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CONCENTRATION AND DRUG PRICES IN THE RETAIL MARKET FOR MALARIA TREATMENT IN RURAL TANZANIA

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SUMMARY

The impact of market concentration has been little studied in markets for ambulatory care in the developing world, where the retail sector often accounts for a high proportion of treatments. This study begins to address this gap through an analysis of the consumer market for malaria treatment in rural areas of three districts in Tanzania. We developed methods for investigating market definition, sales volumes and concentration, and used these to explore the relationship between antimalarial retail prices and competition.

The market was strongly geographically segmented and highly concentrated in terms of antimalarial sales. Antimalarial prices were positively associated with market concentration. High antimalarial prices were likely to be an important factor in the low proportion of care seekers obtaining appropriate treatment.

Retail sector distribution of subsidised antimalarials has been proposed to increase the coverage of effective treatment, but this analysis indicates that local market power may prevent such subsidies from being passed on to rural customers. Policymakers should consider the potential to maintain lower retail prices by decreasing concentration among antimalarial providers and recommending retail price levels.

Keywords

competition; markets; retail sector; pharmaceuticals; malaria

1. INTRODUCTION

Health-care market concentration is potentially a key influence on the price, coverage and quality of services provided. However, there is a lack of evidence on concentration in markets for ambulatory care in the developing world. The majority of the literature concerns US hospitals (Dranove and Satterthwaite, 2000), with a smaller literature on other developed

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countries, such as the UK and New Zealand (Ashton and Press, 1997; Propper and Soderlund, 1998; Roberts, 1993), and a few studies of hospital markets in developing countries (Amin, 2002; Bennett, 1996; Ginson-Bautista, 1995; Muraleedharan, 1999; Nakamba *et al.*, 2002). The non-hospital sector is far less studied, especially in low-income settings, although it is the main source of treatment for pervasive and potentially fatal diseases such as diarrhoea, tuberculosis, acute respiratory infection and malaria.

These non-hospital markets are quite unlike those in most developed countries. The private sector is a very common source of treatment (Mills *et al.*, 2002; Waters *et al.*, 2003), and retailers account for a high proportion of care (Berman, 2000; Brugha and Zwi, 1999; McCombie, 2002; Uplekar *et al.*, 1998). For example, in a review of sub-Saharan African literature, the median percentage of care-seekers using shops during recent childhood illness was around 50% (Goodman *et al.*, 2007a). It is increasingly recognised that to reduce the disease burden for common and serious health problems, governments must look beyond the public sector, and work with retailers to improve the coverage and quality of care obtained (Brugha *et al.*, 1999; WHO, 2005).

Understanding the nature of competition facing retail providers is an important first step in the design of appropriate and effective strategies. In this study, we address this issue in the context of the market for malaria treatment in rural Tanzania. Treatment for malaria is highly inadequate; in 2002 only 20% of Tanzanian children with malarial symptoms obtained appropriate treatment within 24 h, in contrast to a target of 60% set by African Heads of State (Malaria Consortium, 2004). Moreover, the development of resistance to commonly used antimalarials has led to the adoption of artemisinin-based combination therapies (ACT) which are highly effective but much more costly (Bosman and Mendis, 2007). In 2004 a committee on the economics of antimalarials led by Kenneth Arrow argued that without heavy ACT subsidies in the public and private sectors, coverage of effective treatment would remain unacceptably low. This suggestion is now being further developed by the international public health community (Enserink, 2007).

This study analysed the nature of competition in the malaria treatment market in order to inform policy on increasing coverage of appropriate treatment, and in particular, consider the implications of the subsidies recommended by the Arrow committee for the African retail sector.

2. METHODOLOGICAL CHALLENGES

The study drew on the structure–conduct–performance paradigm, exploring the interrelationship between market structure and provider conduct and the implications for market outcomes, which in public health terms encompass the price, coverage and quality of care. Broadly speaking, more concentrated market structures are hypothesised to be associated with greater market power, less price competition, and higher prices and profits (Demsetz, 1973). However, it is widely recognised that the direction of causation between structure and conduct is two way (Scherer, 1970; Waterson, 1984), and that the nature of competition is shaped by potential competition, or contestability, as well as current levels of market concentration (Baumol *et al.*, 1982).

Empirical work in the health economics field has used econometric techniques to investigate the relationship between concentration and measures of price, costs and quality. However, the definition and measurement of markets and concentration entail a number of methodological and empirical challenges. Tirole defines a market as the group of sellers and buyers of a set of products who are in sufficiently close contact for their transactions to affect the terms on which the others buy or sell (Tirole, 1988). However, in practice the delineation of both product range and geographical area is open to debate (Zwanziger *et al.*,

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1994). In healthcare a key decision is the degree of aggregation in product definition, which for hospital markets has ranged from a single procedure to a group of specialities (Ashton and Press, 1997; Gaynor and Vogt, 2000). Geographical market definition may be based on political boundaries, fixed radii or shipment methods, all of which have their weaknesses. Political boundaries and fixed radii are straightforward methods, but may ignore geographical boundaries, ease of travel and the nature of population centres (Luft and Maerki, 1984). The shipment method uses utilisation data by patient origin to define the market area by minimising the proportion of customers who travel outside the area to purchase the product, and maximising the proportion who remain within the area (Gaynor and Vogt, 2000). However, the cut-off points for these proportions are essentially arbitrary, and the resulting boundaries may not reflect contestability.

Market concentration has both horizontal and vertical dimensions. A market has higher horizontal concentration the fewer the number of firms in production or the more unequal the distribution of market shares (Clarke, 1985). Horizontal concentration may be summarised by absolute measures, which relate to both firm numbers and relative market shares, and inequality measures that consider only the dispersion of market shares. Absolute measures are more widely used, with the most common being the concentration ratio and the Hirschman–Herfindahl index (HHI). The concentration ratio, the proportion of output accounted for by the r largest firms, is simple to calculate and interpret but considers only the r largest firms in the industry, and the choice of r is arbitrary. The HHI, the sum of squared firm market shares of all firms in the industry, takes account of both market share inequality and firm numbers. Both measures allow for comparison between markets, but neither provides clear guidance on whether a market should be considered concentrated in absolute terms nor incorporates contestability. For vertical integration, the extent to which a single business unit carries out successive stages in the processing and distribution of a product, standardised measures do not exist.

In non-hospital markets in developing countries, these measurement problems are compounded by lack of routine data. Official records on the number and location of private outlets are frequently out-of-date and inaccurate, and few retailers keep regular sales records, let alone data on the characteristics and area of residence of customers. Moreover, methods for studying the behaviour of retail providers remain relatively under-developed, and particularly lack adaptation for informal outlets (Conteh and Hanson, 2003).

This study aimed to address these methodological and empirical challenges in the context of the malaria treatment market in three rural districts in Tanzania. As far as we are aware it is the first to apply these methodological techniques to the retail market for drugs in the developing world.

3. BACKGROUND

Tanzania is one of the world's poorest countries, with a gross national income per capita of $280 at the time of the study in 2002 (World Bank, 2008). Post-independence, Tanzania followed a broadly socialist economic model, but the private sector has expanded rapidly since economic liberalisation began in the mid-1980s. The health sector has been no exception, with a mushrooming of commercial private facilities and laboratories in urban areas, and an increase in retail drug sales throughout the country (Munishi *et al.*, 1995).

The whole population of Tanzania is at risk of malaria (de Savigny *et al.*, 2004), which is the leading cause of outpatient and inpatient health service attendance, and estimated to account for 100 000-125 000 deaths per year, of which 80 000 are in children under 5 years of age (National Malaria Control Programme, 2003). Mild or 'uncomplicated' malaria involves

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symptoms such as fever, chills, headache and nausea, but can rapidly progress to severe disease, which has a high case fatality rate (Greenwood *et al.*, 1987).

Treatment for uncomplicated malaria can be obtained from health-care facilities and retail outlets. The facilities comprise government and private hospitals, health centres and smaller dispensaries, where patients receive a consultation, possibly a laboratory test, and drugs. In rural areas private facilities are generally mission-owned. Drugs are also widely available without consultation from pharmacies, drug stores and general shops, though pharmacies are rare in rural areas. Care-seekers frequently choose such outlets over government health facilities because retailers are more accessible, have longer opening hours, provide quicker service, have more reliable drug stocks, and are perceived as relatively courteous and approachable (Williams and Jones, 2004). Drug shops sell a wide range of over-the-counter medicines, including painkillers. antimalarials and antibiotics (although the latter are not permitted in these outlets). Nearly all drug shops are commercially owned, though in a few places community-owned 'village-run' drug stores had been established. General shops range from large shops to small roadside stalls, typically stocking a mixture of food products and household goods, and a few medicines, such as common painkillers and the occasional antimalarial. Government facilities are either free or highly subsidised, but fees are charged by all private facilities and shops. Payment is generally made out-of-pocket by consumers, with very low coverage of health insurance or prepayment.

Patients are generally treated presumptively, on the basis of fever alone, although many febrile patients are not parasitaemic. The recommended treatment consists of a course of antimalarials, supplemented by antipyretics to help reduce fever and pain. Until 2001 the main antimalarial used was chloroquine, but high levels of chloroquine resistance led to its official withdrawal and replacement by sulphadoxine-pyrimethamine (SP), with amodiaquine as second line, and quinine as third line and first choice in severe malaria. In 2006, SP was in turn replaced by ACT, but the latter was not in use at the time of the study. Oral amodiaquine was the only antimalarial that drug and general stores were officially allowed to sell, but stocking of others such as quinine, SP and artesunate was widespread.

4. METHODS

4.1. Data sources

This study formed part of the Interdisciplinary Monitoring Project for Antimalarial Combination Therapy in the three rural districts of Kilombero, Ulanga and Rufiji in southeastern Tanzania. The main economic activity is subsistence farming, supplemented by limited cash-cropping. Data were collected in the areas of each district covered by demographic surveillance systems (DSS), which contained populations of 73 839 in Rufiji and 66 503 in Kilombero/Ulanga in mid-2001. There are no towns in the DSS areas, although Ifakara Town is located a few kilometres from the start of Ulanga and Kilombero DSS areas. Government facilities were officially free in Rufiji, but in Kilombero and Ulanga user fees had been introduced in dispensaries (but not in health centres).

Data collection activities are summarised in Table I. Data on household demand for fever/malaria treatment were collected using a household survey. A relative index of household socio-economic status was derived using principal components analysis (Filmer and Pritchett, 2001; McKenzie, 2003), based on 19 variables, covering household construction, utilities and asset ownership (Njau *et al.*, 2006). A census of all private sources of manufactured drugs in the DSS areas was conducted in 2000 and 2001, covering facilities, drug stores and general shops (Goodman *et al.*, 2004). Representative data on antimalarial stocks and prices were collected through an outlet survey.

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Retail audit methods were used to measure antimalarial sales in all public and private facilities and drug shops and a sample of general stores stocking antimalarials. Data were collected during two separate rounds, as providers reported that drug sales varied by day of the week and time of year, but that there was little intra-month variation in weekly sales. During each round, interviewers visited each outlet twice, aiming for a 2-week gap between visits. At both visits they recorded antimalarial stock levels, and at the second visit, any deliveries since their previous visit, plus any drugs that had been removed for other reasons, e.g. thrown away, returned to wholesalers or taken to other shops belonging to the same owner.

4.2. Market definition

Market definition was considered along product and geographical lines. The types of providers making up the market were defined as those widely used for 'fever or malaria' treatment (as initial care-seeking and most treatment were based on clinical symptoms alone, fever and malaria treatment were not separable). Of 577 visits for fever/malaria recorded in the household survey, 65% were to shops and 33% to facilities, with retail visits roughly equally divided between drug shops and general stores. Reported use of traditional healers and community health workers was very rare, only 0.9 and 0.4% of visits, respectively. The product definition for providers was therefore set as health-care facilities, drug stores and general stores, accounting for 98% of provider visits.

For geographical market definition, the suitability of several administrative boundaries was considered, using the insights of the shipment method to define an area as 'self-contained' if the proportion of the population in the market area using providers outside it was low. Only 4% of fever/malaria visits to facilities, drug stores and general stores took place outside the DSS area of residence. However, use of the DSS area as the market definition would overstate market size, as 86% of visits took place in the ward of residence (2-8 villages). The smaller category of village was inappropriate for market definition as 39% of visits were to outlets outside the village of residence. The ward was therefore judged the most appropriate boundary as a starting point for geographical definition, but some adjustments were made to account for local circumstances. First, data from each ward were analysed to identify any completely self-contained areas of two or more villages within a ward, which were then defined as a separate sub-market. Secondly, where over 15% of visits from a given ward were to another ward, the geographical definition was adjusted to allocate villages more appropriately. This resulted in five sub-markets in Rufiji DSS, three in Kilombero, and four in Ulanga, and 93% of visits taking place within the sub-market of residence.

4.3. Estimation of antimalarial market shares

The drugs obtained were a mixture of painkillers, antimalarials and a few antibiotics. For estimation of market shares and analysis of price competition we focused on antimalarials, as they are of greatest public health significance for malaria treatment.

Sales of all antimalarials stocked during each round of the retail audit were calculated as:

$$\begin{aligned}\text{Sales} = {} & (\text{Total at 1st visit}) + (\text{Deliveries between 1st and 2nd visit}) \\ & - (\text{Stocks removed for other reasons}) - (\text{Total at 2nd visit})\end{aligned}$$

To calculate fortnightly sales, volumes were scaled up or down pro rata, depending on the number of days between interviews. Data were extrapolated to cover antimalarial stockists not interviewed (estimated to be 76 outlets in the first audit and 69 in the second) and

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antimalarials with missing sales data (13 out of a total of 788 observations) using mean sales for each drug type by outlet type. Annual sales were estimated by summing the sales figures for the two surveys and scaling up pro rata. This was deemed appropriate, as the data showed no clear seasonal patterns between the two rounds.

To sum across different drug types, total antimalarial sales volumes were calculated in terms of purchases required for equivalent adult treatment doses. The value of private sector antimalarial sales was approximated based on outlet survey data on the median price for each drug category by packaging and outlet type (e.g. median price of loose SP tablets in drug stores).[1] We did not attempt to value antimalarials dispensed from government facilities, as they were either heavily or completely subsidised. Antimalarial market shares in value and volume terms were then calculated for each sub-market.

4.4. Measures of concentration

Antimalarial market shares were used to measure horizontal concentration in each sub-market. Government facilities follow models of service provision and prices set institutionally at the central level, and are therefore unlikely to compete locally. Moreover, large government facility market shares would have obscured the impact of private sector concentration on private outlets, which was likely to have been the most important factor influencing their competitive decisions. Concentration was therefore evaluated using private sector sales volumes and values, and the 3-firm ratio and the HHI were calculated. Results were calculated by owner not outlet, as outlets with common ownership were likely to be run as single businesses. This affected all mission facilities in the DSS areas of Kilombero and Ulanga, which were owned by the Roman Catholic Church, two of the facilities in Rufiji owned by the Free Pentecostal Church, and several shop owners with multiple shops.

The impact of market concentration on antimalarial tablet prices was evaluated using multivariate analysis, controlling for cost and quality variation through proxies based on outlet and product characteristics.

5. RESULTS

As expected, household survey data demonstrated the inadequacy of current treatment for fever/malaria. Only 37% of all care-seekers obtained an antimalarial over the course of their fever/malaria episode, while 39% obtained painkillers only. A third of all antimalarials were dispensed as under-doses, meaning that only 26% of all care-seekers obtained an adequate antimalarial dose. For the poorest third of households only 31% obtained an antimalarial and 23% an adequate antimalarial dose, compared with 46 and 35%, respectively in the least poor third. Private facilities were most likely to dispense antimalarials (antimalarials dispensed at 68% of private facility visits), followed by drug stores (55% of visits) and government facilities (52% of visits). General stores were least likely to dispense antimalarials (12% of visits).

5.1. Market structure

The study areas contained 18 government facilities (4 health centres and 14 smaller dispensaries), and 9 private facilities (7 mission dispensaries, 1 mission hospital and 1 commercial dispensary). In 2001 there were 32 drug shops, 30 commercially owned, and two village-run. Drug stores tended to locate relatively close to facilities, and were generally limited to the more populous areas and main roads. We also identified 535 general retailers with drugs in stock on the day visited. They were much more dispersed than drug stores,

[1]Exchange rate on 1/1/2002: US$1

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reaching right out to remote communities. All commercial drug stores, general stores and the commercial dispensary were run on a for-profit basis, and all government facilities, mission facilities and village-run drug stores on an officially not-for-profit basis.

There was a high turnover in retail outlets. Of the 23 commercial drug stores operating in mid-2000, 2 had closed down by mid-2001, while 9 new drug stores had started up. Turnover among the general retailers was also very high. Over a 1-year period 29% had closed down, and 7% were open but no longer stocked drugs, while an additional 216 general retailers stocking drugs had opened and 14 existing shops had started stocking drugs.

Antimalarials were stocked by all facilities and drug stores, but by only 14% of general stores stocking drugs. The antimalarials available were chloroquine, SP, amodiaquine, quinine and artesunate, in a mixture of tablet, syrup and injectable formulations. The total number of antimalarial products identified during the outlet survey was 81, of which 47 were branded and 34 unbranded. Private facilities had the widest choice, with a median of seven antimalarial products, compared with six in drug shops, five in government facilities and only one in general stores that stocked antimalarials. General shops and village-run drug stores usually had only chloroquine, whereas SP, amodiaquine and quinine were frequently found in facilities and commercial drug stores, and many commercial drug stores stocked several brands of each antimalarial type.

From the antimalarial retail audits it was estimated that 233 606 equivalent adult antimalarial doses were dispensed per annum from all facilities and shops in the DSS areas, equivalent to 1.7 adult doses per capita. SP and amodiaquine accounted for 69 and 17% of antimalarial volumes. No other antimalarial type was responsible for more than 5% of total sales volumes. In volume terms, the private sector supplied 58% of antimalarials, mostly through the retail sector, which accounted for 39%.

The total value of antimalarials dispensed in the private sector was estimated at US$97 844 per annum, equivalent to $0.69 per capita. The retail sector accounted for 67% of private sector sales values, and within that, commercial drug stores supplied 90% of antimalarials in all areas. The average value of antimalarials sold in commercial drug stores was US$1731 per shop per year, compared with US$871 in village-run drug stores, and only US$38 in general stores stocking antimalarials.

5.2. Antimalarial prices

Price data are presented for tablet formulations of the most common antimalarial types (chloroquine, SP, amodiaquine and quinine), which together made up over 95% of total antimalarial sales volumes. Table II shows prices for a 2-year-old child’s dose by drug and outlet type. Village-run drug stores were excluded from the price analysis as there were only two, making it difficult to generalise from their results, and both were in the same sub-market, so were practical options for only 10% of the study population.

For all antimalarials, which they supplied, the three government facilities reporting charging drug fees had the lowest median price and since the remaining 15 government facilities did not report charging for drugs, on average government facilities should be the cheapest source in terms of antimalarial prices.

Drug stores tended to be more expensive than private facilities, with higher median prices for 7 of the 10 antimalarials. The relative prices of general stores compared with facilities and drug stores did not follow a clear pattern, although the scope for comparison was limited by the small number of observations. For chloroquine tablets, the most frequently stocked

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antimalarial in general stores, the median price was significantly higher in general stores than in all other outlet types.

Although facility antimalarial prices were generally lower than those in drug stores, total expenditure per patient would in some cases have been higher. In 7 out of the 18 government facilities and 4 out of 8 private facilities consumers also paid non-drug fees for registration, consultation, laboratory tests or contributions for kerosene. Non-drug charges for an adult ranged from $0.05 to $0.42 in government facilities (median $0.11 where charged), and $0.21 to $1.16 in private facilities (median $0.53 where charged).

In a market characterised by strong price competition one would expect uniform prices for given products, but this was not the case. Table III shows the total price range in drug shops, interquartile range and quartile coefficient of variation, a non-parametric dispersion measure standardised by absolute price (Owen and Jones, 1990). The evidence indicates considerable price variation for each drug type with, for example, the price of a child's dose of packaged SP tablets ranging from $0.18 to $0.79, and of packaged amodiaquine tablets from $0.11 to $0.42. Only chloroquine, historically the most established antimalarial, was sold at a uniform price.

5.3. Concentration

Table IV reports market concentration by sub-market area for private sector antimalarial sales volumes and values. For volumes, the 3-firm ratio ranged from 68 to 100%, and the HHI from 0.18 to 1 (mean of 0.45). If sales values were considered, the concentration ratio and the HHI increased across nearly all sub-markets. The HHI and 3-firm ratio gave similar indications of relative concentration, with a correlation coefficient between the two measures across sub-markets of 0.88 for sales volumes (t-test, $p<0.001$), and 0.79 for sales values (t-test $p = 0.002$).

The variation in concentration across sub-markets did not appear to reflect crowding-out of the private sector in areas with superior government facilities. All sub-markets contained at least one government facility, and those with the higher-level health centres (Mchombe, Lupiro, Ikwiriri and Kibiti) did not have systematically higher concentration than those with government dispensaries only. There was no significant relationship across sub-markets between the HHI by private volumes or values and average socio-economic status, as measured by the percentage of households in the poorest third.

The influence of market concentration on antimalarial prices charged by drug and general stores was explored using regression analysis. A log-linear regression model for the price of a child's dose of antimalarial tablets is specified in Table V. Natural logs were taken of the dependent variable to reflect the skewed price distribution. It was regressed on market concentration as measured by the HHI in the sub-market, a dummy variable for district, and a number of outlet and drug characteristics as proxies for variations in cost and quality. The cost and perceived quality of drugs were represented using four proxies which shopkeepers reported customers to associate with effective medicines: antimalarial type, type of packaging, country of manufacture and brand status. Outlet type was included to capture differences between drug and general shops in perceived quality of service, overhead costs and wholesale prices. Outlet location was potentially a proxy for accessibility for consumers and the cost of wholesale deliveries. The STATA version 10 svyregress command was used to allow for clustering of drug prices within shops, and the strata were defined as the sub-markets at which level the HHI was calculated (Stata Inc., 2003). Variances for sub-markets with only one shop stocking antimalarials were approximated using the average of the variances from sub-markets with multiple shops.

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Table VI shows results for two models, the first using the HHI for private sales volumes, and the second the HHI for private sales values. R^2s were over 0.9. The first model showed that antimalarial prices were significantly affected by the volume-based HHI, antimalarial type, packaging, brand status, and outlet type. Higher market concentration was associated with higher prices, with a 0.1 increase in the HHI leading to a 9% increase in antimalarial prices. To set this in context, if submarkets were ordered in terms of HHI, a shift from the bottom to the second quartile of submarkets would entail an average increase in HHI of 0.07, and a shift from the second to the third, an average increase of 0.25. The results imply that these shifts would lead to average increases in antimalarial prices of 6.3 and 18%, respectively. Being sold from a general store rather than a drug store increased the price by 33%, which may have reflected higher wholesale prices faced by the former (general shopkeepers sourced drugs locally, while drug store owners purchased supplies in Dar es Salaam, where prices for given products were generally lower (Goodman, 2004)). Packaging increased the price by 45% compared with loose tablets. The price of innovator brands was 59% higher than unbranded generics, and also significantly higher than branded generics (*F*-test: $p = 0.049$). Country of manufacture, district and outlet location were not significant. If the sales value-based HHI were used (model 2) there was very little change in the results. The coefficient on HHI was not significantly different from that estimated in model 1. We explored the importance of HHI further by running four separate regressions by drug type (SP ($n = 62$); amodiaquine ($n = 37$); chloroquine ($n = 33$); quinine ($n = 22$)). For SP, HHI remained significant in both models 1 and 2 ($p<0.001$ and $p = 0.002$, respectively). The HHI coefficients were higher than in the pooled models, but not significantly so. HHI was not significant for the other drug-specific models. It was unclear whether this was because concentration was less important in the markets for these drugs, or because of the smaller sample sizes.

Treating sub-markets with only one shop stocking antimalarials as certainty units, rather than approximating their variance with the average from other sub-markets made no difference to the results. As the country of manufacture variable was not significant we reran the regressions omitting this variable, which allowed us to include a further three observations for which this variable was missing. There was no change to the pattern of results for model 1 and only slight changes to model 2 (shop type was no longer significant ($p = 0.065$), and district became just significant ($p = 0.04$)).

6. DISCUSSION

6.1. Limitations

Four potential limitations should be noted concerning data reliability and measures of market definition and sales. Firstly, sales of quinine and artesunate tablets, SP and quinine syrup, and all injectables were not legal in drug or general shops. Although interviewers stressed that they were not connected with any regulatory body, antimalarial stocks may have been under-reported. Secondly, geographical market definition was inevitably not clear-cut. Shipment cut-off points for definition of sub-markets are essentially arbitrary, and reflected only actual, rather than potential, utilisation patterns.

Thirdly, sales data were estimated for one private facility that declined to participate and for the general stores not selected for the sample, based on mean sales for each category. This may have led to an underestimation of sales variation between outlets, biasing the HHI downwards. Finally, it is possible that extrapolation of the retail audit sales data across the year did not fully capture seasonal variation, as malaria incidence would be expected to vary with rainfall. Some justification for a pro rata extrapolation was provided by government facility outpatient data, which showed average monthly visits during the 4 months overlapping with the retail audits (February, March, June and July) to be only 3% higher

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than average monthly outpatients over the whole of 2002. Moreover, the vast majority of outlets operated all year round in a fixed location, and stocking patterns did not appear to vary seasonally based on comparison between the outlet censuses, outlet survey and retail audits, which in combination spanned most months of the year.

The analysis considered horizontal integration only, though vertical integration can also have an important influence on competition. However, in-depth interviews have demonstrated that there was no vertical integration between retailers and their wholesalers or distributors (Goodman, 2004). Moreover, vertical coordination was also very limited; there were no examples of long-term contracts, product tieins, or visits by pharmaceutical company representatives, and only a couple of shops reported receiving recommended retail prices (RRP) from distributors.

6.2. Nature of competition

At first glance the market for malaria treatment might appear relatively competitive in comparison with other health-care markets. The number of drug providers was high, with one provider for every 236 people, and over 80 different antimalarial products, all off-patent. Drug treatments were fully tradable after purchase, in contrast to inpatient care. The agency role of the provider was relatively unimportant as consumers had a free choice of provider and in shops were free to choose their own treatment if they wished. In addition, rates of entry and exit were high, especially for general stores, indicating that contestability in the retail market was relatively strong. Combined with frequent repeat purchase, almost universal out-of-pocket payment, and the commercial orientation of most providers, one might expect relatively strong price competition.

However, in practice antimalarial prices were found to be highly variable, and analysis of demand revealed a strongly geographically segmented market, with the majority of sub-markets having populations under 10 000. Concentration of antimalarial sales by provider could be considered high. It has been suggested that where the 4-firm ratio exceeds 40%, oligopoly is likely to occur (Scherer, 1970). In this antimalarial market even the 3-firm ratio for private sales volumes and values was above 65% in all sub-markets. US anti-trust guidelines state that an HHI below 0.1 is considered unconcentrated, 0.1-0.18 moderately concentrated, and greater than 0.18 is highly concentrated (Gaynor and Vogt, 2000). All sub-markets were at or above 0.18 on the basis of private sales volumes, and all over 0.18 on the basis of values, with some at or close to a monopoly situation.

Competition in certain US hospital markets has been argued to be characterised by models of quality competition, where an increase in competition may result in a rise in price due to the cost of high quality (Dranove and Satterthwaite, 2000). In support of this hypothesis, many econometric studies in the 1980s found a significant inverse relationship between the degree of concentration and costs or quality measures (Chirikos, 1992; Robinson and Luft, 1987; Robinson *et al.*, 1988; Wilson and Jadlow, 1982), although since the introduction of reforms such as managed-care, price competition is argued to have become more important (Propper and Soderlund, 1998). A negative correlation between profits and concentration was also documented in the Bangkok market for hospital services, combined with some association between lower concentration and higher quality (Bennett, 1996). In this market the reverse appeared to hold, with concentration and price being positively linked, as one would expect from standard economic theory. It is possible that concentration in private sector sales values has a larger impact on price than concentration in sales volumes, because sales values more closely reflect turnover, profitability and commercial decisions. The relationship between concentration and price was significant despite the relative homogeneity of the study area; one might expect to find an even stronger relationship in a Tanzania-wide analysis, incorporating both large urban centres and very remote locations.

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However, there are a number of alternative potential explanations for the link between price and concentration. It could be that outlets in more concentrated markets have more market power, and are therefore able to obtain higher profit margins. It is also possible that higher prices in more concentrated sub-markets reflected higher transport costs rather than less intense competition, meaning that the HHI was correlated with remoteness. This was difficult to assess as all sub-markets contained some areas on and off main roads. It was not possible to measure profit margins directly, as data on retailer costs proved too sensitive to collect accurately.

It is possible that the relationship between price and concentration reflected collusive practices. The sub-markets had several characteristics conducive to the maintenance of cartels. The number of outlets was small, and it would be relatively easy to obtain information on competitors' prices. In addition, retailers had 'multi-market' contact (Tirole, 1988), so may have avoided price cuts on particular drugs if competitors were likely to retaliate on other products. Moreover, they may have followed norms of cooperation, rather than competition, as observed among other African microenterprises (Fafchamps, 1994; Tripp, 2003). Tripp notes that many of the poorest microenterprises do not appear to seek profit maximisation, instead prioritising reciprocity, mutuality and fairness (Tripp, 2003).

6.3. Policy options

This study demonstrated that the retail sector is a major source of treatment for fever/malaria, but that antimalarial coverage is low. The literature on treatment-seeking behaviour shows that this is a common finding across sub-Saharan Africa. The proportion of care-seekers using the retail sector ranges between 15 and 83%, but is often in the range of 50-70% (Goodman *et al.*, 2007a). McCombie estimated that overall only a third to a half of febrile illnesses were treated with antimalarials, meaning that this study's figure of 37% is fairly typical (McCombie, 2002).

The determinants of poor access to antimalarials are multi-dimensional, including geographical inaccessibility and poor provider and consumer information, but in these poor rural communities the affordability of antimalarials is likely to be a major factor, which may in part reflect market power.

Since these data were collected the affordability constraint has tightened significantly. Resistance has grown rapidly to SP, leading the Tanzanian government to replace it with ACT. This reflects a common trend across the region, with ACTs being adopted due to their high efficacy and the expectation that the use of a combination will slow the development of drug resistance (White *et al.*, 1999). However, ex-factory ACT prices are 20-40 times greater than the older antimalarials such as chloroquine and SP (Bosman and Mendis, 2007). Retail sector ACT purchases are therefore likely to be restricted to the very wealthiest consumers only. Treatment for the vast majority of people using shops is now contrary to the new national guidelines, with nearly all retail customers using less effective monotherapies or no antimalarial at all (Clinton Foundation and Government of Tanzania, 2007). Some argue that encouraging widespread ACT purchase from retailers is inappropriate due to the risk of adverse reactions and the potential impact on drug resistance (D#x2019;Alessandro *et al.*, 2005). However, WHO contends that targets for effective treatment coverage are very unlikely to be reached without expanding antimalarial access through strategies such as retail distribution (WHO, 2004).

The Arrow committee on the economics of antimalarials argued that the issue of antimalarial affordability should be tackled head on (Institute of Medicine, 2004). They proposed heavy subsidisation of ACT at the point of pooled supra-national procurement, and distribution through both public and private sectors, including retailers, with the intention of achieving

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end-user prices of $0.10-$0.20. Our household data indicate that without such a subsidy high levels of ACT coverage are unlikely to be achieved in poorer groups. Such a subsidy may also be justified by the positive externalities related to both treating an infectious disease effectively, and reducing the development of antimalarial resistance by using combination therapies instead of monotherapies.

However, our data also suggest that even lower-cost monotherapies or subsidised ACT may end up beyond the reach of most rural customers because existing levels of competition do not ensure competitive retail prices. Strong geographical segmentation and high market concentration appear to provide retailers with market power, which may be used to earn substantial profits on these drugs.

Synergistic strategies must therefore accompany subsidy at source to ensure that low prices are passed on to consumers. Evidence of a significant and positive association between concentration and antimalarial prices suggests that decreasing concentration among antimalarial providers could put downward pressure on prices. This could be achieved through an expansion in the number of drug stores, or in the number of general stores stocking antimalarials. However, the desirability of the latter is questionable: general store staff have relatively low levels of education and lack any medical training, their storage facilities are often inadequate, they have high stockout rates, they are not subject to drug-specific regulatory inspections, and their high rates of entry and exit, and frequent changes in stocking patterns, would make monitoring difficult (Goodman, 2004).

An alternative to increasing competition would be price regulation. However, this is likely to be difficult to enforce, given the weak regulatory capacity evidenced by the high rate of regulatory infringements in drug stores (Goodman *et al.*, 2007b). Moreover, price regulation requires sensitive adjustments to changes in producer costs, as if prices are set below the competitive level, shortages are likely to arise and parallel markets with unregulated prices will develop (Bennett *et al.*, 1997).

An alternative approach would be the use of RRP. Although most drug manufacturers and importers provide distributors with schedules of recommended wholesale and retail prices, these were very rarely found to feed down to the periphery. However, RRP are widely used for common products in general stores, such as soft drinks and cigarettes. Although strict enforcement would not be possible, printing recommended prices on product packaging, and publicising them widely through a mass media campaign, could put some downward pressure on profit margins. This would be unlikely to discourage drug stores from stocking antimalarials altogether, as treatment of fever and malaria is such a core part of their business. However, it could be difficult to achieve RRP-adherence in the most remote areas, where transport costs are highest.

7. CONCLUSION

This study analysed the nature of competition faced by retailers in the market for malaria treatment in a rural area of Tanzania. It demonstrated that the market for antimalarials was strongly geographically segmented and highly concentrated, and antimalarial prices were positively associated with market concentration.

High antimalarial prices are likely to be an important factor in the poor quality of treatment obtained by many caretakers. The retail sector has the potential to increase substantially the coverage of effective malaria treatment, but this will not be achieved without affordable antimalarial prices. An understanding of the nature of competition faced by retailers is an important prerequisite for the design of strategies to achieve this goal.

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Table 1

Summary of data collection activities

Activity	Sample
Household Survey May Sep 2001 Quantitative data on treatment seeking for fever and malaria by all household residents during the previous two weeks *Outlet Censuses May Sep 2000 and 2001* Census of all private drug outlets in study DSS areas, updated in 2001	Total sample size of 1250 randomly selected households, stratified by DSS system. Data were collected on 1101 households, 3853 individuals and 577 provider visits 588 outlets interviewed in 2000, 682 in 2001 (private facilities, drugs stores and general stores)
Outlet Survey Nov Dec 2001 Quantitative data on antimalarial drug stocks and prices through structured interviews with public and private providers	All facilities and drug shops in DSS areas, and a random sample of general stores stocking drugs stratified by DSS system. Total sample of 331 outlets, of which 294 were interviewed (18 government facilities, 8 private facilities, 32 drug stores and 236 general stores)
Antimalarial Retail Audits Feb/Apr and June/July 2002 Measurement of antimalarial sales during two 2 week periods	All facilities and drug shops in DSS areas, and random sample of general stores previously reported to be selling antimalarials, stratified by DSS system[a]. In Audit 1 sample size of 122 and data collection completed for 112 outlets (18 government facilities, 8 private facilities, 30 drug stores and 56 general stores). In Audit 2 sample size of 123 and data collection completed for 119 outlets (18 government facilities, 8 private facilities, 36 drug stores and 57 general stores)

[a]Although all the outlets selected had stocked antimalarials in either the outlet survey or the 2001 outlet census, only 25 of the general stores selected (45%) had antimalarial drugs in stock during retail audit 1, and this had fallen to 18 (32%) during retail audit 2.

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Table II

Median price of antimalarial tablet purchase required to treat a 2 year old child (USD) (*n* = number of products identified)

	Government facility with drug fees[a]		Private facility		Commercial drug store		General store	
	n	**Median**	***n***	**Median**	***n***	**Median**	***n***	**Median**
Chloroquine	4	0.01	1	0.02	10	0.02	23	0.06
SP	2	0.07	19	0.21	61	0.26	2	0.16
Amodiaquine	1	0.13	4	0.15	31	0.21	7	0.21
Quinine	1	0.29	8	0.58	22	1.16	1	0.46

SP sulfadoxine pyrimethamine. *Source*: Outlet Survey Nov Dec 2001.

[a]Price data are for the three government facilities that reported charging for drugs; the remaining 15 government facilities reported providing drugs for free. If all government facilities were included, the median price was zero for all antimalarials.

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Table III

Price dispersion for antimalarial tablets in drug shops (child's dose in USD)

	n [a]	Median	Range	IQR	Quartile coefficient of variation[b]
Loose					
SP	9	0.16	0.11 0.32	0.05	17%
Chloroquine	10	0.02	0.02 0.02	0	0%
Amodiaquine	12	0.21	0.11 0.32	0.21	50%
Quinine	9	0.81	0.58 1.16	0.35	21%
Packaged					
SP	52	0.28	0.18 0.79	0.21	37%
Chloroquine	0				
Amodiaquine	19	0.21	0.11 0.42	0	0%
Quinine	13	1.16	0.69 2.78	0.23	10%

IQR interquartile range, *Source*: Outlet Survey Nov Dec 2001.

[a]Number of products identified.

[b]Quartile coefficient of variation 50*IQR/Median.

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Table IV

Concentration measures by sub market

Sub markets	Population	Private sector sales volumes		Private sector sales values	
		3 Firm concentration ratio (%)	HHI[a]	3 Firm concentration ratio (%)	HHI[a]
Kilombero					
Idete	10 511	84	0.26	90	0.35
Mbingu	9523	68	0.19	87	0.33
Mchombe	17 030	73	0.24	69	0.24
Ulanga					
Minepa	7861	79	0.51	89	0.72
Lupiro	12 037	94	0.60	96	0.57
Iragua	4353	91	0.67	93	0.74
Kichangani[b]	5188	100	1.00	100	1.00
Rufiji					
Ikwiriri	19 232	89	0.42	92	0.47
Kibiti	24 244	85	0.27	87	0.34
Mchukwi	9029	96	0.83	98	0.87
Bungu	12 627	71	0.18	85	0.28
Jaribu	8707	69	0.18	75	0.24
Average	11 695	83	0.45	88	0.51

Sources: Population Data DSS systems, May 2001, Sales Data Retail Audits Feb/Apr and Jun/Jul 2002.

[a]The Hirschman Herfindahl index (HHI) ranges from 0 (large number of competitors with small market shares) to 1 (single monopoly supplier).

[b]In Kichangani only 1 private sector antimalarial provider was documented.

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Table V

Definition of variables for model of the price of antimalarial tablets in shops

Variable	Definition	Means
Dependent variable		
Log_price_AM	Log of price for child's dose of antimalarial tablets (Tsh)	5.29
Independent continuous variables		
HHI volume	Hirschman Herfindahl index for private sector antimalarial sales volumes by sub market	0.31
HHI value	Hirschman Herfindahl index for private sector antimalarial sales values by sub market	0.38
Independent dummy variables		
Antimalarial type		
Chloroquine (omitted)	1 if antimalarial is chloroquine	0.22
Amodiaquine	1 if antimalarial is amodiaquine	0.24
Quinine	1 if antimalarial is quinine	0.14
SP	1 if antimalarial is SP	0.40
Type of packaging:		
Loose (omitted)	1 if tablets are sold loose	0.31
Packaged	1 if tablets are sold packaged	0.69
Country of manufacture[a]:		
Tanzania (omitted)	1 if manufactured in Tanzania	0.37
Other_Africa	1 if manufactured in another African country	0.40
Asia	1 if manufactured in Asia	0.08
Europe	1 if manufactured in Europe	0.15
Brand status:		
Unbranded_generic (omitted)	1 if unbranded generic	0.25
Innovator[a]	1 if innovator brand	0.09
Branded_generic	1 if branded generic	0.66
District:		
Kilombero (omitted)	1 if in Kilombero DSS	0.29
Ulanga	1 if in Ulanga DSS	0.07
Rufiji	1 if in Rufiji DSS	0.64
Outlet type:		
Drug store (omitted)	1 if outlet is a commercial drug store	0.79
General_store	1 if outlet is a general store	0.21
Outlet location:		
Market_centre (omitted)	1 if outlet is in market centre	0.55
Rural_area	1 if outlet is in rural area	0.45

Source: Outlet Survey Nov Dec 2001, HHI from Retail Audits Feb/Apr and Jun/Jul 2002.

[a]Innovator brands are those first authorised worldwide for marketing (normally as a patented product); among antimalarials in this study this only applied to Fansidar™ and Metakelfin™, both innovator brands for SP.

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Table VI

OLS log linear regression of antimalarial tablet prices for shops[a]

	Model 1			Model 2		
	n 154; *F*<0.0001; R^2 0.9024			*n* 154; *F*<0.0001; R^2 0.9035		
Explanatory variables	**Coefficient**	**Standard error**	***p* Value**	**Coefficient**	**Standard error**	***p* Value**
HHI volume	0.947	0.320	0.005*			
HHI value				1.028	0.299	0.001*
Amodiaquine	1.698	0.132	<0.001*	1.690	0.134	<0.001*
Quinine	3.490	0.151	<0.001*	3.454	0.152	<0.001*
SP	1.886	0.117	<0.001*	1.883	0.117	<0.001*
Packaged	0.451	0.104	<0.001*	0.423	0.104	<0.001*
Other_Africa	0.187	0.116	0.114	0.158	0.114	0.175
Asia	0.071	0.157	0.654	0.064	0.157	0.685
Europe	0.040	0.162	0.804	0.082	0.160	0.610
Innovator	0.588	0.198	0.005*	0.555	0.193	0.006*
Branded_generic	0.163	0.121	0.183	0.145	0.117	0.218
Ulanga	0.237	0.148	0.117	0.298	0.186	0.116
Rufiji	0.172	0.098	0.084	0.137	0.097	0.164
General_store	0.327	0.121	0.010*	0.314	0.122	0.013*
Rural_area	0.114	0.105	0.284	0.081	0.095	0.401
Constant	2.707	0.161	<0.001*	2.683	0.158	<0.001*

Five observations were dropped because of missing data on country of manufacture or tablet size. *Source*: Outlet Survey Nov Dec 2001.

[a]Each observation is an antimalarial drug. As the HHI was measured at the sub market level, the strata were defined as the sub markets, and tested with an *F* test of (14, 34).

*Coefficient significant at 5% level.