\text{-}2}$=expected number of second birth; B3= $P_{B\text{-}M}*P_{M\text{-}1}*P_{1\text{-}2}*P_{2\text{-}3}$=expected number of third birth $B_4^+= P_{B\text{-}M}*P_{M\text{-}1}*P_{1\text{-}2}*P_{2\text{-}3}*P_{3\text{-}4}^{+}/(1-P_{3\text{-}4}^{+})$ =expected number of forth or higher order birth

8.2.2 Decomposition of progression to second/third birth by sex of first/second birth

In Figure 8.4, I show period parity progression ratios from first to second and from second to third birth by sex of the first or second birth, denoted as $P_{1\text{-}2}$-boy as the progression ratio if the first birth was a boy and P_{1-2}-girl if the first birth was a girl. P_{2-3}-boy and P_{2-3}-girl are defined analogously. As can be seen in this figure, P_{1-2}-boy and P_{1-2}-girl are virtually constant and the two series almost overlap during the entire period. Estimates of P_{2-3}-boy and P_{2-3}-girl are also very close in 1986-96 but the fluctuations of the two series during the last few years preceding the survey may be because of the small number of women having a third child in these years. These findings suggest that sex of existing children had little effect on the likelihood of a second or a third birth in provinces with a dominant 2-child policy.

Figure 8.4: Sex-specific progression ratios from first to second and from second to third birth in provinces with a dominant 2-child policy, 1986-2000

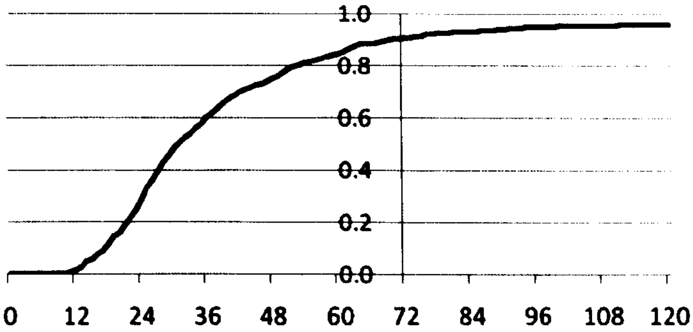


8.2.3 Probability, birth interval and predictors of the second birth

Cumulative probability of second birth

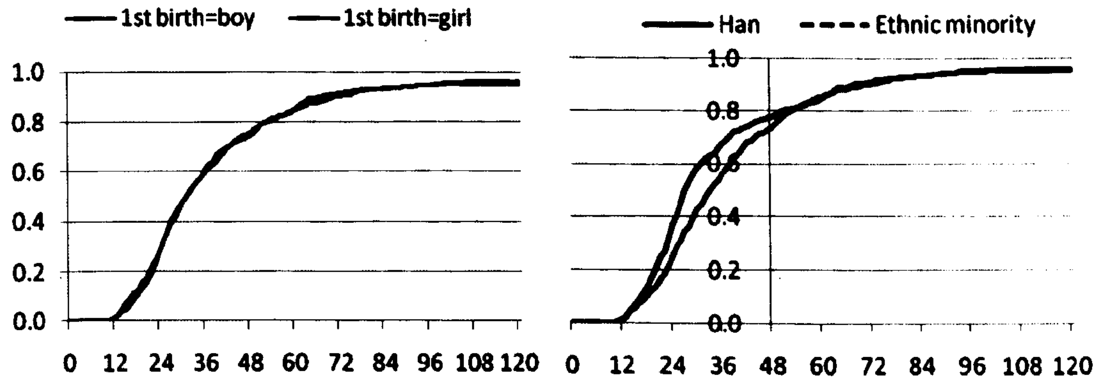
Similar to the previous two chapters, the cumulative probabilities of a second birth within 10 years after a first birth are calculated among women whose first birth was born in 1979-95 (N=987) using life-table method. The probability of a second birth within 6 years after a first birth (B72) is 90.8 per cent, those within 7 years and within 10 years are 93.4 per cent and 96.0 per cent respectively. In fact, three-quarters of women progressed to a second birth within four years after the first birth.

Figure 8.5: Probability of a second birth among women whose first child was born in 1979-95 in provinces with a dominant 2-child policy



Illustrations of the decomposition of the cumulative probability of a second birth by sex of first birth are in the left graph of Figure 8.6. The two birth curves overlap during the entire period (left graph in Figure 8.6), indicating the sex of the first birth is having no effect on the likelihood of a second birth and birth interval at all. Nevertheless, the right graph shows that the fertility curves of a second birth in Han Chinese increase a little faster than that of ethnic minorities during one to four years after the first birth. The two curves overlap in the following years, indicating that the stringent fertility regulations were not effectively imposed on Han Chinese in provinces dominated by 2-child policy.

Figure 8.6: Probability of a second birth among women who had a first birth in provinces with a dominant 2-child policy, by sex of first birth and minority status



Cumulative probability of a second birth within 72 months after the first birth and birth interval between first and second births (trimean)

As indicated by the estimates of B72 (shown in Table 8.3), the probability of a second birth within 6 years after the first birth declines with calendar cohort of the first child.

Women who had their first child at very young ages had a higher probability of a second birth than those at older ages. But this relationship is less pronounced among their husbands. The likelihood of a second birth is not associated with women's education, their son preference, sex of first birth and couple's ethnic minority status.

As for township and village's indicators, the quality of FP services seems to have a positive effect on the likelihood of a second birth; better services of contraceptive provision at FPSCs or in villages are related to a lower probability of a second birth. A higher level of second birth was observed in villages where the average household annual income was at middle level. However, the effect of the economic indicator at provincial level seems less pronounced. It is somewhat surprising that provinces with a higher proportion of rural population had a lower probability of a second birth than those with lower proportion of rural population did. It is expected that provinces with strong son preference had a higher level of second birth than those with weak son preference.

With regard to the birth interval between first and second births, there is a roughly negative relationship between the estimate of B72 and the length of average birth interval. A lower value of B72 is associated with a longer average birth interval. For example, 96.3 per cent of women had a second birth within 72 months after their first birth in provinces with strong son preference, with an average birth interval of 24.8 months, while 89.7 per cent of women in provinces with weak son preference did so, with an average birth interval of 33.8 months. However, not all the associations follow this pattern. For example, the less-educated women had a slightly higher probability of B72 (0.929) but a longer average birth interval (32.8 months) than the better-educated counterparts (0.906 and 28.3 months). Women whose first birth was born in most recent years (1991-95) had a particularly long birth interval (40.8 months).

Table 8.3: Summary measures for birth intervals between first (1979-95) and second birth in provinces dominated by 2-child policy, by individual,- township/village- and province-level indicators

indicators		Summary measure		
		N of 1st birth	B72	Trimean (months)
Individual level				
Cohort of 1st birth			*	
	1979-84	256	0.945	26.5
	1985-90	411	0.920	27.3
	1991-95	320	0.869	40.8
Women's age at first birth			*	
	≤20	486	0.932	29.0
	21-22	259	0.884	29.0
	23-24	126	0.897	27.0
	≥25	116	0.888	29.0
Husband's age at first birth				
	≤21	358	0.919	28.3
	22-23	258	0.907	28.5
	24-25	166	0.892	30.8
	≥26	205	0.912	29.3
Women's education				
	≤Primary School	819	0.906	28.3
	>Primary School	168	0.929	32.8
Couple's ethnic status				
	Both Han Chinese	330	0.918	26.3
	One or both ethnic minority	657	0.906	30.8
Woman's son preference				
	No	795	0.914	32.0
	Yes	192	0.891	30.9
Sex of 1st birth				
	Boy	503	0.903	28.9
	Girl	484	0.917	28.8
Township-village level				
FP services at FPSCs			**	
	No a FPSC	225	0.920	29.0
	Good services for both short- & long-term methods	547	0.892	33.8
	Others	215	0.944	28.0
FP services in villages			*	
	Good	405	0.891	30.0
	Moderate	319	0.903	30.3
	Poor	263	0.947	26.5
Average annual income/family in villages (Yuan)			*	
	<1200	714	0.902	31.0
	~1900	174	0.943	29.3
	>1900	99	0.909	39.5
Provincial level				
GDP per capita (Yuan)				
	<5000	796	0.908	31.5
	>5000	191	0.916	32.0
% of rural population			*	
	<70	302	0.944	29.3
	>75	685	0.896	32.5
Son preference culture			**	
	Weak	796	0.897	33.8
	Strong	191	0.963	24.8
Total		987	0.908	28.5

Predictors of a second birth

Table 8.4 presents parameter estimates of three-level logistic regression models fitting data of a second birth within 6 years after a first birth. While fitting these models, I used the 2nd order predictive quasi-likelihood (PQL) procedure to estimate parameters.

After controlling for other variables, we see that calendar year of first birth, women's age at first birth and average household annual income in villages show significant associations with the likelihood of a second birth. Women whose first birth was born in 1991-95 had a significantly lower probability of a second birth than those whose first birth was born in 1979-84, with log-odds of approximately -0.75. Two possible reasons may contribute to this result. One is that implementation of population policy was intensified in 1990s. The other is that the socio-economic development throughout the country in more recent years may make the small family norm more popular, even among the minority population.

Women having a first birth at age of 22 or older were less likely to have a second birth than those having a first birth at ages of 21 or younger. The youngest group of mothers were perhaps more likely to come from families possessing strong traditional norms, such as desire for a large family and son preference. Women who were from the poorest villages were also less likely to have a second birth than those from middle-level villages. The reason is unknown. Effects of FP services at FPSCs and in villages, proportion of rural population and strength of son preference at provincial level on the likelihood of a second birth within 6 years after their first birth largely disappeared after adjusting for other variables.

Both level-2 and level-3 variances are less than two times of their respective standard error, suggesting the difference in probability of a second birth between townships/villages and across provinces are small. Moreover, random coefficient models indicated that effects of birth years of first child and women's age at first birth did not vary between high-level units (results not shown).

Table 8.4: Parameter estimates of three-level logistic regression models from fitting data on second births in provinces dominated by 2-child policy

	Model 1		Model 2		Model 3		Model 4	
Predictors (reference category)	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Fixed effects								
Intercept term	3.057	0.466**	3.826	0.544**	4.038	0.645**	4.252	0.824**
Individual level (level-1)								
Woman's age at 1st birth (ref: ≤21 years old)								
~23			-0.721	0.299*	-0.787	0.302*	-0.779	0.305
~25			-0.530	0.382	-0.507	0.383	-0.502	0.384
26+			-0.663	0.386+	-0.631	0.387	-0.632	0.390
Calendar cohort of first birth (ref: 1979-84)								
1985-90			-0.324	0.362	-0.300	0.361	-0.290	0.362
1991-95			-0.795	0.355*	-0.762	0.356*	-0.747	0.385*
Township-village level (level-2)								
Average income at village (ref: 1200-1900Yuan)								
<1200					-1.015	0.470*	-0.905	0.470*
>1900					-0.905	0.711	-0.966	0.719
FP services at FPSCs (ref: good for both short- and long-term								
No a FPSC					0.132	0.397	0.080	0.400
Poor short- or long-term method provision					0.728	0.490	0.763	0.494
FP services at villages (ref: good quality)								
Moderate					0.396	0.387	0.357	0.388
Poor					0.543	0.510	0.397	0.545
Provincial level (level 3)								
% of rural population (ref: <70%)								
>70%							-1.039	0.861
Provincial son preference (ref: weak)								
Strong							0.881	0.928
Random effects								
Township/village-level variance	0.238	0.197	0.259	0.203	0.230	0.195	0.202	0.184
Province-level variance	0.826	0.718	0.705	0.635	0.367	0.385	0.553	0.567

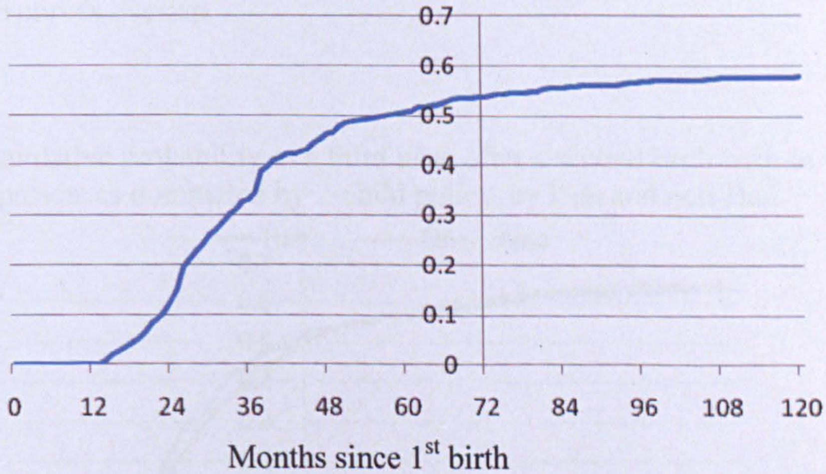
8.2.4 Probability, birth interval and predictors of a third birth

Unlike the previous two chapters, the probability, birth interval and predictors of a third birth are explored in this chapter. This is because most couples in provinces dominated by 2-child policy are allowed to have two children, but this is not the case for a third birth. It is thus of interest to know the level of a third birth, birth interval between second and third birth and predictors of a third birth.

Cumulative probability of a third birth after a second birth

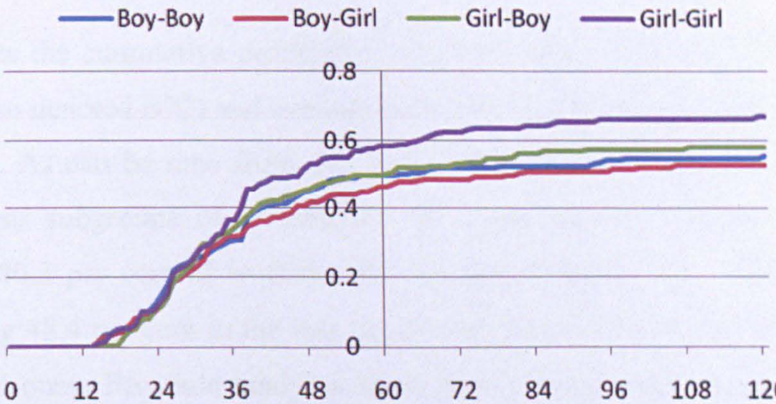
Figure 8.7 shows cumulative probability of a third birth after a second birth that was born in 1979-95. Nearly 54 per cent of the women having a second birth continued to have a third within 6 years after the second birth. The probability increased to 55.7 per cent by the end of 7 years and 58.0 per cent by the end of ten years.

Figure 8.7: Cumulative probability of a third birth after a second birth born in 1979-95 in provinces dominated by 2-child policy



The overall probability of a third birth is further decomposed by sex combination of the first two births. As shown in Figure 8.8, the combination of girl-girl (sex of first birth–second birth) is associated with the highest probability and that of boy-girl with the lowest starting about the third year after a second birth. Clearly, the likelihood of a third birth is affected by both sex and sex order of the first two children. A boy-girl pattern may be the ideal model for the first two children, followed by a boy-boy pattern. Girl-girl pattern is least ideal, reflecting a degree of son preference in the population of these provinces.

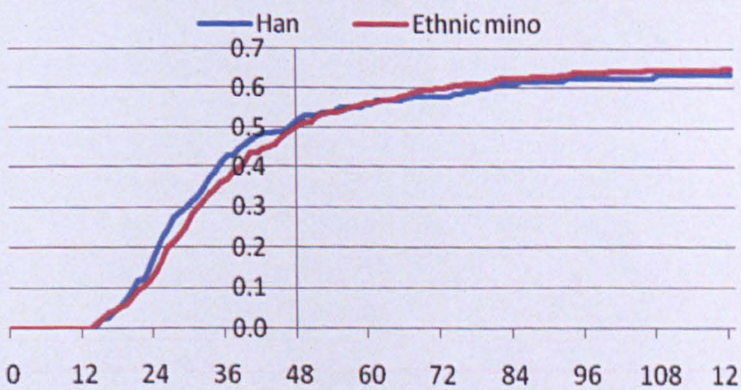
Figure 8.8: Cumulative probability of a third birth after a second birth born in 1979-95 in provinces dominated by 2-child policy, by sex combination of first two children



Months since 1st birth

Figure 8.9 compares the cumulative probability of a third birth after a second birth between Han Chinese and ethnic minorities. Similarly as shown earlier for the second birth, Han Chinese had q slightly higher probability of a third birth than ethnic minorities during the first four years after a second birth. After the year, the two cumulative birth curves overlap.

Figure 8.9: Cumulative probability of a third birth after a second birth born in 1979-95 in provinces dominated by 2-child policy, by Han and non-Han



Cumulative probability of a third birth within 72 months after a second birth and birth interval between second and third births

Table 8.5 reports the cumulative probability of a third birth within 72 months after a second birth (also denoted B72) and average birth interval between the second and third births (trimean). As can be seen from this table, the likelihood of a third birth varied between different subgroups of women, i.e. 47.8 per cent of women without son preference but 80.3 per cent of women with son preference having a third birth; the percentage being 48.4 per cent in the less developed provinces but 75.6 per cent in the more developed ones. Bivariate analyses show that women whose second birth was born in the 1990s, couples having a second birth at older age, the better-educated women without son preference and those whose first two children were boy-girl sequence were significantly less likely to have a third birth than their respective counterparts. Moreover, economically more developed villages with good FP services, economically less developed provinces with higher proportion of rural population or less strong son preference were associated with a significantly lower probability of a third birth. The average birth interval was slightly above 30 months for most categories of indicators. Only the differences between cohorts 1980s and 1990s and between categories of son preference at provincial level were greater than 5 months.

Table 8.5: Probability of a third birth within 72 months after a second birth (B72) born in 1979-95 and average birth interval (trimean) in provinces dominated by 2-child policy

Indicators		B72	trimean
Calendar years of 2nd birth	**		
1980s	485	0.627	31.0
1990s	321	0.412	36.5
Women's age at 2nd birth	*		
<=24	459	0.575	32.3
25+	347	0.496	33.3
Husbands' age at 2nd birth	*		
<=25	372	0.573	31.5
26+	434	0.514	33.8
Women's education	†		
Primary or below	680	0.555	32.3
Middle school or above	126	0.468	33.8
Couple's minority status			
Both Han	273	0.513	31.0
One or both minority	533	0.555	33.0
Women's son preference	**		
No	629	0.478	33.3
Yes	177	0.803	29.8
Sex of first two births	*		
Boy-boy	212	0.519	32.1
Boy-girl	199	0.487	31.8
Girl-boy	204	0.534	32.8
Girl-girl	191	0.629	33.8
FP services at FPSCs			
No a FPSC	199	0.593	33.0
Good short- & poor long-term method provision	436	0.525	32.8
Others	171	0.521	29.4
FP services in villages	*		
Good	331	0.511	33.3
Moderate	243	0.527	32.5
Poor	232	0.599	30.8
Average household income (Yuan)	*		
<1200	577	0.556	32.5
>1200	229	0.502	31.8
GDP per capita (Yuan,)	**		
<4100	638	0.484	32.5
>4100	168	0.756	32.0
% of rural population	**		
<70	261	0.770	30.8
>70	545	0.431	33.8
Son preference culture	**		
No or weak	629	0.475	35.3
Strong	177	0.774	28.0

† p <0.10, * p<0.05, ** p<0.01

Predictors of a third birth

Predictors of a third birth were explored using multilevel logistic regression analysis. The parameter estimates of the multilevel models are presented in Table 8.6. From the fixed parts of the models we see that women whose second birth was born in 1990s were significantly less likely to have a third birth than those having a second birth in 1980s. This result may be due to voluntary reduction of family size in the 1990s but also be partially due to stricter implementation of population policy to prevent third and higher order births in these provinces. Women with son preference and those whose first birth was a daughter, particularly those having two daughters, were significantly more likely to have a third birth than women without son preference and those whose first two births were boy-girl combination. It is not unexpected that women having a strong son preference were associated with increased probability of a third birth. Nevertheless, it is somewhat surprising that women whose first birth was a daughter followed by a son were significantly more likely to have a third birth than women whose first two births were son-daughter combination. This result reflects that the sex order of children has a significant impact on the likelihood of a third birth in addition to the access of a son or daughter in the first two births.

Among the province-level variables, only the proportion of rural population showed a significant association with the likelihood of a third birth; provinces with more than 70 per cent of rural population had significantly lower probability of a third birth. GDP per capita and strength of son preference at provincial level show no association with likelihood of a third birth. These two variables were not included in model 4 because of collinearity. After adjusting for other variables, couple's age at second birth, women's education and villages' economic status or quality of FP services were not associated with likelihood of a third birth.

From the random effects we see that the probability of a third birth varied between townships/villages but were similar between provinces.

Table 8.6: Estimated parameters of three-level logistic models fitting data on a third birth in provinces dominated by 2-child policy

	Model 1			Model 2			Model 3			Model 4		
Fixed effects	Coeff.	s.e.		Coeff.	s.e.		Coeff.	s.e.		Coeff.	s.e.	
Intercept term	1.077	0.609		1.878	0.642	**	2.224	1.122		3.095	0.764	**
Calendar years of 2nd birth (ref: 1980s)												
1990s				-1.952	0.246	**	-1.983	0.242	**	-1.999	0.249	**
Women's age at 2nd birth (ref: <=24)												
25+				-0.376	0.222		-0.377	0.221		-0.361	0.223	
Husbands' age at 2nd birth (ref: <=25)												
26+				-0.351	0.224		-0.349	0.23		-0.346	0.231	
Women's education (Primary Sch. or below)												
Middle school or above				-0.110	0.306		-0.088	0.306		-0.083	0.302	
Women's son preference (ref: No)												
Yes				0.995	0.316	**	0.974	0.318	**	0.957	0.314	**
Sex of first two births (ref: Boy-girl)												
Boy-boy				0.203	0.280		0.216	0.281		0.208	0.284	
Girl-boy				0.662	0.289	*	0.679	0.288	*	0.677	0.288	*
Girl-girl				1.244	0.300	**	1.263	0.306	**	1.257	0.31	**
FP services in villages (ref: Good)												
Moderate							0.170	0.738		0.003	0.830	
Poor							-0.535	0.849		-0.517	0.784	
Average household income (ref: <1200 Yuan)												
>1200							-0.906	0.717		-1.138	0.736	
% of rural population (ref: <70%)												
>70										-1.891	0.785	*
Random effects												
level-2 variance (township/village-level)	2.122	0.710	**	3.025	0.994	**	3.177	1.091	**	3.337	1.075	**
level-3 variance (province-level)	1.232	2.342		1.493	2.180		2.328	4.118		0.698	1.743	
DIC	826.01			721.5			720.2			720.9		

*P<0.05, **P<0.01

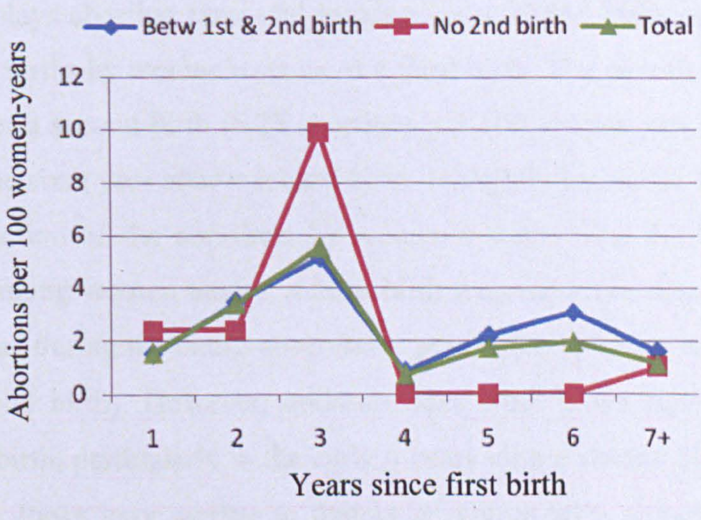
8.3 **Abortion**

8.3.1 Abortion levels and trends after first and second births

Women having a first child in 1979-95 (N=987) are used to estimate abortion levels and trends in provinces with a dominant 2-child policy. Only 4 abortions were reported between marriage and first birth and all occurred in the first year after marriage. They are not used for further analysis.

Abortion rates and trends after a first birth are plotted in Figure 8.10. The abortion rate peaked at the third year after the birth (5 per 100 women-years). It sharply declined in the fourth year. This is the case both for women having a second birth and for those without a second birth. Since only 41 women who had one child but did not progress to a second birth, the abortion series for them looks very unpredictable. The total rates of abortion after a first birth mainly depended on abortions among women having a second child.

Figure 8.10: Abortion rates after a first birth in provinces dominated by 2-child policy, by women's status of a second birth



I decomposed the abortion rates between first and second birth (N=946) by sex of first birth (shown in Figure 8.11). Unlike in provinces dominated by 1-child or 1.5-child policy, the two sex-specific abortion series in provinces dominated by 2-child policy are very close in most of the years after a first birth with only one exception – the fifth-year's abortion rate among women whose first birth was a son (0/100 women-years) was considerably lower than that among women whose first birth was a daughter (3.5

abortions/100 women-years). It is unreasonable to explain this result by selective abortions because it is unlikely that selective abortion only occurred in the fifth year but not in other years after a first birth. Perhaps this result is caused by chance. It is likely that selective abortions between first and second births in provinces dominated by 2-child policy were rare and can be ignored.

Figure 8.11: Sex-specific abortion rate between first and second births in provinces dominated by 2-child policy

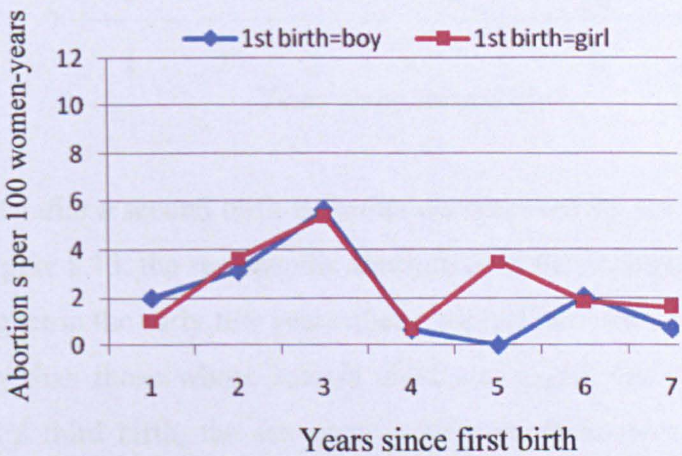
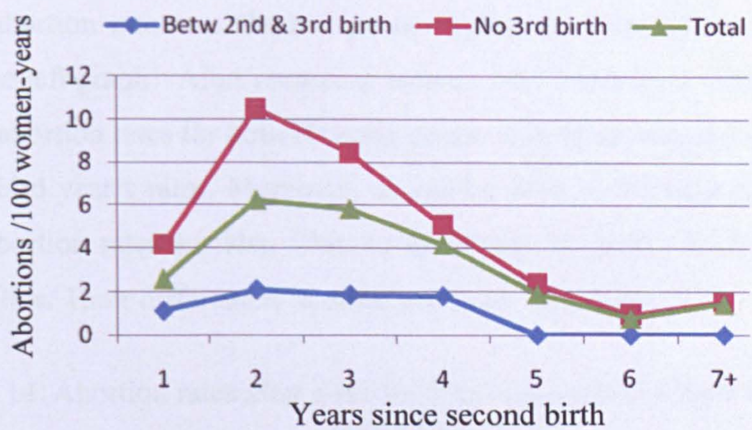


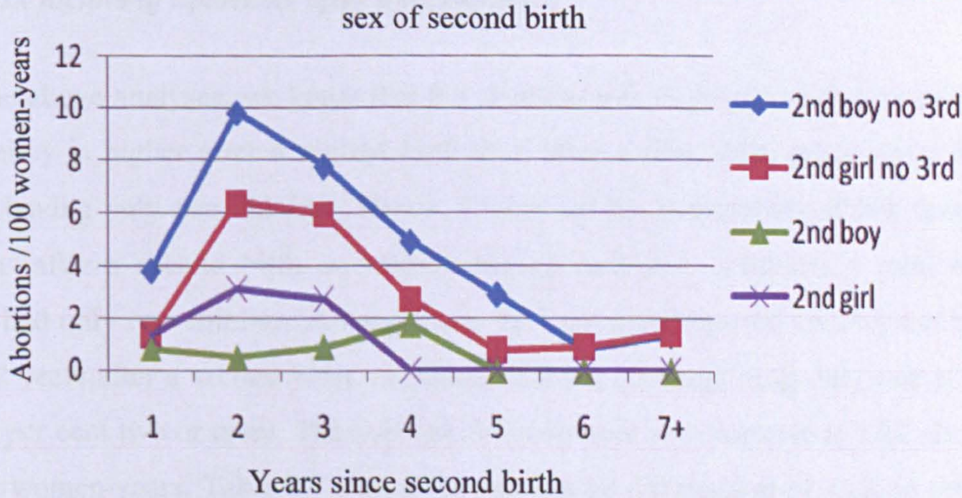
Figure 8.12 displays abortion rates and trends after a second birth among women who had at least two births by women's status of a third birth. The overall rate peaked in the second year after a second birth (6.23 abortions per 100 women-years) and then gently declined until the sixth year after a second birth. It slightly increased in the seventh plus year. Decomposition of the abortions by women's status of a third birth shows that abortion rates among women having a third birth were no more than 2.5 abortions per 100 women-years during the entire observation period (no abortion was reported after 4 years of a second birth). However, abortion rates were much higher among women without a third birth, particularly in the early 4 years after a second birth. Moreover, the abortion pattern looks very similar to that in provinces with a dominant of 1.5-child policy (as shown in Figure 7.8).

Figure 8.12: Abortion rate after a second birth, by women's status of a third birth in provinces dominated by 2-child policy



The abortion data after a second birth is further decomposed by sex of second birth. As we can see in Figure 8.13, the sex-specific abortion rates between second and third birth were slightly higher in the early few years after a second birth for women whose second child was a boy than those whose second child was a girl. On the contrary, among women without a third birth, the sex-specific abortion rates were higher for women whose second birth was a daughter than for those whose second birth was a son. The two abortion series overlap in the last two years after a second birth. Nevertheless, their abortion trends are very similar.

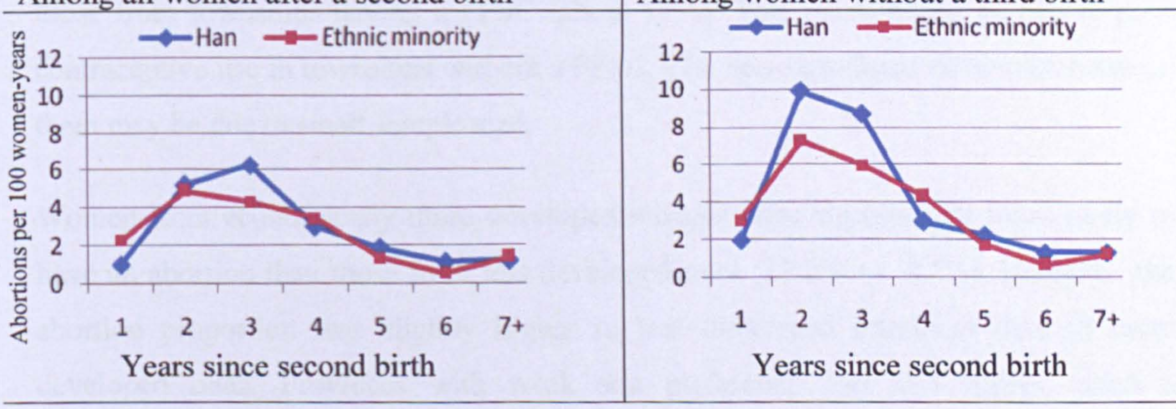
Figure 8.13: Abortion rates after a second birth, by women's status of a third birth and sex of second birth



It is of interest to know whether there is any difference of abortions between Han Chinese and ethnic minorities. The abortion rates and trends after a second birth for the Han majority and ethnic minorities are displayed in Figure 8.14. When including all women having at least two children in analysis, the abortion rates for the Han majority were close to those for the ethnic minorities, with that the single exception that the third-year's abortion rate was about 2 points higher for Han Chinese than for ethnic minorities (the left graph). After removing women who had a third birth from the above calculations, abortion rates for both Han and ethnic minorities increased, particularly the second and third year's rates. Moreover, as can be seen in the right-hand graph, these two years' abortion rates for Han Chinese are about 2.6 points higher than those for ethnic minorities. Their differences in other years are very small.

Figure 8.14: Abortion rates after a second birth among Han Chinese and Ethnic minorities

Among all women after a second birth	Among women without a third birth



8.3.2 Risk factors of abortions after a second birth

From the above analyses, we know that the abortion risk in provinces dominated by 2-child policy is higher after a second birth than after a first birth, particularly among women having only two children. Hence, I focus on the exploration of risk factors of abortions after a second birth on women having only two children. A total of 315 women had only two children. Among them, 12.7 per cent reported an abortion history within 2 years after a second birth, of which 11.8 per cent reporting only one abortion and 0.9 per cent two or more. The average first-two-year abortion rate is 5.22 abortions per 100 women-years. Table 8.7 shows the percentage distribution of women who had at least one abortion after a second birth by categories of women's characteristics.

As shown in the table, abortion risk declined with couple's age at second birth. For instance, 15.5 per cent of women who had a second birth at age of 22 or younger reported at least one abortion after the birth. The proportion reduces to 13.8 per cent and 12.8 per cent in age groups of 23-24 and 25-26 years old and further to 8.2 per cent in the oldest age group of women. Abortion differentials between sex combinations of first and second birth are significant at the 0.10 level. The rate was highest among women having two boys and lowest among women whose first birth was a son and second birth was a daughter. Apparently these results cannot be explained by son preference because, under the assumption of son preference, women who had two sons may have an extremely high abortion rate but those who had two daughters may have an extremely low abortion rate. Our results do not fully match these assumptions.

Slightly more women from townships without a FPSC reported an abortion (17%) than those from townships having a FPSC (about 11%). This result might be due to poor contraceptive use in townships without a FPSC. The non-significant difference between them may be due to small sample size.

Women from economically more developed villages were significantly more likely to have an abortion than those from less developed ones (21.2% vs. 8.5%). However, the abortion proportion was slightly higher in less developed provinces than in more developed ones. Provinces with weak son preference had also higher abortion proportion than those with strong son preference. It is noted that the sample sizes of more developed provinces with strong son preference were small. Hence, these results are not very convincing.

Table 8.7: Percentage of abortions within 2 years after a second birth among women without a third birth, by province, township, village and individual factors

Individual level indicators	No. of 2nd birth	% of abortion
Years that second birth was born		
1979-90	174	13.8
1991-95	141	11.3
Women's age at second birth		
≤22	84	15.5
-24	80	13.8
-26	78	12.8
27+	73	8.2
Husband's age at second birth		
≤24	94	17.0
-26	78	14.1
-28	62	12.9
29+	81	6.2
Women's education		
≤Primary School	255	12.5
>Primary School	60	13.3
Couple's minority status		
Both Han	114	12.3
One or both minority	201	12.9
Woman's son preference		
No	293	12.6
Yes	22	14.3
Sex of first and second birth		†
1st boy, 2nd boy	88	19.3
1st boy, 2nd girl	89	6.7
1st girl, 2nd boy	77	11.7
1st girl, 2nd girl	61	13.1
Township-village level		
Family planning services at township FPSCs		
No a FPSC	64	17.2
Good short- poor long-term method provision	179	11.7
Others	72	11.1
Average household annual income in villages (Yuan)		**
<1200	211	8.5
>1200	104	21.2
Provincial level		
GDP per capita (Yuan)		
<5000	281	13.2
>5000	34	8.8
Strength of son preference		
No or Weak	282	13.1
Strong	33	9.1
Total	315	12.7

† p <0.10, * p<0.05, ** p<0.01

Table 8.8 presents results of a two-level Poisson regression model fitting data of abortions after a second birth among women without a third birth. The *offset* is set to be $Log_e^{(5.22*\text{exposed years to abortion risk within the first two years after the second birth})}$. The two-level rather than three-level model is used because no level-3 (province-level) variable is included in model and, moreover, preliminary analysis shows the relationship between ranked level-3 residuals and normal scores is not linear. Couple's age at second birth, sex combination of first two births and average household income in villages are included in analysis. I used Monte Carlo Markov Chain (MCMC) procedure to estimate the parameter because the 2^{nd} order PQL algorithm did not converge.

After controlling for other variables, husbands who had a second birth at age of 29 or older were associated with a significantly lower risk of abortion for their wives than the youngest age group of husbands. Compared with women whose first birth was a son and second birth was a daughter, those who had two sons were significantly more likely to have an abortion after the second birth. The economically more developed villages were also associated with a significantly increased risk of abortion. Both results could be partly attributed to different patterns of contraceptive use between them. Among women who had a son then a daughter, 48 per cent used sterilisation after their second birth, compared with only 40 per cent women who had two sons. About 42 per cent of women having firstly a daughter then a son used sterilisation and only 33 per cent of women with two daughters did so. In the less developed villages, 47 per cent of women having only two children adopted sterilisation, compared with about 30 per cent in more developed ones. Perhaps women in more developed villages had more freedom to select reversible contraceptive methods than those in the less developed ones. One son and one daughter are usually the best sex combination of offspring for many couples. It is not surprising that more women with such a sex combination of children adopted sterilisation than others.

The township/village-level variance is small and less than its standard error, indicating abortion variation being small between townships/villages.

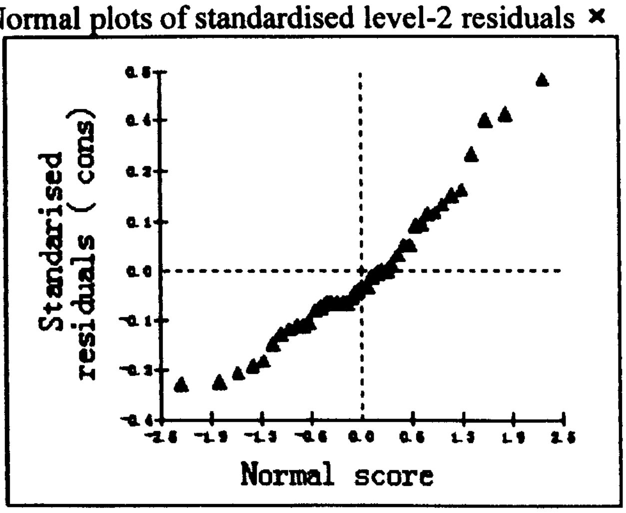
Tables 8.8: Parameter estimates of three-level Poisson regression model fitting data on abortions after a second birth among women without a third birth in provinces dominated by 2-child policy

Predictors (reference category)	Coeff.		s.e.
Fixed effects			
Intercept term	-7.103	**	0.468
Individual level (level-1)			
women's age at second birth (ref: <=22)			
-24	-0.287		0.408
-26	-0.149		0.462
27+	-0.130		0.592
Husband's age at second birth (ref:<=24 years old)			
-26	-0.402		0.410
-28	-0.785		0.494
29+	-1.326	*	0.587
Sex combination of first two children (ref: Boy-girl)			
Boy-boy	1.138	**	0.462
Girl-boy	0.388		0.527
Girl-girl	0.486		0.546
Township-village level (level-2)			
average household annual income (ref: <1000 Yuan)			
>1000	0.849	*	0.347
Random effects			
Township-village level variance	0.061		0.120

* p<0.05, ** p<0.01

Figure 8.15 plots standardised level-2 residuals against their normal scores. The relationship between ranked level-2 residuals and normal scores is fairly linear, suggesting that the assumption of normality at level 2 is reasonable.

Figure 8.15: Normal plots of standardised level-2 residuals × normal scores



8.4 SRB by calendar years and birth order

As can be seen in Table 8.9, the overall sex ratios of first and second births are slightly above the upper limit of normal range of 1.07, but their 95% CIs overlap the normal value. The overall ratio of third births is 1.259 with 95% CI ranging from 1.065 to 1.493, providing some evidence of imbalance in sex ratio of the third birth. Since the numbers of first, second and third births in this chapter are small, there are no sensible differentials between women's characteristics or other factors and imbalance in SRBs. Detailed numbers of births can be found in appendix F.

Table 8.9: Sex ratios of first, second and third births and 95% confidence intervals (CI) in provinces dominated by 2-child policy: 1979 - 2000

	First birth			Second birth			Third birth		
	Boy	Girl	SRB 95% CI	Boy	Girl	SRB 95%CI	Boy	Girl	SRB 95%CI
1979-84	130	126	1.032 0.807-1.320	101	98	1.031 0.780-1.364	75	49	1.531 1.079-2.235
1985-90	213	198	1.076 0.887-1.307	184	166	1.108 0.899-1.370	99	91	1.088 0.818-1.451
1991-95	160	160	1.000 0.803-1.246	131	126	1.040 0.814-1.330	77	54	1.426 1.014-2.050
1996-00	157	117	1.342 1.059-1.714	147	129	1.140 0.900-1.233	55	49	1.122 0.763-1.665
Total	660	601	1.098 0.983-1.227	563	519	1.084 0.963-1.223	306	243	1.259 1.065-1.493

8.5 Summary of key points

The total fertility rates in provinces dominated by 2-child policy fell between1986 and 2000 but remained above replacement level (2.1 children per couple) except in 1999. As in other provinces, the progressions to first birth in provinces dominated by 2-child policy were constant and close to one. In contrast, progressions to second birth in these provinces remained high, ranging from 0.83 to 0.97 during 1986-2000. Thus the decline of fertility level is mainly contributed by falls in progression to third and higher order births. All these results can be mainly attributed to the effect of the lenient population policy because a second birth was normally approved but a third or higher order birth was largely restricted.

Results in this chapter also show that sex of first birth had little impact on the probability of a second birth, but the sex combination of the first two children significantly affected the likelihood of a third birth. Women who had a son followed by a daughter were least, but those who had two daughters were most likely to have a third birth. The adjusted odds ratio for a third birth is about 3.51 times higher for women having two daughters than for those having a son then a daughter. These results also suggest that there is some degree of son preference in provinces dominated by 2-child policy. It is somewhat surprising that Han Chinese and ethnic minorities had almost equal levels of a second or a third birth, but Han Chinese had slightly shorter birth interval than ethnic minorities did.

After controlling for potential confounding, only calendar year of first birth and average household income in the village are significantly associated with the likelihood of a second birth. However, more factors are associated with the likelihood of a third birth, including calendar year of second birth, women's son preference, sex combination of the first two children and the proportion of rural population. Women with son preference or having two daughters were more likely, but provinces with more rural population were less likely to have a third birth than their respective counterparts. The likelihood of a third birth varies between townships within a province. Women whose first child was born in earlier years tended to have shorter birth intervals between the first two children than those whose first child born in most recent years did (ranging from 26.5 months to 35.5 months); provinces with a strong son preference culture were associated with shorter birth intervals (24.8 months) than those with weak son preference (33.8 months). Similar trends were seen in the intervals between second and third births.

Findings in this chapter confirm our hypothesis that the abortion rate is lower in provinces dominated by a lenient population policy than those dominated by strict population policies. The abortion level after the first birth is lower than that after the second birth because the majority of women progressed to a second birth whereas many did not have a third birth. Somewhat surprising, fertility and abortion differences between Han Chinese and ethnic minorities were small.

Factors that are associated with risk of abortions after second births include youngest fathers, women having two sons and those from richer villages. Unexpectedly, women's education and ages at second birth as well as FP services at FPSCs had little effect on the risk of abortion.

The overall sex ratios of first and second births in 1979-99 were largely normal, but some evidence showed that the ratio of third births might be distorted, partly reflecting the features of 2-child policy.

Chapter 9: Discussion and implications

9.1 Data limitations

This thesis is chiefly based on data from a review of local population policies throughout China and a national survey in 2001. The key limitation of the policy data set is the unavailability of information below the level of the province. Thus the present analysis has had to ignore intra-province differences in population policy. A further limitation is the absence of trend data. The most obvious limitations in this study relate to underreporting of female births and abortions in the 2001 survey, a problem experienced by all analysts of Chinese fertility. As indicated by the sex-specific progression ratios to second birth and sex-specific abortion rates in Chapters 6 and 7, second births in provinces implementing strict 1- and 1.5-child policies were most likely to be underreported, particularly female births. A female birth is most likely to be concealed due to desire for a son or one more child of either sex. However, children over 6 years old are less likely to be underreported because they are of school age and more difficult to conceal. Consequently, TFRs may be underestimated but SRB be overestimated in the few years preceding the 2001 survey in provinces with strict population policies. It is difficult to estimate the extent of underreporting of female births, but I estimate it to be small because the fertility levels derived from data used in this study were close to results from other sources (*Pan J 2004; Yan 2006*).

Another concern is underreporting of abortions. A comparison of abortion-live-birth ratios derived from the 2001 NFPRHS and 1997 NFPRHS in Chapter 3 provided some evidence of this data defect. Furthermore, sex ratios of second births among women having a first-born daughter in 1.5-child provinces were highly imbalanced, even among those who reported no abortion, while the ratios among women having a son were normal or close to normal. These results indicate that sex-selective abortions between first and second birth might be seriously underreported.

Defects in one predictor variable were also apparent. As discussed in Chapter 3, the ideal number of sons and daughters partly reflects rationalisation of achieved fertility, resulting in enlargement of effects of sex preference on SRB.

The nature of FP services at FPSCs and in villages were summarised by using latent class analysis. This indicator is inadequate to measure the quality of FP services at grassroots institutions because only the availability of contraceptive methods and abortion services were considered. In China, FP methods are available both in the public health sector under the administration of the Ministry of Health (MOH) and in the FP sector under jurisdiction of the National Population and Family Planning Commission (NPFPC). A previous study found that, although the FP sector was the dominant source of contraceptive methods in rural China, public hospitals played a key role in some areas (*Zhou 2004*). Unfortunately data on FP services in the public health sector are not available. Moreover, the findings in this thesis indicate that good FP services, particularly long-term contraceptive methods, might be a programmatic response to high local demand for second or higher order births rather than a determinant. This explains why good provision of long-term contraceptive methods was associated with a higher level of a second birth in 1-child provinces.

9.2 Fertility by population policy

Table 9.1 summarizes key indicators of fertility for the three types of provinces dominated by 1-, 1.5- or 2-child policy, respectively. Fertility fell by about one-third between 1986 and 2000 regardless of the policy. Nevertheless, the TFRs followed the policy-fertility gradient: highest in 2-child provinces and lowest in 1-child provinces TFRs in 2000 for the three types of provinces were 1.15, 1.56 and 2.19, respectively, close to 1, 1.5 and 2 children per couple as the policy fertilities indicated. These results suggest that China's population policies were very successful though the decline since 1986 indicates that success was achieved over a relatively long time period.

This study also reveals that declines in TFRs can be mainly attributed to falls of progression to second birth in 1- and 1.5-child provinces, but to that of progression to third or higher order births in 2-child provinces. These results are not unexpected because fertility regulations are focused on restricting the second child in the former two types of provinces and limiting the third and higher order births in 2-child provinces. As can be seen in Table 9.1, the average birth intervals for women whose first child was born in late 1980s ranged from 27 to 29 months for the three types of provinces. The birth intervals for 1991-95 cohorts increased to 44.8, 40.8 and 35.5 months respectively. The rising interval in more recent years may have partly contributed to drops in period fertility for the three types of provinces. Moreover, birth intervals for the 1991-95 cohort followed the policy-fertility gradient: the lower the policy fertility, the longer the birth intervals. This result indicates that birth intervals may have partly contributed to fertility differentials between types of provinces in the 1990s.

Table 9.1: Fertility level, parity progression ratio and birth interval between first and second births, by policy fertility

Provinces	TFR			PPR_{1-2}		Trimean (months)	
	1986	2000	% Change	1986	2000	1985-90 cohort	1991-95 cohort
1-child policy	1.69	1.15	32.0	0.532	0.224	29.0	44.8
1.5-child policy	2.46	1.56	36.6	0.879	0.530	27.3	40.8
2-child policy	3.26	2.19	32.8	0.951	0.962	27.3	35.5

9.3 Abortion by population policy

As shown in Table 9.2, abortion rates between marriage and first birth, between first and second births and after the birth of an only child were lower in provinces dominated by more lenient population policies. Although these results are expected, the explanations appear not as simple as I had anticipated. My basic hypothesis on abortion (lower fertility level results in higher risk of abortion) may explain differences in overall abortion rates between the three types of provinces. However, abortion rates shown in Table 9.2 were measured during three specific reproductive segments. Effect of fertility on the risk of abortion was largely controlled. As discussed earlier, the primary abortion causes in China include inconsistency with policy requirements, unplanned pregnancy due to contraceptive failure or non-use, and sex-selection for a son (*Chu 2001; Qiao and Suchindran 2006*). However, the first reason cannot be used to explain abortions between marriage and first birth because all couples are approved to have one child. Thus the abortion differentials before first birth between the three types of provinces mainly resulted from the other two causes. More specifically, the results suggest that: women in provinces dominated by the 1-child policy are more likely to have a sex-selective abortion before first birth. Inconsistency with policy requirements could be one cause of abortions between first and second birth because a minimum of three to five years' gap between the two births is usually required. Implementation of this regulation might be stricter in 1-child provinces than in 1.5-child policy and least strong in 2-child provinces. Selective abortion may also partly contribute to this result. This would be most likely to occur in 1-child provinces because a second birth is highly restricted. Abortion level in this study is also affected by duration of exposure. Since women in 1-child provinces had longer birth intervals than others, they have a higher risk of abortion due to longer exposure. The finding that the abortion rate after the first birth among women having only one child was highest in 1-child provinces and lowest in 2-child provinces no doubt reflects inconsistency with policy requirements because women from provinces dominated by more stringent population policies are more likely to have an unapproved pregnancy after the first birth.

The abortion rate before the first birth is higher than that between first and second birth in 1-child provinces, perhaps because there were more selective abortions before the first birth. Greater reliance on less effective contraceptive methods before the first birth than after the birth might partly contribute to this result. On the contrary, the rate between first and second births is higher than that before the first birth in 1.5-child provinces. This difference is almost certainly caused by the greater incidence of sex-selective abortion after than before first birth. In all types of provinces, the rates were highest after the first birth among women having only one child, indicating a need to improve FP services for postpartum women in China.

Selective abortion was reported to be the primary cause of the abnormal SRB in China, though not the only one (*Chu 2001; Wang et al. 2001; Wu, Viisainen and Hemminki 2006*). Using SRBs derived in Chapters 6 and 7, I estimated the possible numbers of selective abortions before first and second births, assuming that imbalance in SRB is entirely due to selective abortion, rather than a reflection of underreporting of daughters, and only one selective abortion was performed for one woman. Supposing a normal SRB of 1.06, a maximum of 74 female foetuses between marriage and first birth and 64 female foetuses between first and second births might be aborted in 1-child provinces. If underreporting of abortions is ignored, selective abortions might account for 68.5 per cent and 15.0 per cent of reported abortions before first and second births, respectively. However, as has been discussed, selective abortion could be seriously underreported. Supposing that 60 per cent of selective abortions were underreported, thus 60.3 per cent [74/(108+74*0.6-74*0.4)] of abortions before first birth and 14.6 per cent [64/(426+64*0.6-64*0.4)] of those between first and second birth were due to son preference. On the extreme assumption that all selective abortions were underreported, then the two proportions were estimated to be 40.7 per cent and 13.1 per cent respectively. Under either scenario, selective abortion appears to be a major contributor to overall abortions before first birth but a minor one between first and second birth in 1-child provinces.

In provinces dominated by 1.5-child policy, the normal sex ratio of first births suggests that selective abortion before first birth was uncommon. However, the sex ratio of second births was highly distorted and the estimated number of selective abortions was as many as 1210 female foetuses between first and second birth. Similarly as above, I calculated the possible proportions of selective abortions among total abortions between the first two births by supposing that nil, 60 per cent or 100 per cent of selective abortions were underreported. The estimates were 97.0 per cent, 81.3 per cent and 49.2 per cent, respectively. Recall that I have assumed that one woman had a maximum of one selective abortion. In fact, some women might have multiple abortions to achieve a son, so that the above percentages might be slightly higher. Thus selective abortion may be the dominant reason for abortion between first and second birth in 1.5-child provinces.

Since there is no serious evidence of distorted sex ratios in 2-child provinces, the potential numbers of sex-selective abortions are not calculated.

Table 9.2: Abortion rates, reported and estimated numbers of abortions, by policy fertility

	Abortion rate #			Reported number of abortions		Estimated number of selective abortions	
Provinces	Betw. Mar. & 1st birth	Betw. 1st and 2nd birth	After birth of the only child	Betw. Mar. & 1st birth	Betw. 1st and 2nd birth	Betw. Mar. & 1st birth	Betw. 1st and 2nd birth
1-child policy	2.63	2.04	5.86	108	426	74	64
1.5-child policy	1.01	1.33	4.12	/	1247	/	1210
2-child policy	0.25	0.99	1.80	4	72	/	/

abortions/100 women-years; / not applicable

9.4 Sex ratios at birth by population policy

Table 9.3 summarizes overall sex ratios of first and second births in 1991-2000 by population policy. The sex ratios of first births were slightly distorted in 1-child and 2-child provinces but their 95% CIs overlap the normal range. In view of the abortion data, it is probable that the sex ratio in 1-child provinces is distorted but that the estimate in 2-child provinces has arisen by chance, a verdict supported by the normal ratio for second births. Sex ratios of second births were significantly distorted in 1- or 1.5-child provinces. The basic reasons of imbalance in SRB include sex-selective abortion and underreporting of female births. The above results suggest that the two factors were most likely to occur before second births in 1.5-child provinces, before first birth in 1-

child provinces but seldom in 2-child provinces. SRB did not increase with birth order in 2-child provinces because a second birth is normally approved for the majority of couples.

There is little doubt that selective abortion is the dominant cause of rising SRB in the 1990s. Distortion in the sex ratio of first births in 1-child provinces reflects the likelihood that some couples resorted to selective abortion for a first birth because a second birth was strictly limited. It is not surprising that the sex ratio of second births increased in 1-child provinces because a few couples with strong son preference might resort to selective abortions for a son as a second birth even if the second birth was not approved by the local authority. It was expected that the sex ratio of second births in 1.5-child provinces would be imbalanced but somewhat surprising that the ratio was much higher than that in 1-child provinces. One reason for this result may be that son preference in the former provinces was stronger than the latter, a verdict supported by the measure of son preference at province-level. The other reason may be due to the effect of the 1.5-child policy that allows a second birth for couples having a daughter. A couple would be less likely to seek selective abortion before a first birth because they can have a chance for a second child if their first is a daughter. Thus selective abortion is squeezed between first and second births, resulting in a highly imbalanced SRB of second births in 1.5-child provinces. Other reasons may have also contributed to this result. For instance, the provinces dominated by 1.5-child policy are mainly located in central and western China and rely heavily on agriculture and thus there is great demand of sons for agricultural work. The normal SRBs of first and second births in 2-child provinces suggest that distortion in SRB of first and second births in 1-child or 1.5-child provinces may be largely remedied by relaxing the strict population policies to a 2-child policy, though the problem may not be totally resolved. Moreover, findings in Chapter 8 indicated that the sex ratio of third births might be distorted. I expect the influence on the overall SRB be small because the number of third births could be small.

Table 9.3: Sex ratios at birth and 95% confidence intervals in 1991-2000, by policy fertility and birth order

Provinces	1st birth	2nd birth
1-child policy	1.16 (1.048-1.286)	1.35 (1.153-1.598)
1.5-child policy	1.03 (0.977-1.077)	1.66 (1.556-1.773)
2-child policy	1.14 (0.975-1.346)	1.09 (0.920-1.294)

9.5 Mediating effects of province, township, village and individual factors between policy and reproductive outcomes

Province-level factors

Effects of province-level factors on the reproductive outcomes by types of population policies are summarized in Table 9.4. Parameter estimates that are significant at the 0.10 level in multilevel multivariate analyses are presented. In 1- and 1.5-child provinces, the more developed areas had significantly lower probability but provinces with less than 60 per cent of rural population had significantly higher probabilities of a second birth than their respective counterparts. The main reason for these results may be that couples from the more developed provinces and those with the least proportion of rural population tend to desire smaller family sizes. Desire for a small family size can be caused by a combination of a number of demographic and socioeconomic factors, i.e., adjustment to socioeconomic changes, labour market rigidities, insufficient child-care support, rising cost of child education and change of social norms on son preference. These factors may be more common in the more developed provinces with lower rural population than in their respective counterparts in 1- and 1.5-child provinces. The effects of economic development and rural population on fertility level of a second birth appear stronger in 1-child provinces than in 1.5-child provinces, indicating variations of the probability of a second birth between provinces dominated by 1-child policy being greater than those between provinces dominated by 1.5-child policy.

Table 9.4: Effects of province-level factors on likelihood of a second birth, risk of abortion and probability of a son as a second birth by policy fertility

Province-level factors	Likelihood of 2nd birth			Risk of abortion betw. 1st & 2nd birth		Risk of abortion after 1st birth		Prob. of a son as a 2nd birth in 1990s	
	1-child	1.5-child	2-child	1-child	1.5-child	1-child	1.5-child	1-child	1.5-child
GDP per capita	-2.918	-2.001	-	-	1.007	-	-	-	-
% of rural pop. (r: <60%)									
60-70	-4.388	-2.844	-	-	-	-	-	-	-
-75	/	-2.356	-	/	-	/	-		
>75	-5.013	-2.874	-	-	-	-0.524	-0.960	-	-
Strength of son preference (r:No)									
Weak	/	2.968	-	/	-	/	-0.394	/	-
Strong	/	3.491	-	/	-1.295	/	-	/	-
% of ethnic minority (r: <3%)									
3-9	-	-	-	-	-	-	-	-	-
>9	/	-	-	/	-	/	-	/	-

r: reference group; -: not significant at least at 0.10 level; /: not applicable.

Son preference culture at the province-level was identified in provinces dominated by 1.5- or 2-child policy. This culture is associated with an increased probability of a second birth in the 1.5-child provinces but not in the 2-child provinces. This result can be also attributed to their respective population policies because a second birth is restricted in the former provinces and not in the latter ones. Somewhat surprisingly, the proportion of ethnic minorities showed little effect on levels of a second birth for the three types of provinces, indicating that inhabitants of any particular locality are influenced by the circulation of a wider trans-local public culture. In 2-child provinces, none of the province-level factors showed significant effects on the likelihood of a second birth, but provinces with more than 70 per cent of rural population were significantly less likely to have a third birth, perhaps reflecting that the population policy was implemented more strictly in provinces with more rural population.

Effects of province-level factors on abortions in 1-child provinces differ from those in 1.5-child ones. For example, the abortion risk between first and second births was significantly higher in more developed areas than in less developed ones in 1.5-child provinces. As having mentioned in Chapter 7, this result may be because women from more developed provinces were more likely to use condoms and other less effective contraceptive methods than those in less developed ones. This association is not seen in 1-child provinces, indicating that variation of women's contraceptive behaviour between 1-child provinces was small. Strong son preference culture in 1.5-child provinces was associated with a significantly lower risk of abortion after the first birth. This is mainly because the culture encouraged women to carry out a pregnancy to term rather than have an abortion. This culture was less pronounced in 1-child provinces. Provinces with over 75 per cent of rural population were associated with significantly lower risk of abortion among women having only one child in either 1-child or 1.5child provinces. The reasons for these results are that long-term contraceptive methods were strongly promoted in areas with the highest level of rural population and particularly stricter follow-up of contraceptive use after the first birth was applied in provinces with highest level of rural population than in those with lowest level of rural population. The increased risk of an abortion in a 1.5-child province with weak son preference culture is partly due to its high level of rural population. Detailed explanation can be found in page 198. Somewhat surprisingly, the ethnic factor had little effect on the risk of abortion regardless of the status of women's second birth and provincial population policy, providing some more evidence that reproductive behaviour of any particular locality is influenced by the circulation of a wider trans-local public culture.

Province-level socio-economic factors showed little effects on sex of second births in the 1990s no matter what type of population policies was implemented. This conclusion is reached by controlling for other factors.

Township and village-level FP services

Effects of FP services at grassroots institutions on reproduction are of particular interest in this study. This is because China's population policy has been implemented primarily through the FP programme. This study provides an opportunity to examine how the characteristics of FP services at local level in rural China have influenced reproductive outcomes. However, as shown in Table 9.5, the capacities of FP services at FPSCs and in villages showed no associations with most of the reproductive outcomes for the three types of provinces. These results may be partly because of limitations in the measurement of the capacity of FP services in this study. Hence, effects of FP services in rural areas on reproductive outcomes, particularly abortion, are not ascertained and need to be investigated further.

Table 9.5: Effects of township- and village-level FP services on likelihood of a second birth, risk of abortion and probability of a son as a second birth by policy fertility

Province-level factors	Likelihood of 2nd birth			Risk of abortion betw. 1st & 2nd birth		Risk of abortion after 1st birth		Prob. of a son as a 2nd birth in 1990s	
	1-child	1.5-child	2-child	1-child	1.5-child	1-child	1.5-child	1-child	1.5-child
FP services at FPSCs (r: good short- term, poor long-term meth.)									
No a FPSC	1.892	-	-	-	-	-	-	-	-
Good short- & long-term method provision	1.466	-	-	-	-	-	-	-	-
Poor short-term & moderate long-term method provision	-	-	-	-	-	-	-	-	-0.387
FP services in villages (r: Good)									
Moderate	-	-	-	-	-	-	-	-	-
Poor	-	-	-	-	-	-	-	-	-

r.: reference group; -: not significant at least at the 0.10 level.

Village and individual characteristics

Table 9.6 summarizes effects of village and individual characteristics on reproduction for the three types of provinces. The probability of a second birth in more developed villages was significantly lower than that in the less developed ones in provinces dominated by strict population policy. This result is similar to the relationship between GDP per capita and progression to second birth. Thus women from more developed villages may also tend to desire smaller family sizes than those from the less developed ones. However, in 2-child provinces, couples in the least developed villages were less likely to have a second birth than those where economic development was at middle level. Further analysis reveals that 31.1 per cent of respondents in villages with average household annual income less than 1200 Yuan were Han Chinese, compared with 53.5 per cent in villages with the household income between 1200 and 1900 Yuan. Findings in Chapter 8 showed that Han-Chinese had shorter birth intervals between first and second births than ethnic minorities did. Hence, the above fertility differential between villages in 2-child provinces can be attributed to their different distributions of Han Chinese. More developed villages are associated with significantly higher risk of abortion than the less developed ones. The reasons may be that IUDs and sterilisations were less promoted and birth intervals were longer in more developed villages. This association is not seen in 1-child provinces perhaps because differences in contraceptive use and birth intervals between villages in 1-child provinces were small. Economic development in villages had little effect on SRB of second births in the 1990s in 1-child provinces, but the richest villages were associated with significantly lower SRB of second births than those at middle-level in 1.5-child provinces. The reason may be that son preference culture is less strong in rich villages than in poor ones in 1.5-child provinces. Nevertheless, this culture prevails less in 1-child provinces.

After controlling for other factors, progression to second birth declined with calendar year of first birth regardless of population policy. It fell fastest in 1.5-child provinces and slowest in 2-child provinces. As discussed in Chapters 6 and 7, decline of progression to second birth in the 1990s may be due mainly to tightening up of population policy. Economic development may also have played a role. The fastest speed in 1.5-child provinces is perhaps because implementation of 1.5-child policy was stricter than in the two other types of policy regime in the 1990s.

The risk of abortion between first and second birth was significantly higher for cohort 1991-95 than for cohort 1979-84 in 1.5-child provinces, partly reflecting more sex-selective abortions in most recent years than before. This is not the case for women having only one child. However, this risk after the birth of women's only child in 1-child and 1.5-child provinces was significantly reduced in most recent years, which is probably due mainly to promotion of more effective contraceptive methods in China in most recent years. The probability of a son as a second child in the 1990s was similar between calendar cohorts of first birth in both 1-child and 1.5-child provinces. It should be noted that this analysis only included second births born in a limited time period (1990s).

Women and their husbands' ages at first birth had little effect on the likelihood of a second birth regardless of the population policies. Moreover, couples' ages at a first birth had little effect on the risks of abortion as well as the probability of a son as a second birth with few exceptions. Clearly, under the circumstances that the number of children and birth interval are stipulated in the fertility regulations, couples' ages are not of importance on reproduction.

Somewhat unexpectedly, the better-educated women were significantly less likely to have a second birth than their less-educated counterparts in provinces dominated by strict population policies. This is not the case at where the 2-child policy was implemented. Moreover, the better-educated women were significantly more likely to have an abortion than the less-educated ones in 1-child provinces. This result is perhaps because that the former group of women was less likely to use IUDs and sterilization than the latter. This differential was not seen in 1.5-child provinces perhaps because effective contraceptive methods were equally promoted between the better- and less-educated women. Compared with the better-educated women, those who had less education were significantly more likely to have a son as a second birth in 1.5-child provinces, reflecting stronger son preference and more selective abortions among the less-educated women. This effect was not seen in 1-child provinces due partly to the small sample sizes in analysis.

In my hypotheses, I had expected that fertility level would be higher among ethnic minorities than Han Chinese. Unexpectedly, couple's minority status is not associated with any reproductive outcomes in this study. This result is consistent to that of proportion of ethnic minority in a province.

Compared with women who preferred a daughter, those without sex preference were significantly more likely to have a second birth in 1-child and 1.5-child provinces. This is not the case in 2-child provinces. The reason in 2-child provinces is obvious because a second birth was normally allowed without a need of approval from the local authority.

Women having no sex preference in 1- and 1.5-child provinces might be more likely to want two or more children than those preferred a daughter. Unexpectedly, this association was not statistically significant for women with son preference. As we have seen, the sample size of women either having daughter or son preference was much smaller than those without sex preference in the two types of provinces. The sample sizes might be insufficient to detect fertility differences between women with daughter preference and those with son preference. However, the negative association might be due partly to misclassifications of women's sex preference because this variable partially reflects women's fertility experience. Women's sex preference is not associated with risk of abortion between first and second births because fertility regulations required at least three to five years space between two successive births in all provinces. This cannot be detected in this study because only the first two-year's abortions were included in analyses. Similar reason can be applied to explain the effect of sex of first birth on risk of abortion between the first two births. However, among women having only one child, son preference and having a daughter showed significantly lower risk of abortion than their respective counterparts in 1.5-child provinces. One possible explanation for those results is that a second birth was underreported among women having a daughter or having son preference.

In 1- or 1.5-child provinces, women having a daughter were significantly more likely to have a male child as a second birth, reflecting that sex of existing child is a crucial determinant of sex of second birth under strict population policy. Women with son preference or without sex preference were also more likely to have a son as a second birth than those with daughter preference in 1.5-child provinces; while in 1-child provinces, this association was not seen. It appears that the 1.5-child policy that allows a second birth for daughter-only families enlarges the imbalance in SRB of second birth and it was perhaps interpreted by many couples as an invitation to ensure a son after a first-born daughter. In fact, only 849 women ended up with two daughters in 1.5-child provinces, compared with 2763 women who had a first-born daughter and ended up with a second-born son, a ratio of 1:3.2.

Table 9.6: Effects of village and individual characteristics on likelihood of a second birth, risk of abortion and probability of a son as a second birth by policy fertility

characteristics	Likelihood of 2nd birth			Risk of abortion betw. 1st & 2nd birth		Risk of abortion after 1st birth		Prob. of a son as a 2nd birth in 1990s	
	1-child	1.5-child	2-child	1-child	1.5-child	1-child	1.5-child	1-child	1.5-child
Average household annual income in villages									
Continuous	-1.320	-0.424	/	-	0.412	-	0.219	-	/
<1200			-0.905						-
1200-1900			r.						0.331
1900-2800			-						0.239
>2800			/						r.
Calendar year of 1st birth (r: 1979-84)									
1985-90	-0.682	-1.265	-	-	-	-	-	-	-
1991-95	-2.293	-3.156	-0.747	-	0.537	-0.411	-0.377	-	-
Women's age at 1st birth (r: <=21)									
22-23	-	-	-	-	-	-	-	-	-
24-25	-	-	-	-	-	-	-	-	-
26+	-	-	-	-	-	-	-	-	-
Husbands' age at 1st birth (r: <=22)									
23-24	-	-	-	-	-	-	-	-	-
25-26	-	-	-	0.412	-	-	-	-	-
27+	-	-	-	-	-	-	-	-	-
Couple's minority status									
Both Han	-	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-	-
Women's education (r:<=prim. sch.)									
Middle sch.+	-0.338	-0.237	-	0.446	-	-	-	-	-0.150
Sex of 1st birth (r: son)									
Daughter	1.345	1.086	-	-	-	-	-0.400	0.347	0.724
Women's sex preference (r:daughter pref.)									
No	0.626	0.440	-	-	-	-	-0.349	-	0.974
Son	-	-	-	-	-	-	-0.698	-	1.199

r.: reference group; -: not significant at least at 0.10 level; /: not applicable.

In summary, this is the first analysis to have looked so closely at the effects of China's population policy on reproduction. Findings in this thesis present researchers and policymakers with challenge to develop appropriate population policy to benefit contemporary China and its future.

9.6 Policy implications

Comparisons between provinces dominated by 1-, 1.5- and 2-child policies suggest great demographic impacts of population policy on fertility, abortion and SRB in rural China during 1979 and 2000. Fertility rates for the three types of provinces were close to respective policy fertilities. I believe these results are fairly reliable as it is implausible to attribute the consistency of policy and fertility outcomes to widespread underreporting of female births. What factor, other than forceful implementation of population policy, could be so powerful as to bring the fertility rates of different types of provinces so close to respective policy fertilities in the most populous country in the world? Thus we can conclude that the parity TFR in rural areas of 1-child provinces reached about 1.2 children per couple by the end of last century, mainly because of government policy. Such a low TFR was only seen in some developed countries, i.e. Italy, Spain, Greece and Japan (*DESAPD, 2003; Frejka and Sobotka, 2010; Yuan and Zhang, 2010*). TFR in rural areas of 1.5-child provinces in 2000 was slightly lower than that of Europe as a whole (1.61 in 2001-2003) (*Frejka and Sobotka 2010)* and the rate in 2-child provinces was very close to that of United States and Brazil (2.1 in 2000) (*Kohler, Billari and Ortega 2006*).

Most countries whose fertility rates were below replacement level were from the developed world. China is one of the few exceptions. As in many other countries with low TFR, China is now facing problems of accelerated population ageing and labour force shortages. These problems are particularly serious in 1-child provinces. For instance, over 21 per cent of the total population in Shanghai was over 60 years old in 2008 (*Zhou and Gao 2009*). This municipality has heavily relied on migrants from other provinces in the past decade to achieve its sustainable economic development, adjust its population age structure and contribute to old-age pensions. However, this strategy can hardly be adopted by Chongqing and Sichuan provinces (also dominated by 1-child policy) because the two provinces are far less developed than Shanghai and 67 to 81 per cent of total population live in rural areas with fragile social security systems. As a matter of fact, many young men and women in Sichuan and Chongqing had moved to more developed areas for economic reasons. We know that the population in 1-child provinces accounts for slightly less than one-fifth of China's total population (18.17% in 2000, *NBS 2010b*). If the ageing problem only occurred in 1-child provinces, the situation may be not very serious for the country. However, it can become a disaster for China after one or two decades when provinces dominated by 1.5-child experience rapid ageing. The population of these provinces accounts for about three-quarters of the country's total population (950 million in 2000, *NBS 2010b*). There will never be enough migrants to offset the deficit of young generations in 1.5-child provinces. If migrants are not a practical remedy, relaxation of strict population policy may be the only solution to solve this problem.

As indicated in this study, there are also other benefits of relaxing strict population policy, including reducing abortion risk and normalizing SRB.

Contraceptive patterns in rural China appeared closely related to population policy. Reversible short-term methods were more common in sites under 1-child policy. Effective long-term methods were more common in sites under 1.5-child policy (as indicated in Table 5.10). It can be expected that more couples will adopt long-term methods in 1-child provinces if the strict policy is relaxed. Under current conditions very few couples with only one child are willing to be sterilized but willingness will surely increase if they are allowed a second child. To some degree, relaxation of the strict policy can also reduce sex-selective abortions. However, results from this study also suggest a need to improve the quality of postpartum contraceptive services throughout the country, particularly during the first two years after the last birth within fertility regulations. This verdict is consistent with that of a previous study (*Che and Cleland 2004*).

Growing discrimination against girls and imbalance in SRB have been big challenges for China, particularly after strict population policy was implemented. The adverse consequences of rising SRB in China, including rising violent crime, shortage of women in the marriage market, expansion of sex industry and so on, have been discussed by many other researchers (*Li 2007; Hesketh and Xiang 2006; Mo 2005; Wang and Yi 2004; Wu, Viisainee and Hemminki 2006*). The Chinese government has made it a high priority to reduce SRB and protect girl children. For example, the "Care for Girls" campaign was scaled up across the country in 2003. However, the latest information showed that the overall SRB in China was 119.45 in 2009 *(DPID 2010)*, even higher than that in 2000 (117.8, *Sun 2003*). This result is not very surprising because it is unrealistic to negate the thousand-year tradition of son preference overnight. Experience from South Korea suggests that stricter enforcement of the law banning the practice of sex-selective abortion has been successful in reducing SRB (*Hesketh and Xiang 2006*). The Chinese government has learned from South Korea's experience (personal communication with the deputy director, office for reducing SRB, NPFPC), but the relevance of the experience of a small and more developed country to China is dubious. Relaxation of the 1- and 1.5-child policies could be a good solution. As can be seen in chapter 8, SRBs of first and second births in 2-child provinces were largely normal. Though the sex ratio of third or higher order births may be imbalanced, the parity progression ratio to third or higher order births would be small because of fertility regulations and spontaneous decline of desired family size. Controlling rising SRB of higher order births can be much easier than controlling the sex ratios for all parities. Furthermore, it should be stressed that to allow a second birth for a couple having a daughter may not be a good policy because it inflates SRB of second births and increases the risk of selective abortion. This policy obviously impairs gender equality. Chinese central and local governments need a wiser population policy to avoid discrimination against girls. Obviously, reducing SRB should integrate modification of population policy with other measures, i.e., equal social and economic rights for males and females, free basic health care, special supportive measure for families with no sons and protection for the elderly.

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Appendixes

Appendix A: Questionnaires

National Family Planning & Reproductive Health Survey 2001

<u>Questionnaire 1: TOWNSHIP FAMILY PLANNING SERVICE STATION</u>

Address:
Study site code:
Investigator signature & code:

	Questions	<u>Choices/answers</u>
1.	Is there a family planning service station at the township?	No/yes
2.	Is the name of the station clearly shown at the gate of station?	No/yes
3.	Is there a label at each service room of the station?	No/yes
4.	Is there pipe water at this station?	No/yes
5.	Is there a TV set at the waiting room of this station for clients use?	No/yes
6.	Is there a Gynecology check up room at this station?	No/yes
7.	Can the Gynecology check up room protect clients' privacy?	No/almost/yes
8.	Is there any surgery room at this station?	No/yes
9.	Is the surgery room separated from that check up room?	No/yes
10.	How many patients' beds at this station?	Fill in number
11.	Does this station provide any consulting service?	No/yes
12.	Is there any recode for consulting service at this station?	No/yes
13.	Is there a separated room for consulting service?	No/yes
14.	Does this station provide postpartum follow-up services?	No/yes
15.	Is this post-partum follow-up service recorded?	No/yes
16.	Does this station provide follow-up service for FP surgical operation?	No/yes
17.	Is this follow-up service recorded?	No/yes
18.	Is there any B-ultrasound machine at this station?	No/yes
19.	How many years has the machine been used?	Number of years
20.	What is the B-ultrasound machine used for:	
	IUD check	No/yes
	Gynecological disease detection	No/yes
	Liver, kidney or thorax disease detection	No/yes
21.	Is there any B-ultrasound machine at private clinics at this township?	No/yes
22.	Did the station provide any of the following services in 2000?	
	βHCG test	No/yes
	prenatal health check up	No/yes
	common gynecological disease diagnosis & treatment	No/yes
	infertility diagnosis & treatment	No/yes
	STD diagnosis & treatment	No/yes
	Pap smear	No/yes
	blood/urine/stool lab examination	No/yes
	sperm examination	No/yes
	X-ray examination	No/yes
23.	How many people received the following FP operation services?	
	male sterilization	Fill in number
	female sterilization	Fill in number
	IUD insertion/removal	Fill in number
	Norplant insertion/removal	Fill in number
	induced abortion (include medical abortion)	Fill in number

24.	Of them, how many were performed by staff of this station?	Fill in number
	male sterilization	Fill in number
	female sterilization	Fill in number
	IUD insertion/removal	Fill in number
	Norplant insertion/removal	Fill in number
	induced abortion (include medical abortion)	
25.	What contraceptive methods are currently provided by this station?	No/yes
	Daily pills	No/yes
	Once-a-month pills	No/yes
	Visiting pills	No/yes
	Emergency pills	No/yes
	Condom	No/yes
	Spermcide	No/yes
	Anti-side-effect drug (for contraceptive methods)	No/yes
26.	Is there any service of retail sales of contraceptives?	
27.	Is there any of the following equipment or medicine in case of emergency?	No/yes
	Oxygen bag	No/yes
	Liquid transfusion equipment	No/yes
	Blood transfusion equipment	No/yes
	Emergency drug	No/yes
28.	Is there referral service recode book at this station?	Fill in number
29.	How many staff does this station have?	Fill in number
30.	How many can provide FP technical services among them?	Fill in number
31.	Among the technical service providers, how many have service licenses?	Fill in number
32.	What is the population size of this township in 2000?	Fill in number
33.	How many square kilometres of this township?	

End of township FP service station's investigation

Questionnaire 2: VILLAGE SURVEY

Study site & code:
Number of household in 2000:
Number of population in 2000:
Investigator signature & code:
Recode interviewees' names and their titles/positions:

	Questions:	Choice/answer
1.	Is there collective enterprise owned by this village?	No/yes
2.	The average income of this village in 2000	Fill in number
3.	Is there any of the following facilities at this village have?	
	Library	No/yes
	Broadcast station	No/yes
	Cable TV	No/yes
	Kindergarten	No/yes
	Primary school	No/yes
	how many boys in grade one	Fill in number
	how many girls in grade one	Fill in number
4.	Is there any countryside doctor at this village?	No/yes
5.	Does this doctor have medical license?	No/yes
6.	Is there any trained midwife at this village?	No/yes
7.	Is there any FP personnel at this village?	No/yes
8.	Please recode the FP personnel's sex, education, times of training in 2000 and annual income in 2000	No/yes

9. Who paid the salary for the FP personnel?
   1) Not decided yet — No/yes
   2) Up-level authority — No/yes
   3) From village's income — No/yes
   4) Part from up-level authority and part from village — No/yes
   5) Others — No/yes
10. Is there any FP room at this village? — No/yes
11. What types of contraceptive methods are provided by this village?
    - Daily pills — No/yes
    - Once-a-month pills — No/yes
    - Visiting pills — No/yes
    - Emergency pills — No/yes
    - Condom — No/yes
    - Spermcide — No/yes
    - Anti-side-effect drug (for contraceptive methods) — No/yes
12. Is the contraceptive distribution recorded or not? — No/yes
13. Was 'informed choice' publicized at this village? — No/yes
14. What of the following services does this village have?
    - Vaccination — No/yes
    - Blood pressure measurement — No/yes
    - Conceptive consulting — No/yes
    - Baby delivery — No/yes
    - Post-partum follow-up — No/yes
    - Follow-up service after FP operations — No/yes
15. Are these services recoded? — No/yes
16. Does this village have FP statistical book? — No/yes
17. Has the computer system been used for women's information management? — No/yes
18. If yes, whether this system provided information for FP services? — No/yes
19. Is there a Population School at this village? — No/yes
20. How to provide FP knowledge to villagers?
    - Workers from up-level organization — No/yes
    - Persons from this village — No/yes
    - Video/VCD watching — No/yes
21. How far away (km) from this village to the nearest township FP station? — Fill in number
22. Are there any environmental problems at this village?
    - Land desertification — No/yes
    - Land salivation — No/yes
    - Water resources deficiency — No/yes
    - Water pollution — No/yes
    - Air pollution — No/yes
    - Others — No/yes
23. Is there any change of the area of farming land during recent years?
    - Declined — No/yes
    - Almost no change — No/yes
    - Increased — No/yes
24. If yes, what are the causes of the change?
    - Land desertification — No/yes
    - Land salivation — No/yes
    - Expropriation for state's purpose — No/yes
    - Expropriation for collective purposes — No/yes
    - Civil house building — No/yes
    - Others — No/yes

End of village investigation

Questionnaire 3: INDIVIDUAL SURVEY (women aged 15-49)

Study site & code:
Type of study site: rural / urban
Household code:
Individual code:
Investigator signature & code:
Name of women:

Questions	Choices/answers
1- Background information:	
1. Birth date	Date
2. Nationality:	Han/minority
3. Education:	Five categories
4. Marriage status:	Five categories
5. Registry/wedding date of the first marriage	Date
6. How far away of your (wife) parents' home?	Seven categories
2- Fertility information	
1. What is your ideal number of children?	Fill in number
Among them, how many boys? How many girls? How many, don't mind sex?	Fill in number
2. Have you ever been pregnant?	No/yes
3. How many pregnancies have you had?	Fill in number
4. Please give detail information on each pregnancy, including: Date of termination, outcome, prenatal health check up, Calcium supplement, place of delivery, who helped to delivery, time of starting supplemental food, the child still alive? Contraceptive method before each pregnancy, place of induced abortion /medical abortion(if any).	
5. How many children of your own?	Fill in number
6. (If only one child): have you had the one-child certification?	No/yes
7. (If only one child): did you or your child receive any of the following benefits?	
Insurance for parents	No/yes
Health care insurance for the child	No/yes
Monthly one-child compensation	No/yes
Priority to enter kindergarten or school for the child	No/yes
Gained more farming land	No/yes
Other benefits..	No/yes
3- Contraception	
1. Are you using any contraceptive method?	
2. If no, why don't use any method? Main cause	
3. Have you ever used any method before?	No/yes
4. What is the current or latest method you use?	17 choices
5. Where did you get this method?	No/yes
6. Is the method free, partly or fully paid by you?	10 choices
7. When did you start this method?	9 choices
8. Who decided or recommended this method for you?	3 choices
9. Before using this method, did you get any advice from service provider?	Date
10. If yes, did she/he introduce any other method to you?	7 choices
11. Do you or your husband know any potential side effect of the method you used?	No/yes
	No/yes/forgot
12. Have you ever experienced any side effect of this method?	No/a bit/yes
13. What side effects you experienced?	

14. Did you see a doctor because of the side effects?	No/yes
15. Did you encounter any of the following problems when using this method?	9 multi. choices
Husband's objection	No/yes
Elder generation's objection	
Too expensive	No/yes
Inconvenience	No/yes
Wanting a child after sterilization	No/yes
Fear of method failure	No/yes
16. Do you satisfy with this method?	No/yes
17. Does your husband satisfy this method?	No/yes
18. When did you use contraceptive method for the first time?	No/natural/yes
19. (Ask breastfeeding women): Do you know what contraceptive methods can	No/natural/yes
be used for breast-feeding woman?	Date
20. Do you know which of the following condition that a woman can't use IUD:	5 multi. choices
heavy bleeding	
infection of reproductive system	
tumour of reproductive system	No/yes
uterine problems or abnormity	No/yes
21. Have you ever heard of emergency contraception?	No/yes
22. Do you know what emergency contraception is?	No/yes
23. Do you agree that a couple can have premarital sex if they plan to get	No/yes
married?	Unknown/know
24. Do you think it is needed to provide contraception to unmarried people?	4 choices
	4 choices
4- Information about husband	
1. Husband's birth date	
2. Husband's nationality	Date
3. Husband's education	Han/minority
4. Have you ever used condom?	5 categories
5. Did your husband ever discuss contraception with you?	Yes/no/unclear
6. How often does your husband attend FP or RH education courses?	Yes/no/unclear
	Often/sometime
5- Service utility of reproductive health	s/never
1. Do you know it is required to have premarital health check up?	
2. Have you had the premarital health check up?	
3. Have you heard of folic acid?	Yes/no
4. Do you know what the functions of folic acid are?	Yes/no
5. Have you had any gynaecological examination after 2000?	Yes/no
6. Why did you have the examination? Organized by work unit or voluntarily	4 multi. choices
7. Where did you have the examination?	Yes/no
8. Did the examination include the following items?	2 choices
Vagina, uterus check up	8 choices
Breast X-ray check up	
Pap smear	Yes/no
B-ultrasound examination (for disease examination)	Yes/no
B-ultrasound examination (for IUD or pregnancy check)	Yes/no
Blood examination	Yes/no
Urine examination	Yes/no
X-ray examination	Yes/no
9. The above examinations free, partially paid, or totally paid by you?	Yes/no
10. Any gynaecological disease was detected by the examinations?	Yes/no
11. If yes, had you ever sought any treatment?	3 choices
6- STDs and HIV/AIDS	Yes/no
1. Have you ever heard of sexually transmitted disease?	Yes/no

2. Please tell me which of the following diseases is STD.	
3. What of the following methods can be used for STD prevention?	Yes/no
4. Have you ever heard of HIV/AIDS?	8 multi. choices
5. Do you think that AIDS can be transmitted from one to another?	4 multi. choices
6. Do you know which behavior is the HIV/AIDS transmission routine?	Yes/no
7. Do you think HIV carriers and AIDS patients are different?	Yes/no/not clear
8. Do you think AIDS is curable or not?	10 multi.
9. How did you acquire the knowledge about HIV/AIDS?	choices
	Yes/no
7- Propaganda and education	Yes/no/unknow
1. Does your family receive any educational materials about FP /RH during	n
recent two years?	
2. Have you ever read these materials?	6 multi. choices
3. Can you understand the meaning of these materials?	
4. Have you ever paid for these educational materials?	Yes/no
5. What kinds of materials do you have at this time?	Yes/no/partially
About policy and regulation	Yes/no/partially
About contraception	
About prevention of gynecological diseases	Yes/no
About prevention and treatment of STDs, AIDS	Yes/no
Educational materials on woman's five key phases	Yes/no
Health birth	Yes/no
Others	Yes/no
6. Have you ever watched any video or VCD on FP/RH in recent one year?	Yes/no
	Yes/no
	Yes/no

How well is the woman cooperated?
Excellent, good, neutral, poor, very poor

End of woman's interview

Appendix B: Numbers and sex ratios of first births in 1980s and in 1990s in provinces dominated by 1-child policy, by province, township, village and individual factors

Categories of indicators	1980s (including 1979)			1990s			Total		
	Boy	Girl	SRB	Boy	Girl	SRB	Boy	Girl	SRB
Woman's age at first birth									
≤23	584	574	1.017	526	467	1.126	1110	1041	1.066
24+	435	393	1.107	323	251	1.287	758	644	1.177
Husband's age at									
≤24	454	436	1.041	512	432	1.185	966	868	1.113
25+	551	516	1.068	331	279	1.186	882	795	1.109
Woman's education									
≤Primary School	639	593	1.078	449	415	1.082†	1088	1008	1.079
Middle school+	380	374	1.016	400	303	1.320	780	677	1.152
Couple's minority									
Both Han Chinese	990	950	1.042	823	696	1.182	1813	1646	1.101
One or both minority	29	17	1.706	26	22	1.182	55	39	1.410
Women's sex			##			##			##
≤-1	77	93	0.828**	44	79	0.557**	121	172	0.703**
0	859	835	1.029	713	619	1.152	1572	1454	1.081
1+	83	39	2.128	92	20	4.600	175	59	2.966
Family Planning services at townships' FPSCs									
No a FPSC	184	141	1.305	134	101	1.327**	318	242	1.314**
Good short-, but poor	540	522	1.034	465	353	1.317	1005	875	1.149
others	295	304	0.970	250	264	0.947	545	568	0.960
Family Planning services at villages									
Good	527	472	1.117	414	345	1.200	941	817	1.152
Moderate or Poor	492	495	0.994	435	373	1.166	927	868	1.068
Average annual income/family at									
≤2000	405	369	1.098	284	271	1.048†	689	640	1.077
2000+	614	598	1.027	565	447	1.264	1179	1045	1.128
Geographical region									
East	529	497	1.064	438	332	1.319*	967	829	1.166
West	490	470	1.043	411	386	1.065	901	856	1.053
% of Minority groups at province									
<3	451	452	0.998	403	297	1.357*	854	749	1.140
~9	568	515	1.103	446	421	1.059	1014	936	1.083
Total	1019	967	1.054	849	718	1.182	1868	1685	1.109

Appendix C: Numbers and sex ratios of second births in 1980s and in 1990s in provinces dominated by 1-child policy, by province, township, village and individual factors

	1980s (including 1979)			*1990s*			Total		
	Boy	Girl	SRB	Boy	Girl	SRB	Boy	Girl	SRB
Woman's age at 2nd birth									
≤26	294	268	1.097	210	139	1.511	504	407	1.238†
27+	258	266	0.970	171	143	1.196	429	409	1.049
Husband's age at 2nd birth									
≤27	228	207	1.101	195	133	1.466	423	340	1.244
28+	324	327	0.991	186	149	1.248	510	476	1.071
Woman's education									
≤Primary School	423	416	1.017	275	188	1.463	698	604	1.156
Middle School+	129	118	1.093	106	94	1.128	235	212	1.108
Women's sex preference									
≤-1	36	30	1.200	13	15	0.867	49	45	1.089
0	488	476	1.025	338	249	1.357	826	725	1.139
1+	28	28	1.000	30	18	1.667	58	46	1.261
Sex of first birth									
Boy	227	272	0.835**	130	122	1.066*	357	394	0.906**
Girl	325	262	1.240	251	160	1.569	576	422	1.365
Family Planning services at townships' FPSCs									
No a FPSC	85	98	0.867	65	64	1.016†	150	162	0.926†
Good short-, poor long-term	284	257	1.105	165	99	1.667	449	356	1.261
others	183	179	1.022	151	119	1.269	334	298	1.121
Family Planning services at villages									
Good	263	261	1.008	195	128	1.523	458	389	1.177
Moderate+Poor	289	273	1.059	186	154	1.208	475	427	1.112
Average annual income at villages									
≤2000	246	218	1.128	168	145	1.159†	414	363	1.140
2000+	306	316	0.968	213	137	1.555	519	453	1.146
Geographical region									
East	265	272	0.974	168	105	1.600†	433	377	1.149
West	287	262	1.095	213	177	1.203	500	439	1.139
% of Minority groups									
<3	243	235	1.034	156	87	1.793**	399	322	1.239
~9	309	299	1.033	225	195	1.154	534	494	1.081
Total	552	534	1.034	381	282	1.351	933	816	1.143

Appendix D: Numbers and sex ratios of first births in 1980s and in 1990s in provinces dominated by 1.5-child policy, by province, township, village and individual factors

Indicators	1980s (including 1979)			1990s			Total		
	Boy	Girl	SRB	Boy	Girl	SRB	Boy	Girl	SRB
Woman's age at first birth									
≤21	1783	1607	1.110*	759	657	1.155**	2542	2264	1.123**
22-23	1635	1684	0.971	1067	1024	1.042	2702	2708	0.998
24-25	1285	1184	1.085	912	1014	0.899	2197	2198	1.000
26+	723	697	1.037	608	649	0.937	1331	1346	0.989
Husband's age at first birth									
≤22	1275	1170	1.090	649	536	1.211**	1924	1706	1.128**
23-24	1534	1422	1.079	1180	1199	0.984	2714	2621	1.035
25-26	1242	1264	0.983	818	807	1.014	2060	2071	0.995
27+	1271	1204	1.056	680	791	0.860	1951	1995	0.978
Woman's education									
≤Primary School	3805	3561	1.069	1799	1816	0.991	5604	5377	1.042
Middle School+	1621	1611	1.006	1547	1528	1.012	3168	3139	1.009
Couple's minority status									
Both Han Chinese	4974	4710	1.056	3006	2989	1.006	7980	7699	1.036
One or both minority	452	462	0.978	340	355	0.958	792	817	0.969
Woman's son preference			##			##			##
≤-1	179	243	0.737**	99	213	0.465**	278	456	0.610**
0	4387	4405	0.996	2641	2885	0.915	7028	7290	0.964
1+	781	453	1.724	585	216	2.708	1366	669	2.042
Township-village level indicators									
Family Planning services at FPSCs									
No a FPSC	195	211	0.924†	133	119	1.118	328	330	0.994
Good short-, po or long-term methods	2673	2584	1.034	1591	1630	0.976	4264	4214	1.012
Good short- and long-term methods	2171	1961	1.107	1366	1383	0.988	3537	3344	1.058
Poor short-, mo derate long-term methods	387	416	0.930	256	212	1.208	643	628	1.024
Family Planning services at villages									
Good	2813	2757	1.020	1760	1806	0.975	4573	4563	1.002
Moderate	2137	1976	1.081	1267	1250	1.014	3404	3226	1.055
Poor	476	439	1.084	319	288	1.108	795	727	1.094
Average annual income/family at villages (Yuan)									
≤1200	1419	1375	1.032	833	859	0.970	2252	2234	1.008
-1900	1376	1302	1.057	858	875	0.981	2234	2177	1.026
-2800	1493	1424	1.048	973	920	1.058	2466	2344	1.052
>2800	1138	1071	1.063	682	690	0.988	1820	1761	1.034

Appendix D: Continued from previous page

	1980s (including 1979)			1990s			Total		
Indicators	Boy	Girl	SRB	Boy	Girl	SRB	Boy	Girl	SRB
Province-level indicators									
Geographical region									
East	2052	1940	1.058	1186	1173	1.011	3238	3113	1.040
Central	2465	2323	1.061	1510	1499	1.007	3975	3822	1.040
West	909	909	1.000	650	672	0.967	1559	1581	0.986
GDP per capita (Yuan)									
<4200	795	774	1.027	522	518	1.008	1317	1292	1.019
6000	2402	2300	1.044	1536	1546	0.994	3938	3846	1.024
9000	1479	1458	1.014	841	830	1.013	2320	2288	1.014
>9000	750	640	1.172	447	450	0.993	1197	1090	1.098
% of rural population									
<60	1712	1550	1.105*	983	964	1.020	2695	2514	1.072†
-70	999	1058	0.944	622	649	0.958	1621	1707	0.950
-75	1910	1827	1.045	1224	1192	1.027	3134	3019	1.038
>75	805	737	1.092	517	539	0.959	1322	1276	1.036
% of ethnic minority groups									
<3	3003	2816	1.066	1881	1922	0.979	4884	4738	1.031
-9	1238	1209	1.024	661	683	0.968	1899	1892	1.004
>9	1185	1147	1.033	804	739	1.088	1989	1886	1.055
Strength of son preference									
No	1208	1118	1.081	660	638	1.034	1868	1756	1.064
Weak	3206	3080	1.041	2029	2004	1.012	5235	5084	1.030
Strong	1012	974	1.039	657	702	0.936	1669	1676	0.996
Total	5426	5172	1.049	3346	3344	1.001	8772	8516	1.030

† P <0.10, * p<0.05, ** P<0.01; Chi square test for linear trend: # p<0.05, ## p<0.01

Appendix E: Numbers and sex ratios of second births in 1980s and in 1990s in provinces dominated by 1.5-child policy, by province, township, village and individual factors

Indicators	*1980s (including 1979)*			*1990s*			Total		
	Boy	Girl	SRB	Boy	Girl	SRB	Boy	Girl	SRB
Individual women's characteristics									
Woman's age at birth									
≤24	1184	1075	1.101	733	481	1.524	1917	1556	1.232
25-26	894	799	1.119	604	342	1.766	1498	1141	1.313
27-28	720	579	1.244	472	316	1.494	1192	895	1.332
29+	632	540	1.170	802	519	1.545	1434	1059	1.354
Husband's age at birth									
≤25	1016	847	1.200	673	444	1.516	1689	1291	1.308
26-27	775	696	1.114	574	351	1.635	1349	1047	1.288
28-29	678	586	1.157	521	290	1.797	1199	876	1.369
30+	961	864	1.112	843	573	1.471	1804	1437	1.255
Woman's education									
≤Primary School	2439	2146	1.137	1670	1010	1.653*	4109	3156	1.302
Second School+	991	847	1.170	941	648	1.452	1932	1495	1.292
Couple's minority status									
Both Han Chinese	3135	2735	1.146	2363	1488	1.588	5498	4223	1.302
One or both minority	295	258	1.143	248	170	1.459	543	428	1.269
Woman's son preference			##			##			##
≤-1	90	126	0.714**	55	84	0.655**	145	210	0.690**
0	2897	2546	1.138	2260	1411	1.602	5157	3957	1.303
1+	443	321	1.380	296	163	1.816	739	484	1.527
Sex of first birth									
Boy	1601	1538	1.041**	886	823	1.077**	2487	2361	1.053**
Girl	1829	1455	1.257	1725	835	2.066	3554	2290	1.552

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Appendix E: continued from previous page

Indicators	*1980s (including 1979)*			*1990s*			Total		
	Boy	Girl	SRB	Boy	Girl	SRB	Boy	Girl	SRB
Average annual income/family at villages									
≤1200	908	820	1.107	720	504	1.429**	1628	1324	1.230*
-1900	892	774	1.152	757	385	1.966	1649	1159	1.423
-2800	973	853	1.141	700	425	1.647	1673	1278	1.309
>2800	657	546	1.203	434	344	1.262	1091	890	1.226
Geographical region									
East	1226	1033	1.187	815	579	1.408*	2041	1612	1.266
Central	1589	1419	1.120	1179	711	1.658	2768	2130	1.300
West	615	541	1.137	617	368	1.677	1232	909	1.355
GDP per capita (Yuan)						##			#
<4200	530	466	1.137	522	285	1.832*	1052	751	1.401
-6000	1593	1404	1.135	1237	765	1.617	2830	2169	1.305
-9000	897	748	1.199	474	329	1.441	1371	1077	1.273
>9000	410	375	1.093	378	279	1.355	788	654	1.205
% of rural population									
<60	894	852	1.049†	703	488	1.441	1597	1340	1.192*
-70	679	533	1.274	470	307	1.531	1149	840	1.368
-75	1327	1162	1.142	981	597	1.643	2308	1759	1.312
>75	530	446	1.188	457	266	1.718	987	712	1.386
% of ethnic minority groups									
<3	1900	1607	1.182	1545	962	1.606	3445	2569	1.341†
-9	767	734	1.045	521	336	1.551	1288	1070	1.204
>9	763	652	1.170	545	360	1.514	1308	1012	1.292
Strength of son preference									
No	575	537	1.071	397	261	1.521	972	798	1.218
Weak	2180	1800	1.211	1608	995	1.616	3788	2795	1.355
Strong	675	656	1.029	606	402	1.507	1281	1058	1.211
Total	3430	2993	1.146	2611	1658	1.575	6041	4651	1.299

Chi square test for linear trend: # $p<0.05$; ## $p<0.01$

Appendix F: Numbers and sex ratios of first and second birthsin provinces dominated by 2-child policy, by province, township, village and individual factors: 1979-2000

Numbers and sex ratios of first and second births in 1979-2000 in provinces dominated by 2-child policy, by province, township, village and individual factors

Indicators	*First birth*				Second birth		
	Boy	Girl	SRB		Boy	Girl	SRB
Woman's age at birth							
≤21	356	333	1.069	≤22	294	261	1.126
22+	364	318	1.145	23+	236	228	1.035
Husband's age at birth							
≤23	370	334	1.108	≤24	232	210	1.105
24+	350	317	1.104	25+	298	279	1.068
Couple's minority status							
Both Han Chinese	239	238	1.004		185	160	1.156
One or both minority	481	413	1.165		345	329	1.049
Woman's son preference							
No	574	541	1.061		423	397	1.065
Yes	146	110	1.327		107	92	1.163
Sex of first child							
Boy					272	254	1.071
Girl					258	235	1.098
Township-village level indicators							
Family Planning services at FPSCs							
No FPSC	166	142	1.169		136	105	1.295
Good short-term, poor l ong-term meth.	393	363	1.083		280	272	1.029
Others	161	146	1.103		114	112	1.018
Family Planning services at villages							
Good	299	255	1.173		213	192	1.109
Poor	421	396	1.063		317	297	1.067
Average annual income/family at villages							
≤1000	471	427	1.103		351	319	1.100
1000+	249	224	1.112		179	170	1.053
Province-level indicators							
GDP per capita (Yuan)							
<5000	593	526	1.127		423	398	1.063
>5000	127	125	1.016		107	91	1.176
% of rural population							
<70	223	200	1.115		174	148	1.176
>70	497	451	1.102		356	341	1.044
Total	720	651	1.106		530	489	1.084

None is statistically significant