

Benefits from competition in a high-inequality economy: The case of mobile telephony in South Africa

Ryan Hawthorne*

Lukasz Grzybowski[†]

Abstract

South Africa is the most unequal society in the world. An important means of reducing inequality is lowering prices for goods consumed by low income consumers by increasing competition. We test for the distributional effects of entry in the mobile telecommunications sector using six waves of a consumer survey for years 2009-2014 which consists of about 150,000 individuals. First, we estimate a discrete choice model allowing for individual-specific price-responsiveness and preferences for network operators. Next, we use a demand and supply equilibrium framework to simulate prices and distribution of welfare in a counterfactual situation without entry. We find that while a ‘rising tide lifts all boats’, in that all consumers benefit from entry, high-income consumers benefit more. However, entry results in a greater increase in mobile penetration among poor consumers than among rich consumers.

Keywords: Mobile telecommunications; Competition; Entry; Discrete choice; Inequality

JEL Classification: L13, L15, L16, L41, L50, L96

* *Corresponding author* Acacia Economics & University of Cape Town, School of Economics, Rondebosch, 7701, Cape Town, South Africa. E-mail: ryan@acaciaeconomics.com. We thank the University of Cape Town's ICTS High Performance Computing team for providing us with computational facilities: <http://hpc.uct.ac.za>

[†]Telecom ParisTech, 46 rue Barrault, 75013 Paris, France & University of Cape Town, School of Economics, Rondebosch, 7701, Cape Town, South Africa. E-mail: lukasz.grzybowski@telecom-paristech.fr

1 Introduction

South Africa is the most unequal country in the world, with a Gini coefficient in 2015 equal to 0.62 according to OECD statistics, which is a consequence of South Africa's Apartheid-era racial discrimination policies (see Leibbrandt et al. 2010). The top 10% of income-earners earn thirty times more than the bottom 10%. These high levels of inequality have important consequences for policymakers who are under pressure to find policy levers to reduce inequality. One such means is by reducing the prices of consumer services through greater competition.

The mobile telecommunications sector is a prime example of an industry in which the number of competitors, and thus to some extent competition, is under state control. An important question therefore is how many competitors the state ought to provide spectrum licenses to. Despite competition between four network operators in South Africa, the prices of mobile services remain at a relatively high level, as compared to other African and developing economies (Calandro and Chair 2016). This has an important impact on the poor, since mobile telecommunications services account for up to 5% of the bottom income quartile's expenditure in South Africa (see Figure 1).¹

Antitrust and regulation of markets such as telecommunications are not suited to tackle the issue of income inequality but they may have impact on it. For instance, telecommunications operators set prices at national level and a reduction in price may cut more expenses of low-income consumers. At the same time, mobile operators enter most attractive local markets first, which are in general urban areas with higher average income levels. Since spectrum licences typically set coverage obligation on the firms, competition should eventually also spread to rural and less economically attractive areas. The coverage obligation should guarantee that the majority of population benefits from competition on mobile networks but the reality may be different. Also, the regulators cannot control which market segment firms target and what are their pricing strategies. In countries with relatively small share of wealthy and masses of poor consumers,

¹Based on authors' computations using the National Income Dynamics Survey (NIDS), which is a nationwide survey of South African individuals and households collected by the Southern Africa Labour and Development Research Unit (SALDRU) at the University of Cape Town (UCT) in four waves: 2008, 2010/2011, 2012 and 2014/2015 (Southern Africa Labour and Development Research Unit 2008-2016).

firms may not be keen to lower prices enough to attract the less profitable consumers. While this issue may be mitigated in many markets by the availability of cheaper substitutes that can be purchased by poor people, this is not the case with mobile telecommunications.

Since mobile services in developing economies are the only means to overcome poor or non-existent fixed-line infrastructure and lack of Internet access, there is a concern that high mobile telecommunications prices slow down economic development. This is reflected in recent political debates in South African which led to a market inquiry into the cost of mobile data, launched by the South African Competition Commission in October 2017. As documented by many empirical studies, development of mobile telecommunications networks has a positive impact on market performance and economic growth. For example, in an earlier paper Roller and Waverman (2001) find a significant, positive relationship between universal access to telecommunications infrastructure and economic development.

In this paper, we use six waves of South African survey data of about 150,000 individuals collected between 2009 and 2014 to estimate the distribution of benefits across different segments of society from the entry of new market players in mobile telecommunications. South African society is multi-racial, multi-lingual and highly segmented with respect to income, which is also reflected in preferences and affordability of mobile telecommunications services. We estimate a discrete choice model allowing for individual-specific price-responsiveness and preferences for network operators. Overall, we find that price sensitivity of subscriptions to mobile networks is impacted by income directly and by factors which indirectly determine individual wealth and social group such as race and language. Next, we use the estimates of demand parameters and individual price-responsiveness to simulate market outcomes in the absence of new entrant, Telkom Mobile, which launched mobile services in 2010, and in addition without Cell C, which launched services in around 2002.

Based on our equilibrium model, we find that without entry of Telkom Mobile and Cell C the adoption of mobile phones in South Africa would be lower by about four percentage points in 2014. Thus, entry led to a relatively small increase in the total number of adopters, where the

effect is higher for low-income groups. Without entry mobile penetration among high-income consumers would have been two percentage points lower in 2014, while penetration among low-income consumers would have been four percentage points lower. We also use the model to simulate changes in consumer welfare for different income groups and segments of society. In this way, we test the idea that an increase in competition benefits poor people more than rich people and thus, at least marginally, contributes to reduction in income inequality. However, we find that rich people benefited more from entry in terms of change in consumer welfare. Overall, we find that entry does not reduce inequality but has the opposite effect with relatively small welfare effects. The concern with high prices and ongoing market inquiry into competition in mobile markets in South Africa is a consequence of this. This paper provides an important evidence on the distributional effects of competition, which can be of use to the policy makers in South Africa and other countries.

The remainder of the article is organized as follows. Section 2 discusses relevant literature. Section 3 describes the market being analysed. Section 4 presents the data which we use in the estimation. Section 5 introduces the econometric framework. Section 6 presents the estimation results and finally, Section 7 concludes.

2 Literature review

Our paper contributes to various streams of the literature. First, we estimate demand for telecommunications using a discrete choice model, a common approach used in previous research to estimate price elasticities, define relevant markets, simulate the effects of mergers and address related questions. For instance, Cardona et al. (2009) use household survey data for Austria to estimate discrete choice models for Internet access through DSL, cable and mobile broadband via UMTS. In a related paper, Grzybowski et al. (2014) estimate a mixed logit model for choices of broadband technologies in Slovakia and use the estimates of price elasticities to conclude on market definition. In another paper, Grzybowski and Liang (2015) estimate choices of mobile tariff plans using data on subscribers to mobile services from a single European operator and

find that consumers face substantial switching costs when changing to an alternative tariff, which reduce consumer surplus.

Second, we contribute to the literature which illustrates the impact of mobile telecommunications services on welfare and economic development using micro-level data. For example, Jensen (2007) uses data on fishermen in the Indian state of Kerala to show that usage of mobile phones may improve market performance and increase welfare. Aker (2008) analyzes how the phasing-in of mobile phone coverage between 2001 and 2006 affected grain prices in Niger. Muto and Yamano (2009) use panel data of households in Uganda to analyze the impact of mobile network coverage on sales of agricultural products. In another paper, Muto (2012) uses the same panel data to analyze how the possession of mobile phone influences labor market and migration. Klöpper and Nolen (2010) analyze the effect of mobile phone coverage on rural labor market outcomes in South Africa. Finally, Aker and Mbiti (2010) survey the evidence on the impact of mobile telephony on economic development in Sub-Saharan Africa, and find that the expansion in mobile usage improves consumer and producer welfare.

Third, our paper is also related to the literature on the impact of competition and regulation on prices and welfare in telecommunications markets. Nicolle et al. (2018) estimate hedonic price regressions using data on tariff plans offered by the main mobile telecommunications operator in France between May 2011 and December 2014 to obtain a quality-adjusted price index. In the second stage, they find that competition due to entry of new network operator and investments in 4G networks were the main factors which contributed to price reductions. Economides et al. (2008) quantify the benefits of entry into local telecommunications service markets. They find that consumers benefit significantly, though rather than resulting in reduced prices, entry results in product differentiation and new plan introductions. In another paper, Genakos et al. (2018) analyze how entries and exits influence prices of mobile services and investments in networks using cross-section panel data for 33 OECD countries in years 2002-2014. They use the estimates to comment on the effects of mergers on prices and investments. They find that mobile markets become more concentrated in the analyzed period and prices increased, while the effect

of concentration on investment is not significant at the industry level.

Fourth, we contribute to the literature on the impact of competition on inequality and welfare more generally. This is important in light of recent calls for a greater role for competition policy in reducing inequality (see (Baker and Salop 2015)). In a seminal paper, Deaton (1988) proposes a methodology to estimate elasticities of demand using household survey data in order for developing country governments to be better able to design taxes and subsidies for commodities, since they typically do not have the ability to raise general income taxes. Argent and Begazo (2015) show that reducing sugar and maize prices by 20% by making markets more competitive in Kenya could result in a reduction in poverty of 1.5% and 1.8% respectively. However, competition may not always benefit equally market participants belonging to different income groups and thus can alleviate inequality. For example, Wodon and Zaman (2009) find that lower food prices would benefit non-poor consumers at the expense of poor producers.

In highly unequal economies, firms may enter the market and compete in the segment of high-income consumers, where they can get higher margins, rather than provide services on low margin to masses of poor consumers. From a welfare perspective, these are the poor consumers who should benefit the most from access to telecommunications services, which may help them to get jobs and escape poverty. In this paper, we detail how entry impacted the well-being of South African consumers in different income and societal segments. Thus, our paper brings important evidence distributional effects of government policies towards competition in telecommunications markets in South Africa and other developing economies with high levels of inequality.

3 Industry

There are two full-coverage mobile operators in South Africa, MTN and Vodacom, and two partial-coverage networks, Telkom Mobile and Cell C, which roamed on the MTN and Vodacom networks respectively in the sample period.²

²We dropped subscribers to Virgin Mobile from the analysis due to small market size which was XXX in 2014. In an alternative specification, we estimated a model with subscribers to Virgin Mobile and including this provider in the choice set of all consumers. The estimation results are comparable.

Vodacom and MTN began rolling out their Global System for Mobile (GSM) networks in the mid-1990s, at around the same time that GSM networks were being rolled out in many countries. Cell C entered the market in late 2001, while Telkom Mobile entered in late 2010. Cell C and Telkom Mobile focus largely on higher-income cities and towns. As a result of this, these newer entrants have largely captured higher-income consumers (see Figure 2). While Cell C and Telkom Mobile roam on the Vodacom and MTN networks for voice services and some data services (3G), roaming is not seamless. For example, Cell C consumers busy on a call while moving outside of the coverage of a Cell C antenna are not automatically handed over to the Vodacom network, and the call is dropped. Furthermore, the lack of 3G and 4G roaming, at least in the earlier years in the sample period, meant that Cell C and Telkom Mobile effectively do not have national coverage, while MTN and Vodacom cover more than 70% of the population with 4G services.

As a result of racial discrimination during Apartheid, White consumers have significantly higher incomes compared to other racial groups. Indian and Coloured consumers were discriminated against during Apartheid but benefited from having more access to public resources and from living in urban areas, while many Black people were forced to live in rural ‘homelands’ with substantially lower funding for education and healthcare. Indian and Coloured consumers therefore have lower incomes than White consumers though all three groups have higher incomes than Black consumers.

Based on our data, the entrants, Cell C and Telkom Mobile, have a significantly higher share of Coloured and Indian consumers than of Black consumers (see Figure 2). MTN has a disproportionately high share among Black consumers (between 45% and 50%), while Vodacom has a disproportionately high share among White consumers (close to 60%).

There are nine provinces in South Africa which have very different population groups due to the discriminatory policies implemented during Apartheid. The provinces of the Western Cape and Gauteng have significantly more people living in urban areas, while the provinces of the Eastern Cape, KwaZulu-Natal, Limpopo Mpumalanga and the North-West have large

populations living in former ‘homelands’ which are largely rural areas. The Northern Cape is a sparsely populated province that has a relatively small population. There are eleven official languages in South Africa which are, ranked by number of speakers: Zulu, Xhosa, Afrikaans, English, Northern Sotho, Tswana, Sesotho, Tsonga, Swazi, Venda, Ndebele. In the dataset, languages sharing common traits or geographic region are grouped together. Thus, Zulu is grouped with Swazi and Ndebele (called ‘Zulu+’), while Sesotho, the main language spoken in the largest cities Johannesburg and Pretoria, is grouped together with Northern Sotho, Tswana, Tsonga and Venda (called ‘Sesotho+’).

Mobile network choice patterns among language groups follow those among race groups. The main difference is in respect of Xhosa-speaking consumers, who mainly live in the Eastern Cape and the Western Cape, and who predominantly choose MTN (around two-thirds).³

Cell C and Telkom Mobile have largely rolled out their networks in urban areas, and their market shares are therefore relatively higher in cities and towns (see Figure 2). Vodacom and MTN have relatively higher market shares in rural areas than in towns and cities due to their full-coverage networks. Low-income consumers based in rural areas have not taken up new entrant services, despite the new entrants having roaming agreements with the full-coverage networks.

Termination rates are an important determinant of voice prices on mobile networks. ICASA, the telecommunications sector regulator, began reducing mobile termination rates in 2010, when Telkom Mobile, owned partly by government, complained about high MTRs due to their imminent entry.⁴ Overall, MTRs declined substantially in years 2009-2014, as shown in Table XXX, and so did retail prices (see Figure 3). We show that the decline in retail prices is to large extent due to lower MTRs rather than entry and expansion by smaller rivals.

³Note that Indian consumers largely speak English, while approximately three-quarters of Coloured consumers speak Afrikaans.

⁴Dividends from Telkom appear on the budget in the telecommunications line ministry’s annual report, accounting for the bulk of incoming funds into that ministry.

4 Data

We estimate a discrete choice model using six waves of the All Media Products Survey (AMPS), a survey of approximately 25,000 consumers each year between 2009 and 2014, amounting to 150,000 observations in total (South African Audience Research Foundation (SAARF) 2009-2014). The AMPS dataset contains consumer choices of a range of products and services as well as personal and household characteristics.⁵

Prices were obtained from Research ICT Africa (2010-2015) and Tarifica.⁶ In addition, we used online archive service, archive.org's Wayback Machine to complete the pricing database. Prices were matched to consumers by payment method (prepaid and postpaid) and estimated usage of voice minutes, in order to arrive at a price per minute for each operator in the choice set faced by each consumer.

First, we have grouped consumers as prepaid and post-paid users based on the type of contract they have. All prepaid consumers belong to one segment. Post-paid consumers were divided into three groups: low, medium and high users according to their declared monthly cellphone spend.⁷ Low-usage consumers are assumed to have monthly bills in the range R1-R150 per month, medium-usage consumers in the range R151-500 per month and high-usage consumers above R500 per month.⁸

Next, we computed average prices per calling minute which are faced by consumers assigned to these four market segments as follows. For each segment we assumed different monthly usage of minutes: 30 minutes for prepaid users (1 minute per day), 180 minutes for low-usage postpaid consumers (6 per day), 540 minutes for medium-usage consumers (18 per day) and 1,080 minutes for high-usage consumers (36 per day). In South Africa, prices differ depending on whether calls

⁵This is an annual survey conducted by the South African Advertising Research Foundation (SAARF) on buyers of a range of products, in order to match media companies (such as newspapers, TV stations and radio stations) and advertisers of the various products surveyed.

⁶Research ICT Africa is a non-governmental organisation that collects data and conducts research on telecommunications in Africa.

⁷The data for cellphone spend were not available in AMPS 2013. A conditional tree method was applied using the `ctree` function in the `partykit` package in R to assign cellphone spend to users in 2013.

⁸The South African currency is highly volatile but as of June 2018 one US dollar was approximately 13.6 Rands.

are on the same network (on-net), to other mobile networks (off-net) and terminated on the fixed network. For prepaid and postpaid consumers we assumed the same distribution pattern of calls where 10% of minutes are terminated on fixed lines and 90% of minutes are terminated on mobile networks. There are also time-based tariffs which differ between ‘peak’ and ‘off-peak’ times, for which we assume a 50% / 50% calling pattern. Using this call distribution pattern, we computed average per minute price for all prepaid tariffs which were on the market and picked the lowest one for each operator in a given year. We assume that these prices are faced by pre-paid consumers when making choice of pre-paid contracts from different operators. In a similar way we computed the average per minute prices faced by post-paid consumers belonging to three different segments. We tested our results against different calling patterns and our estimates of elasticities are robust with this respect.

5 Econometric Model

5.1 Demand

5.1.1 Discrete choice model

We estimate demand for mobile subscriptions by means of a discrete choice model, where consumers choose the network operator that maximizes their utility function. We use a standard linear utility specification for individuals $i = 1, \dots, N$ over the different network operators $j = 1, \dots, J$, which depends on network characteristics and on observable and unobservable individual characteristics. More specifically, we skip time subscript for year t and let the utility of individual i for mobile network j be given by:

$$U_{ij} = x_j' \tilde{\beta}_i - \tilde{\alpha}_i p_{ij} + \epsilon_{ij}. \quad (1)$$

Here, x_j is a $J \times 1$ vector of network dummy variables interacted with individual characteristics and $\tilde{\beta}_i$ is a $J \times 1$ vector of coefficients denoting the individual-specific valuations for the different networks (which are estimated relative to the base not having mobile services at all). Further-

more, p_{ij} denotes the price paid by consumer i for making a phone call on network j , and $\tilde{\alpha}_i$ is a coefficient for the individual-specific valuation of price. We discuss the construction of the price variable in Section 4. Finally, ϵ_{ij} is an individual-specific valuation for network j , i.e. the “logit error term”. It is identically and independently distributed across mobile networks according to the Type I extreme value distribution.

The vector of coefficients $\tilde{\beta}_i$ and the price coefficient $\tilde{\alpha}_i$ may depend on both observed individual characteristics and unobserved heterogeneity. More specifically, we define:

$$\begin{pmatrix} \tilde{\beta}_i \\ \tilde{\alpha}_i \end{pmatrix} = \begin{pmatrix} \beta \\ \alpha \end{pmatrix} + \Pi D_i + \begin{pmatrix} 0 \\ \sigma_\alpha \end{pmatrix} \nu_i, \quad \nu_i \sim N(0, 1) \quad (2)$$

where (β, α) refers to a $(J + 1) \times 1$ vector of mean valuations. D_i is a $d \times 1$ vector of observable individual characteristics and Π a $(J + 1) \times d$ matrix of parameters capturing the impact of individual characteristics on the valuations for the J network dummy variables x_{jt} and the price variable p_{jt} . The randomly drawn vector from the standard normal distribution ν_i captures unobserved individual heterogeneity regarding price, and σ_α is a vector of standard deviations around the mean valuations. In our empirical analysis, the vector of observable characteristics D_i includes gender, age category (15 – 25, 26 – 50, 51 – 65, 65+), race, language, province, income group (below R2,500, R2,500 – 4,999, R5,000 – 9,999, above R10,000), employment status, whether the person is self-employed, whether the person has a telephone at home and/or at work, and whether the person has a computer.

In the special case, where $\sigma_\alpha = 0$, there is no unobserved individual heterogeneity and we obtain the conditional logit model. In a more general framework, we have a mixed or random coefficients logit model, which allows for unobserved in addition to observed heterogeneity between individuals. The utility function specified above with observed and unobserved heterogeneity allows for flexible substitution patterns between network operators. In this way we can capture which network operators are closer substitutes from the consumer’s perspective.

An individual i chooses a network j if this maximizes its utility among all available alternatives, i.e. if $U_{ijt} = \max_{k \in C_i} U_{ikt}$, where C_i is individual i ’s available choice set. Hence, the

probability that individual i with given coefficients $\tilde{\beta}_i$ and $\tilde{\alpha}_i$ chooses network j is given by:

$$\begin{aligned} l_{ijt}(\tilde{\beta}_i, \tilde{\alpha}_i) &= \Pr\left(U_{ij} = \max_{k \in C_i} U_{ik}\right) \\ &= \frac{\exp\left(x'_j \tilde{\beta}_i - \tilde{\alpha}_i p_{ij}\right)}{\sum_{k \in C_i} \exp\left(x'_k \tilde{\beta}_i - \tilde{\alpha}_i p_{ik}\right)} \end{aligned}$$

where the second line follows from the distributional assumptions of the logit error term ϵ_{ij} . With unobserved heterogeneity we need to integrate the conditional choice probability $l_{ij}(\tilde{\beta}_i, \tilde{\alpha}_i)$ over the distribution of $\tilde{\alpha}_i$:

$$P_{ij} = \int_{\tilde{\alpha}} l_{ij}(\tilde{\beta}_i, \tilde{\alpha}) f(\tilde{\alpha}) d\tilde{\alpha}, \quad (3)$$

where we specified the distribution of $\tilde{\alpha}_i$ earlier in (2) to consist of an observable part and an unobservable part that is normally distributed, $\nu_i \sim N(0, 1)$.

We can express individual i 's probability of choosing the alternative that it actually made as $\prod_j P_{ij}^{y_{ij}}$, where $y_{ij} = 1$ if individual i chose alternative j and $y_{ij} = 0$ otherwise. Assuming that each individual's choice is independent of that of other individuals, the probability of each individual in the sample choosing the observed alternative can be written as the log-likelihood function:

$$\mathcal{L}(\theta) = \sum_i y_{ij} \sum_j \log(P_{ij}). \quad (4)$$

where θ is the vector of all parameters to be estimated. To approximate the integral entering the choice probabilities P_{ij} in (3), we use a simulation method. Following Train (2009), we take R draws for ν_i from the standard normal distribution to obtain the average choice probability per individual:

$$\hat{P}_{ij} = \frac{1}{R} \sum_{r=1}^R \frac{\exp\left(x'_j \beta - (\alpha + \sigma \nu_i^r) p_{ij} + (x'_j, p_{ij}) \Pi D_i\right)}{\sum_{k \in C_i} \exp\left(x'_k \beta - (\alpha + \sigma \nu_i^r) p_{ik} + (x'_k, p_{ik}) \Pi D_i\right)}. \quad (5)$$

In the special case of no unobserved individual heterogeneity ($\sigma = 0$), this expression reduces to

the multinomial choice probability:

$$\hat{P}_{ij} = \frac{\exp\left(x'_j\beta - \alpha p_{ij} + (x'_j, p_{ij})\Pi D_i\right)}{\sum_{k \in C_i} \exp\left(x'_k\beta - \alpha p_{ik} + (x'_k, p_{ik})\Pi D_i\right)}.$$

The maximum simulated likelihood estimator is the value of the parameter vector θ that maximizes the likelihood function \mathcal{L} given by (4), after substituting (5) in place of P_{ij} .

5.1.2 Price Elasticities of Demand

We calculate the own- and cross-price elasticities for subscriptions to mobile networks as follows. The effect of a *percentage* price increase of network k on the *level* of individual i 's probability of choosing network j is:

$$\frac{\partial P_{ij}}{\partial p_{ik}} p_{ik} = \begin{cases} -\tilde{\alpha}_i P_{ij}(1 - P_{ij}) p_{ij} & \text{if } k=j \\ \tilde{\alpha}_i P_{ij} P_{ik} p_{ik} & \text{otherwise} \end{cases}.$$

This could also be called individual i 's semi-elasticity of demand for j with respect to the price of k . Let the aggregate market share for network j be given by $s_j \equiv \sum_i P_{ij}/N$, where N is the number of consumers in the sample in a given year. Thus, the aggregate elasticity of demand for subscriptions to network j with respect to the price of k may be defined as:

$$\varepsilon_{jk} = \frac{1}{N} \left(\sum_i \frac{\partial P_{ij}}{\partial p_{ik}} p_{ik} \right) \frac{1}{s_j} = \begin{cases} \sum_i (-\tilde{\alpha}_i) P_{ij}(1 - P_{ij}) p_{ij} / \sum_i P_{ij} & \text{if } k=j \\ \sum_i \tilde{\alpha}_i P_{ij} P_{ik} p_{ik} / \sum_i P_{ij} & \text{otherwise} \end{cases}. \quad (6)$$

5.1.3 Consumer surplus

We use the estimates to calculate changes in consumer surplus due to entry of new operator. In the discrete choice framework, the expected consumer surplus of consumer i is given by (see Small and Rosen (1981)):

$$E(CS_{it}) = \int_{\tilde{\alpha}} \frac{1}{|\tilde{\alpha}_i|} \ln \left(\sum_j \exp(V_{ijt}) \right) d\tilde{\alpha} + C_i$$

where α_i is the individual-specific price coefficient, V_{ijt} is the observed part of the utility function 1 and C_i is an unknown constant which represents the unmeasured level of utility. A change in consumer surplus due to policy intervention, for instance letting a new mobile operator enter the market, can be written as:

$$\Delta E(CS_{it}) = \int_{\tilde{\alpha}} \frac{1}{|\tilde{\alpha}_i|} \left| \ln \left(\sum_j \exp(V_{ijt}^1) \right) - \ln \left(\sum_j \exp(V_{ijt}^0) \right) \right| d\tilde{\alpha} \quad (7)$$

where V_{ijt}^1 denotes the utility after and V_{ijt}^0 before entry.

5.2 Supply

We aggregate the individual choice probabilities and derive market shares of firms, s_{jt} , which are used on the supply side to infer marginal costs. We then use both the demand and supply sides to simulate how entry of mobile operators, Cell C and Telkom Mobile, impacted welfare and how consumer surplus is distributed across population segments. In this computation we consider that mobile operators are single product firms, which compete by setting per minute call prices. Since the vast majority of consumers in our sample are pre-paid consumers, the average per minute market prices are very close to prices which are charged to pre-paid consumers, which are shown on Figure 3. Note that on the demand side, individual consumers choose mobile subscription by comparing per minute prices. But apart from pre-paid consumers, we also have three smaller segments of post-paid consumers who choose between post-paid subscription offers.

Since we can also use the model to simulate price effects of mergers, in what follows we consider a more general notation with multi-product firms. For ease of notation we skip time subscript t . Let F_f be the set of products sold by firm f . The profits of firm f are given by:

$$\Pi_f(\mathbf{p}) = \sum_{k \in F_f} (p_k - c_k) s_k(\mathbf{p}) L \quad (8)$$

where c_k is the marginal cost of product k , and $s_k(\mathbf{p})$ is product k 's market share as a function of the price vector. Market size is denoted by L . Assume firms choose prices to maximize profits.

The first-order conditions that define the Bertrand-Nash equilibrium are given by:

$$s_j(\mathbf{p}) + \sum_{k \in F_j} (p_k - c_k) \frac{\partial s_k(\mathbf{p})}{\partial p_j} = 0. \quad (9)$$

for products $j = 1, \dots, J$. The market shares and price derivatives of market shares are computed by aggregating individual-level choice probabilities and price derivatives in a similar way to aggregate price elasticities discussed in Section 5.1.2. The FOCs can be written in vector notation as:

$$\mathbf{s}(\mathbf{p}) + (\boldsymbol{\Theta}^F \odot \boldsymbol{\Delta}(\mathbf{p})) (\mathbf{p} - \mathbf{c}) = 0. \quad (10)$$

where \mathbf{p} and $\mathbf{s}(\mathbf{p})$ are $J \times 1$ price and market share vectors, $\boldsymbol{\Delta}(\mathbf{p}) \equiv \partial \mathbf{q}(\mathbf{p}) / \partial \mathbf{p}'$ is a $J \times J$ matrix of own- and cross-price derivatives, $\boldsymbol{\Theta}^F$ is a $J \times J$ block-diagonal matrix, with ones for products of the same firm and zeros otherwise, and \odot denotes element-by-element multiplication of two matrices.

The system of first-order conditions (10) can be inverted at the current price and market shares to compute the current marginal costs \mathbf{c}^0 :

$$\mathbf{c}^0 = \mathbf{p} + (\boldsymbol{\Theta}^F \odot \boldsymbol{\Delta})^{-1} \mathbf{s}. \quad (11)$$

Furthermore, the system of first-order conditions (10) can be used to perform counterfactual simulations. In particular, we solve this system of equations after removing the equations for Cell C and Telkom Mobile. The solution gives the counterfactual equilibrium price vector \mathbf{p}^1 , which contains only prices for the remaining mobile operators Vodacom and MTN. We then use this price vector to compute the counterfactual market shares \mathbf{s}^1 , profits given by (8), and change in individual consumer surplus given by formula (7), which can be aggregated for different population segments.

6 Results

When estimating the demand model we need to account for the endogeneity of the price variable. As is the case in many discrete choice settings, consumer choices depend on price but are also likely to be driven in part by unobserved quality differences, and quality in turn is likely to drive price (Petrin and Train (2010)). Following Petrin and Train (*ibid.*), we therefore use the control function approach to account for endogeneity.

In the first stage, we regress per minute prices used in the demand estimation on a set of controls. In particular, we use call termination charges to approximate the marginal cost of per minute calls. Since termination rates differ by call destination and they are zero for on-net calls, we compute the cost of termination based on our usage basket approach, which we discuss in Section 4. But instead of the average price of a call we compute the average termination rate of a call for prepaid and different post-paid contracts. In addition, we use in the regression a set of dummy variables for years, operators and type of tariff as well as interaction terms of the last two variables. Our first stage regression is shown in Table 1. The estimation results indicate that the cost of call termination has a significant impact on per minute price. An increase in termination cost by 1 cent increases retail price by 0.68 cents. A positive relation between termination charges and retail prices was also found in earlier literature (see for instance Hawthorne 2018). We include the residuals from the first stage regression in our demand estimation.

The estimation results for the multinomial and mixed logit models are shown in Table 2. The price coefficient is highly significant and negative in both models but a bit smaller for mixed logit. There is significant unobserved heterogeneity with respect to responsiveness to price, which is given by significant standard deviation for the price variable. We also allow observable individual characteristics to determine price responsiveness with the following findings. Higher-income consumers have a lower elasticity of demand than poorer consumers, which is intuitive. Black, Coloured and Indian consumers are more price-sensitive than White consumers. English- and Xhosa-speaking consumers are less price-sensitive than consumers speaking Sesotho and other official languages. It is important to note that in South Africa race and language variables are

correlated with income levels. While English speaking consumers have higher incomes, it is something of a puzzle that Xhosa-speaking consumers are also less price sensitive than other language groups. It appears as though this may be related to the fact that disproportionately more Xhosa-speaking consumers choose the MTN network, regardless of better priced alternatives. This may be due to MTN having better coverage in the Eastern Cape, where Xhosa-speaking consumers predominantly live.

We also include in the estimation a number of other control variables interacted with operator dummy variables and with a dummy variable for having a mobile phone. Consumers who live in cities and towns are significantly more likely to choose Telkom and Cell C than Vodacom and MTN, after controlling for quality of networks using operator dummy variables. Being employed, and self-employed particularly, as well as having a telephone at work, being young and having a computer all mean that consumers are more likely to take up a mobile service. Being older than 50 and having a landline telephone at home mean that taking up a mobile service is less likely. Being in almost any other province outside of the largely urban province of Gauteng makes taking up a mobile service less likely.

We use the estimates to compute individual-level price elasticities which are then aggregated using formulas shown in Section 5.1.2. The demand for mobile services is relatively elastic, as shown in Table 3. The own-price elasticities of demand are the highest for Telkom Mobile equal to -2.94, and the lowest for Vodacom at -2.14. The cross-price elasticities indicate that there are differing degrees of substitution between mobile operators. The largest networks MTN and Vodacom are closer substitutes to each other than to Cell C and Telkom. For instance, when MTN increases price a relatively greater share of consumers will go to Vodacom than to Cell C. On the other hand, when Cell C increases price, the shares of consumers going to Vodacom and MTN are comparable.

We also compute average price elasticities for all networks for different income groups and years, as shown in Table 4. Demand among low-income consumers is significantly more elastic than among high income consumers. Price elasticities decline over time for all network operators,

in line with falling prices (see Figure 3).

We use our demand estimates to compute marginal costs under the assumption of Nash-Bertrand equilibrium using equation (11). The imputed average marginal costs, average prices and markups in percentage terms for 2014 are shown in Table 5. Cell C and MTN have the highest mark-ups (86% and 81%), greater than Vodacom's (73%) and Telkom (48%). The average prices and estimated marginal costs decline over time but markups increase because the demand becomes less elastic.⁹

We use our demand estimates and marginal costs computed under Nash-Bertrand equilibrium to simulate how entry into the mobile market in South Africa impacted consumer welfare in different population segments. We also simulate the effects of a 'spectrum merger', currently proposed by the South African government (a monopoly wholesale open-access network operator, 'WOAN'). We do this using the iterated best-response algorithm. We consider two cases. First, we remove Telkom Mobile from the market. Telkom had a market share of around three percent in 2014, having entered in 2010, which suggests a very small impact of its presence on consumer welfare. In the second case, we also remove Cell C from the market, which leaves it with just two main competitors, MTN and Vodacom. The subscriber market share of Cell C in 2014 was around sixteen percent, with potentially much bigger impact on the consumer welfare. The simulations are conducted for 2014, the last year in our data.

We find that the entry of Telkom Mobile had minimal impact on equilibrium prices, consumer surplus and producer surplus, as shown in Tables 6 and 7. However, a merger to monopoly of all of the operators (the likely outcome of a spectrum merger into a monopoly WOAN) has significantly reduces consumer surplus. In the absence of Telkom, the average welfare loss per minute is slightly over half a cent, which is very little compared to the average price of a call in 2014, 68 cents per minute. Assuming that consumers make on average 1200 minutes of phone calls per annum (100 per month), the gain in consumer welfare due to the entry of Telkom amounts to 51 cents per month. This represents less than one percent of the average monthly bill for 100

⁹For comparison, we also compute marginal costs assuming collusion between all four market players. Given the high asymmetry in market shares, it is rather unlikely that Cell C and especially Telkom Mobile would take part in such an agreement. The resulting computed marginal costs are indeed negative for all firms.

minutes of R68, and significantly only 0.01 percent of average salaries and wages in South Africa which were around R5,000 per month in 2014. The increase in producer surplus (the increase in price, given constant marginal costs) did not compensate for the reduction in consumer surplus: producer surplus increased by a negligible amount (since prices did not increase significantly).

The average loss in consumer surplus in the absence of Cell C and Telkom is estimated at almost fourteen cents per minute. Assuming again 100 minutes of calls per month at an average price of R0.68 per minute and thus average bill of R68 per month, the average gain of entry represents 20 percent of the bill and 0.3 percent of average monthly income in 2014. Overall, we consider that the welfare effect of competition with the late entrants Cell C and Telkom is relatively small. The entrants did not price aggressively and were not able to acquire large market shares and challenge the position of dominant duopoly MTN and Vodacom. Producer surplus only increased by seven cents per minute (before accounting for the reduced probability of joining a network at all, discussed below), and so total welfare declined.

If the government were to proceed with implementing the Wholesale Open Access Network (a merger of all of the spectrum holdings owned by the mobile operators), consumer surplus declines substantially by around 56 cents per minute. This is compensated for to some degree by higher producer surplus generated by higher prices per minute (around 64 cents) when assessing total welfare. However, given the skewed patterns of ownership of assets in South Africa, the increase in producer surplus is likely to accrue to higher income consumers and not mitigate consumer surplus losses for lower-income consumers.

It is thus important to consider how consumer surplus from entry is distributed across income segments in the population. According to our estimates, the benefits of competition are not distributed equally in absolute terms. As shown in Table 6, the poorest consumers earning 2,500 Rands and less gained on average thirteen cents per call. Consumers earning between 2,500 and 5,000 Rands gained fourteen cents per call, between 5,000 and 10,000 Rands gained fifteen and those earning more than 10,000 Rands gained sixteen cents per minute. Relative to usage intensity, since high income consumers tend to use mobile services more intensively, they also

benefit respectively even more. There are also differences in gain in consumer surplus across race groups, as shown in Table 6. Black and Coloured people benefit on average thirteen cents per minute call, Indian people gain fourteen cents and White people gain fifteen cents. We get a similar picture when computing changes in consumer surplus by language groups, as shown in Table 6. Afrikaans-speakers benefit fourteen cents per minute call, English-speakers fifteen cents, Zulu-speakers fourteen cents, and Xhosa and Sesotho-speakers thirteen cents.

Next, we also use the model to simulate the impact of entry on mobile subscriptions in different population segments. We find that in the absence of Telkom, the uptake of mobile services in 2014 does not vary significantly from 90% and also across different population segments. In the absence of Telkom and Cell C, the penetration of mobile phone would drop to 86%. As shown in Table 7, these were mainly poor people who subscribed to mobile services after the entry. In the biggest segment of people earning 2,500 Rands and less, entry increased penetration from 82% to 87%. In the segment of people with earnings of 10,000 and above, penetration increased from 93% to 95%. Entry had different impact on subscriptions among people from different race and language groups. There are also some differences in how subscriptions changed in geographic regions. Consumers in the more-rural provinces of Gauteng, the Western Cape and Kwa-Zulu Natal benefited significantly more from the new entrants, which is unsurprising given their greater sensitivity to price.

Allowing the operators to merge their spectrum holdings into a WOAN results in a substantial reduction in mobile penetration, from around 90% in 2014 to around 64%. The effects are particularly acutely felt among low-income consumers earning less than R2,500 per month, among who mobile penetration would fall from 87% to 55%.

7 Conclusion

In this paper, we study distributional welfare effects of entry into mobile telecommunications in South Africa, which is a country with the highest level of inequality in the world. We use six waves of South African survey data of about 150,000 individuals collected between 2009 and

2014 and estimate a discrete choice model allowing for individual-specific price-responsiveness and preferences for network operators. We find that price sensitivity of subscriptions to mobile networks is impacted by income directly and by factors which indirectly determine individual wealth and social group such as race and language. We use the estimates of demand parameters and individual price-responsiveness to simulate market outcomes in the absence of new entrant, Telkom Mobile, which launched mobile services in 2010, and in addition without Cell C, which launched services in around 2002. We also simulate the effects of a merger to monopoly if the government were to proceed with a proposed wholesale open-access network, which would result in a substantial decrease in consumer surplus and mobile penetration, particularly among low-income consumers. While high-income asset-owning consumers would benefit from an increase in consumers, this is only enough to outweigh the reduction in consumer surplus in the event of a monopoly WOAN.

Based on our equilibrium model of demand and supply, we find that without entry of Telkom Mobile and Cell C the adoption of mobile phones in South Africa would be lower by about four percentage points in 2014. Thus, entry led to a relatively small increase in the total number of adopters. The positive effect of entry is higher for low-income groups. Without entry mobile penetration among high-income consumers would have been two percentage points lower in 2014, while penetration among low-income consumers would have been five percentage points lower. We also use the model to simulate changes in consumer welfare for different income groups and segments of society. We find that rich people benefited more from entry in terms of change in consumer welfare.

Our paper contributes to the literature by providing an equilibrium-based assessment of distributional welfare effects of entry in mobile telecommunications market in a country with extremely high income inequality. We find that while a ‘rising tide lifts all boats’, in that all consumers benefit from entry, high-income consumers benefit more. The mobile telecommunications industry is of particular importance in South Africa and other developing economies which lack fixed-line infrastructure to make phone calls and access Internet. The concerns with the

functioning of this industry resulted in market inquiry into competition in South Africa which was launched by the competition authority in October 2017. This paper provides an important evidence on the distributional effects of competition, which can be of use to the policy makers in South Africa and other countries. The policy implications of these results are that roaming agreements between small and large networks are not enough. Access to incumbent infrastructure and greater infrastructure sharing may be necessary if new entrants were to successfully roll out networks in low-income urban and rural areas, which could reverse the distributional welfare effects and bring more benefits to poor consumers.

References

- Aker, Jenny C and Isaac M Mbiti (2010). “Mobile phones and economic development in Africa”. In: *Journal of Economic Perspectives* 24.3, pp. 207–32.
- Aker, Jenny (2008). “Does digital divide or provide? The impact of cell phones on grain markets in Niger”. In:
- Argent, Jonathan and Tania Begazo (2015). “Competition in Kenyan markets and its impact on income and poverty: a case study on sugar and maize”. In:
- Baker, Jonathan B and Steven C Salop (2015). “Antitrust, competition policy, and inequality”. In: *Geo. LJ Online* 104, p. 1.
- Calandro, Enrico and Chenai Chair (2016). “Policy and regulatory challenges posed by emerging pricing strategies”. In: *Information Technologies & International Development* 12.2, pp–13.
- Cardona, Mélisande, Anton Schwarz, B Burcin Yurtoglu, and Christine Zulehner (2009). “Demand estimation and market definition for broadband Internet services”. In: *Journal of Regulatory Economics* 35.1, pp. 70–95.
- Deaton, Angus (1988). “Quality, quantity, and spatial variation of price”. In: *The American Economic Review*, pp. 418–430.
- Economides, Nicholas, Katja Seim, and V Brian Viard (2008). “Quantifying the benefits of entry into local phone service”. In: *the RAND Journal of Economics* 39.3, pp. 699–730.
- Genakos, Christos, Tommaso Valletti, and Frank Verboven (2018). “Evaluating market consolidation in mobile communications”. In: *Economic Policy* 33.93, pp. 45–100.
- Grzybowski, Lukasz and Julianne Liang (2015). “Estimating demand for fixed-mobile bundles and switching costs between tariffs”. In: *Information Economics and Policy* 33, pp. 1–10.
- Grzybowski, Lukasz, Rainer Nitsche, Frank Verboven, and Lars Wiethaus (2014). “Market definition for broadband internet in Slovakia—Are fixed and mobile technologies in the same market?” In: *Information Economics and Policy* 28, pp. 39–56.
- Hawthorne, Ryan (2018). “The effects of lower mobile termination rates in South Africa”. In: *Telecommunications Policy* 42.5, pp. 374–385.

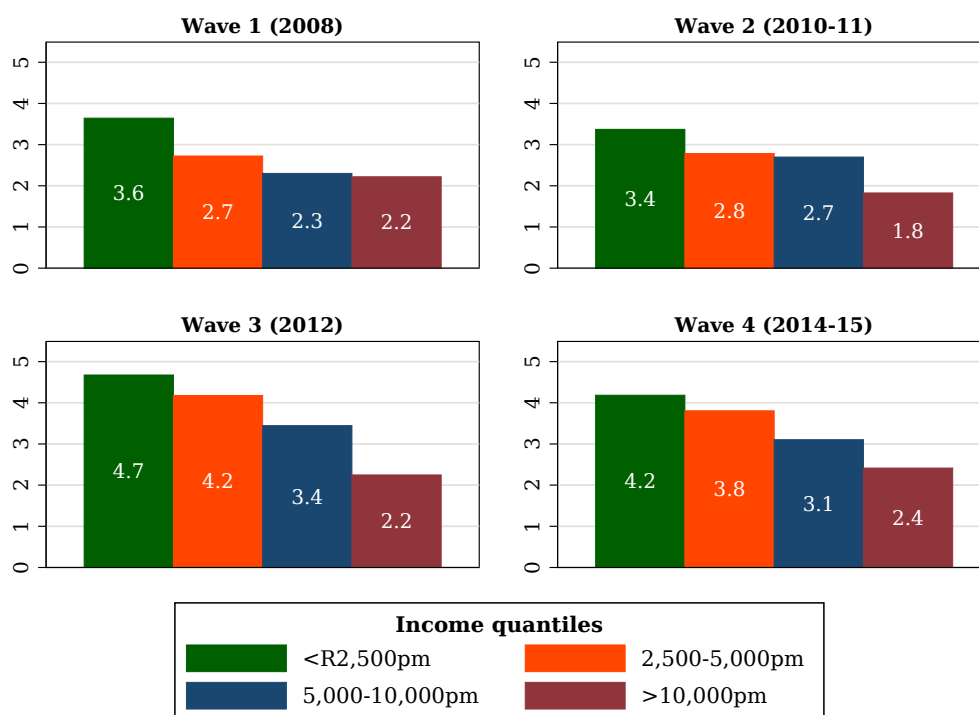
- Jensen, Robert (2007). “The digital divide: Information (technology), market performance, and welfare in the South Indian fisheries sector”. In: *The quarterly journal of economics* 122.3, pp. 879–924.
- Klonner, Stefan and Patrick J Nolen (2010). “Cell phones and rural labor markets: Evidence from South Africa”. In:
- Leibbrandt, Murray, Ingrid Woolard, Arden Finn, and Jonathan Argen (2010). “Trends in South African income distribution and poverty since the fall of apartheid”. In:
- Muto, Megumi (2012). “The impacts of mobile phones and personal networks on rural-to-urban migration: Evidence from Uganda”. In: *Journal of African Economies* 21.5, pp. 787–807.
- Muto, Megumi and Takashi Yamano (2009). “The impact of mobile phone coverage expansion on market participation: Panel data evidence from Uganda”. In: *World development* 37.12, pp. 1887–1896.
- Nicolle, Ambre, Lukasz Grzybowski, and Christine Zulehner (2018). “Impact of competition, investment and regulation on prices of mobile services: evidence from France”. In: *Economic Inquiry*.
- Petrin, Amil and Kenneth Train (2010). “A control function approach to endogeneity in consumer choice models”. In: *Journal of marketing research* 47.1, pp. 3–13.
- Research ICT Africa (2010-2015). *RIA African Mobile Pricing 2010-2015*. [dataset]. Cape Town: DataFirst [distributor]. International Development Research Centre [funding agency]. URL: <https://www.datafirst.uct.ac.za/dataportal/index.php>.
- Roller, Lars-Hendrik and Leonard Waverman (2001). “Telecommunications infrastructure and economic development: A simultaneous approach”. In: *American economic review* 91.4, pp. 909–923.
- South African Audience Research Foundation (SAARF) (2009-2014). *All Media Products Survey 2009 - 2014, Waves 1-4*. [dataset]. Cape Town: DataFirst [distributor]. URL: <https://www.datafirst.uct.ac.za/dataportal/index.php>.

- Southern Africa Labour and Development Research Unit (2008-2016). *National Income Dynamics Study 2008 - 2015, Waves 1-4*. [dataset] versions 6.1(w1), 3.1(w2), 2.1(w3), 1.1(w4). Cape Town: DataFirst [distributor], 2016. Cape Town: Southern Africa Labour and Development Research Unit [implementer], 2016. Pretoria: Department of Planning Monitoring and Evaluation, SA Presidency [funding agency]. URL: <https://www.datafirst.uct.ac.za/dataportal/index.php>.
- Train, Kenneth E (2009). *Discrete choice methods with simulation*. Cambridge university press.
- Wodon, Quentin and Hassan Zaman (2009). “Higher food prices in Sub-Saharan Africa: Poverty impact and policy responses”. In: *The World Bank Research Observer* 25.1, pp. 157–176.

A Appendix

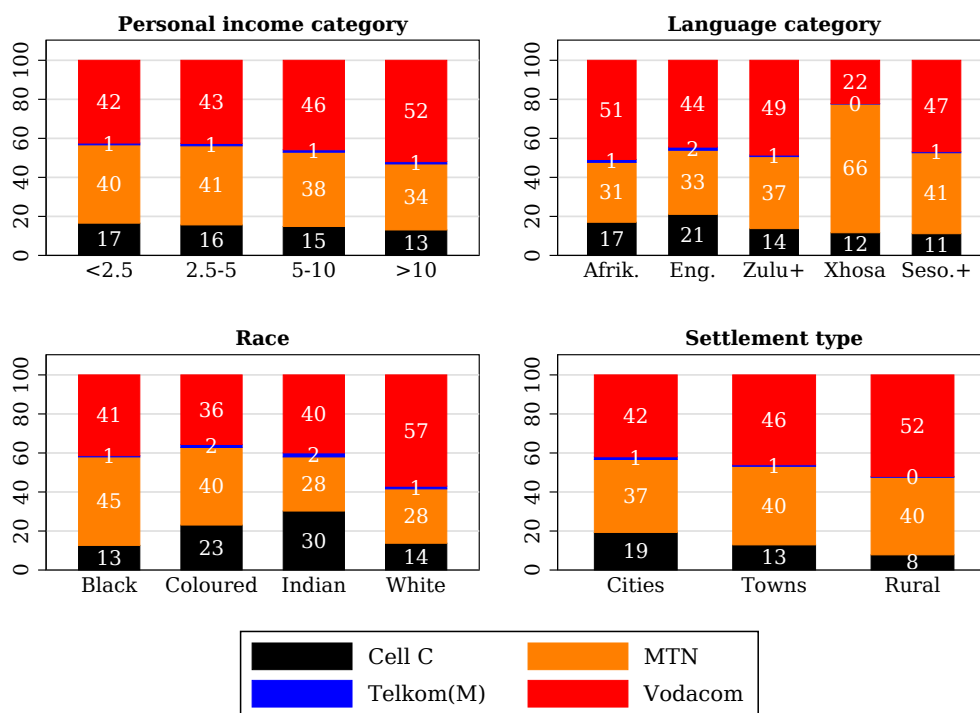
A.1 Figures

Figure 1: Share of spend on mobile by income segments



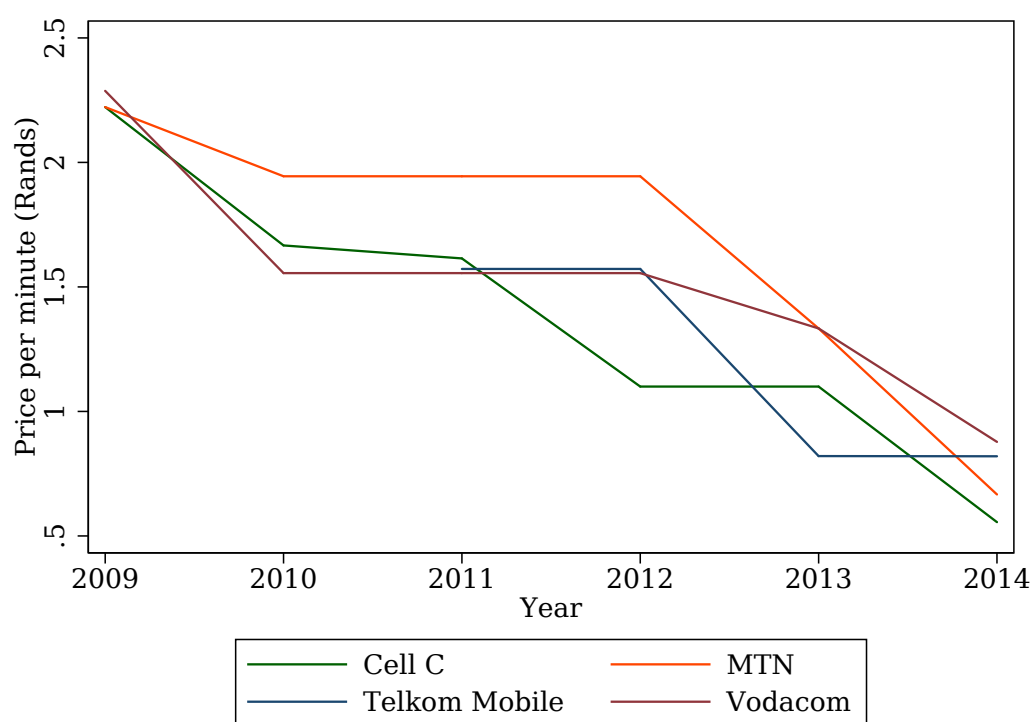
Source: NIDS survey waves 2008-2015. Net income levels per month.

Figure 2: Operator market share by income quartile (2014)



Source: AMPS survey 2009-2014.

Figure 3: Operator minimum prepaid prices (2009-2014)



Sources: Research ICT Africa, Tarifica and archive.org.

A.2 Data tables

Table 1: Control function estimation results

		Coeff.	(STD)
Termination cost		0.68*	(0.34)
Cell C		0.29	(0.25)
MTN		1.00***	(0.21)
Telkom		0.67*	(0.26)
Vodacom		0.67**	(0.20)
Prepaid		0.26	(0.19)
Postpaid*	Medium	0.04	(0.15)
	High	0.17	(0.19)
Cell C*	Prepaid	0.42+	(0.24)
	Medium	0.14	(0.22)
	High	0.27	(0.24)
MTN*	Prepaid	0.14	(0.24)
	Medium	-0.07	(0.22)
	High	0.05	(0.24)
Vodacom*	Prepaid	0.35	(0.24)
	High	0.08	(0.24)
Telkom*	Medium	-0.07	(0.24)
2009		-0.01	(0.13)
2011		-0.10	(0.10)
2012		-0.10	(0.12)
2013		-0.19	(0.14)
2014		-0.26	(0.17)
Constant		0.11	(0.13)
Number of obs		94	
R-squared		0.79	

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 2: Estimation results

		Conditional logit		Mixed logit	
		Coeff.	(STD)	Coeff.	(STD)
Price		-2.72***	(0.05)	-2.66***	(0.05)
SD Price				0.35***	(0.04)
Price*	Black	-0.08**	(0.03)	-0.07*	(0.03)
	Coloured	-0.32***	(0.02)	-0.34***	(0.02)
	Indian	-0.49***	(0.02)	-0.52***	(0.02)
	Income5-10	0.25***	(0.01)	0.26***	(0.02)
	Income10-20	0.35***	(0.02)	0.37***	(0.02)
	Income20+	0.42***	(0.02)	0.44***	(0.02)
	Afrikaans	0.01	(0.03)	0.01	(0.03)
	English	0.14***	(0.03)	0.15***	(0.03)
	Zulu+	-0.02	(0.02)	-0.02	(0.02)
	Xhosa	0.16***	(0.02)	0.17***	(0.02)
Cell C		2.71***	(0.07)	2.71***	(0.07)
MTN		5.21***	(0.08)	5.18***	(0.08)
Telkom		-0.29+	(0.15)	-0.29+	(0.15)
Vodacom		4.99***	(0.07)	4.97***	(0.07)
Towns*	CellC	0.80***	(0.04)	0.81***	(0.04)
	MTN	0.38***	(0.02)	0.41***	(0.03)
	Telkom	0.79***	(0.15)	0.84***	(0.15)
	Vodacom	0.35***	(0.02)	0.35***	(0.03)
Cities*	CellC	1.23***	(0.04)	1.24***	(0.04)
	MTN	0.50***	(0.03)	0.55***	(0.03)
	Telkom	1.17***	(0.15)	1.26***	(0.15)
	Vodacom	0.41***	(0.03)	0.41***	(0.03)
Cell*	Age26-50	-0.02	(0.02)	-0.03	(0.02)
	Age51-65	-0.55***	(0.02)	-0.59***	(0.03)
	Age65+	-1.30***	(0.03)	-1.38***	(0.03)
	Male	-0.38***	(0.02)	-0.40***	(0.02)
	Working	0.45***	(0.02)	0.46***	(0.03)
	Self-employed	0.34***	(0.04)	0.33***	(0.04)
	Telephone-home	-0.15***	(0.02)	-0.20***	(0.02)
	Telephone-work	0.60***	(0.04)	0.60***	(0.04)
	Computer	0.47***	(0.02)	0.47***	(0.02)
	WesternCape	-0.29***	(0.03)	-0.29***	(0.03)
	NorthernCape	-0.70***	(0.04)	-0.74***	(0.04)
	FreeState	-0.17***	(0.03)	-0.18***	(0.04)
	EasternCape	-0.82***	(0.03)	-0.85***	(0.03)
	KwaZuluNatal	-0.06*	(0.03)	-0.06*	(0.03)
	Mpumalanga	0.43***	(0.05)	0.46***	(0.05)
	Limpopo	-0.06	(0.04)	-0.03	(0.04)
	NorthWest	-0.07+	(0.04)	-0.06	(0.04)
Control function		2.72***	(0.05)	2.65***	(0.05)
Number of obs		697836		697836	
Log-likelihood		-181681		-181681	

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 3: Own-price and cross-price elasticities, by operator - mixed logit

Operator	Cell C	MTN	Telkom	Vodacom
Cell C	-2.92	1.39	0.02	1.47
MTN	0.34	-2.38	0.02	1.29
Telkom(M)	0.35	1.36	-2.94	1.39
Vodacom	0.37	1.32	0.02	-2.14

Table 4: Own-price elasticity of demand by income group (2009 - 2014) - mixed logit

Income group	2009	2010	2011	2012	2013	2014	Mean
<2.5	-2.71	-2.33	-2.39	-2.34	-1.90	-1.21	-2.14
2.5-5	-2.60	-2.24	-2.26	-2.17	-1.75	-1.11	-2.02
5-10	-2.44	-2.14	-2.15	-2.06	-1.65	-1.06	-1.92
>10	-2.28	-2.05	-2.06	-1.97	-1.54	-1.04	-1.82
Total	-2.61	-2.26	-2.29	-2.22	-1.78	-1.14	-2.05

Table 5: Operator average prices, marginal costs and mark-ups (2014) - mixed logit

Operator	Mean price ZAR/min	Marginal cost ZAR/min	Mark-up %
Cell C	0.58	0.11	81
MTN	0.70	0.10	86
Telkom	0.82	0.43	48
Vodacom	0.88	0.24	73

Table 6: Change in prices, consumer surplus and producer surplus (2014) - mixed logit

	Mean price	No Telkom			No Telkom, Cell C			Spectrum merger			N
		Price	ΔCS	ΔPS	Price	ΔCS	ΔPS	Price	ΔCS	ΔPS	
Income											
<2,500	0.65	0.65	-0.00	0.00	0.72	-0.13	0.06	1.25	-0.52	0.61	13487
2,5-5,000	0.69	0.69	-0.01	0.00	0.77	-0.14	0.07	1.33	-0.58	0.65	3319
5-10,000	0.72	0.72	-0.01	0.00	0.81	-0.15	0.07	1.38	-0.60	0.66	3693
>10,000	0.76	0.76	-0.01	0.00	0.86	-0.16	0.08	1.45	-0.64	0.69	4284
Race											
Black	0.68	0.68	-0.01	0.00	0.76	-0.13	0.07	1.32	-0.56	0.64	13033
Coloured	0.61	0.61	-0.00	0.00	0.67	-0.13	0.06	1.21	-0.51	0.60	3508
Indian	0.64	0.64	-0.00	0.00	0.72	-0.14	0.06	1.28	-0.56	0.64	1751
White	0.73	0.73	-0.01	0.00	0.82	-0.15	0.07	1.38	-0.59	0.65	6491
Language											
Afrikaans	0.67	0.67	-0.00	0.00	0.75	-0.14	0.07	1.29	-0.54	0.62	6473
English	0.69	0.69	-0.01	0.00	0.78	-0.15	0.07	1.35	-0.59	0.66	5875
Zulu+	0.70	0.71	-0.01	0.00	0.79	-0.14	0.07	1.35	-0.58	0.65	3865
Xhosa	0.60	0.61	-0.01	0.00	0.67	-0.13	0.06	1.20	-0.52	0.60	2974
Sesotho+	0.71	0.71	-0.01	0.00	0.79	-0.13	0.07	1.35	-0.57	0.65	5596
Province											
W. Cape	0.66	0.66	-0.01	0.00	0.73	-0.14	0.06	1.29	-0.55	0.63	3449
N. Cape	0.63	0.63	-0.00	0.00	0.69	-0.12	0.06	1.21	-0.49	0.59	1216
F. State	0.69	0.69	-0.00	0.00	0.77	-0.14	0.07	1.32	-0.56	0.64	1911
E. Cape	0.60	0.60	-0.00	0.00	0.65	-0.13	0.06	1.19	-0.48	0.59	3466
KZN	0.66	0.66	-0.01	0.00	0.75	-0.14	0.07	1.31	-0.57	0.65	4496
Mpumal.	0.77	0.77	-0.01	0.00	0.86	-0.13	0.08	1.42	-0.61	0.65	1403
Limpopo	0.77	0.77	-0.00	0.00	0.86	-0.12	0.07	1.42	-0.56	0.65	1437
Gauteng	0.72	0.72	-0.01	0.00	0.81	-0.16	0.07	1.38	-0.61	0.66	6034
N. West	0.70	0.70	-0.00	0.00	0.78	-0.12	0.07	1.34	-0.55	0.64	1371
Total	0.68	0.68	-0.01	0.00	0.76	-0.14	0.07	1.32	-0.56	0.64	24783

Table 7: Mobile penetration (%) with and without entry (2014) - mixed logit

	Actual	No Telkom	No Telkom, Cell C	Spectrum monopoly	N
Income					
<2,500	87	87	82	55	13487
2,5-5,000	91	91	87	67	3319
5-10,000	92	92	89	73	3693
>10,000	95	95	93	82	4284
Race					
Black	90	90	86	64	13033
Coloured	86	86	81	54	3508
Indian	90	90	86	61	1751
White	91	91	88	72	6491
Language					
Afrikaans	88	88	84	62	6473
English	92	91	88	70	5875
Zulu+	92	91	88	66	3865
Xhosa	86	86	81	57	2974
Sesotho+	91	90	87	64	5596
Province					
W. Cape	89	89	85	63	3449
N. Cape	84	84	79	52	1216
F. State	90	90	86	65	1911
E. Cape	83	82	77	51	3466
KZN	91	91	87	65	4496
Mpumal.	94	94	92	74	1403
Limpopo	90	90	87	63	1437
Gauteng	93	93	90	72	6034
N. West	90	90	86	63	1371
Total	90	90	86	64	24783