The Impact of Telecommunication Regulatory Policy on Mobile Retail Price in Sub-Saharan African Countries

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Abstract

This paper examines the effect of regulatory policies on mobile retail prices. Using quarterly data for 8 African countries for the period 2010:Q4 to 2014:Q4 we estimate structural demand and supply equations. We find that mobile termination rates (MTR) have significant positive impact on mobile retail prices. A decline in average MTR of 10% decreases average mobile retail prices by 2.5%. On the other hand, mobile number portability (MNP) has an insignificant effect on price and subscriptions in selected African countries. This may be due to inadequate implementation of MNP and consecutively low demand for porting numbers. The average market conduct in mobile telecommunications industry for selected African countries can be approximated by Cournot Nash equilibrium, while price elasticity of demand is on average -0.27.

Keywords: mobile telephony, regulation, market conduct

JEL Classification: L31, L43, L52, L96

1 Introduction

Switching costs and mobile termination rates (MTRs) are the focal point of many telecommunication regulatory policies and antitrust cases.[1] Switching costs bias consumers' choices towards previously selected products and services. This, in turn, reduces their responsiveness to price and allows firms to charge higher prices. In an effort to reduce switching costs in mobile telecommunications markets, many regulatory authorities worldwide introduced mobile number portability (MNP), which allows consumers to take their mobile phone numbers with them when changing to a different mobile operator.

On the other hand, MTRs refer to charges which are set by mobile operators for terminating calls on each others' networks. Although the MTRs have a direct impact on mobile retail prices, they are not observed by the consumers who make subscription decisions without taking them into consideration. Therefore, each network is a de facto monopoly for termination of calls, which can be a source of collusion.[2] The regulatory authorities generally recognize this fact and intervene by regulating MTRs.

In spite of the importance of MNP and MTRs, we are not aware of any economic literature which provides an assessment of the effect which these policies have on prices and competition in low income countries. This gap in the literature is largely due to the scarcity of data on the telecommunication market in these countries. Our study contributes to the literature by examining the effect of MNP and MTRs on pre-paid mobile phone service prices in Sub-Saharan African countries. Our approach is similar to Parker & Röller (1997) and Grzybowski (2005) who, assuming that mobile services are homogenous products, applied a static Cournot model to study competition in mobile telecommunication market. In particular, Grzybowski (2005) analyzes the impact of MNP on mobile retail prices for a number of European countries. However, in the

[1] Klemperer (1987a), Klemperer (1987b) and Klemperer (1987c) extensively discusses the theory of switching costs. Switching costs refer to costs which inhibit consumers from changing products and services, which in general allows firms to set prices above marginal costs. Grzybowski (2008b) states that switching costs in the mobile telecommunication market arise from incompatability, transaction and search costs.

[2] For example, a number of African regulatory authorities have adopted a glide path in MTR regulation. This is a policy which requires operators to reduce the charges they set for terminating calls on each other's networks over time.

estimation, he does not control for country-specific MTRs as a determinant of marginal costs, but instead uses country-specific cost dummies to take into account differences in marginal costs between countries. In this study, we control for differences in marginal costs in terms of country-specific MTRs.

We estimate a structural model of demand and supply using quarterly time series data between 2010:Q4 and 2014:Q4 for eight African countries. The data was constructed by aggregation of firm level information for 35 mobile operators which are active in these countries.

On the supply side, we find that MTRs have a significant and positive impact on mobile retail prices. On average a 10% increase (decrease) in MTRs will result in a 2.5% increase (fall) in prices. This result opposes the waterbed effect theory, which was tested for telecommunications markets by Genakos & Valletti (2011). The waterbed effect theory suggests that in two-sided markets when prices in one market are pushed down by regulatory controls, the prices in the unregulated market will increase towards monopoly prices. This holds when demand or marginal costs are interdependent; firms use non-linear pricing or there is a zero-profit constraint (see (Schiff, 2008)). Thus, pushing down the price in the regulated market, in other words, the termination rate, does not increase unregulated mobile retail prices in the group of countries used in this analysis. Our result supports the glide path termination rate policy. A glide path in termination rate refers to regulated price control where regulators mandate operators to reduce termination rate charges over time rather than an immediate move to to the cost-oriented level. This allows operators time to plan for the decreased revenue from mobile termination charges. This policy is expected to offer stability as compared to a one-off shock if the difference between the existing MTRs and the cost-orientated MTRs is great. [3] Moreover, we do not find that MNP has a significant negative impact on retail prices for the selected African countries, which contrast with the results found by Grzybowski (2005), Park (2011) and Cho et al. (2013) for European countries. This may be due to less effective implementation of MNP in African countries and consequently lower attractiveness and take up of this option by consumers. For instance, even though it has been found that the effectiveness of MNP depends on porting time and charges, the porting process in Africa is characterized by long porting time. Furthermore,

[3]This policy has been implemented by a number of countries worldwide, including the United Kingdom, Botswana, Ghana, Kenya, South Africa, Tanzania and Zambia

in some countries such as Nigeria, subscribers are not allowed to port again for the next three months.

On the demand side, we find that MNP does not change the responsiveness of consumers to price, a result which coincides with our findings on the supply side. This may be due to the fact that in many African countries, it is common to use multiple subscriber identity module (SIM) cards.[4] A household survey, conducted by ResearchICTAfrica in different African countries in 2008, reports that 36.3% of adult mobile phone subscribers hold more than one SIM card in Benin, 25.8% in Kenya and only 2.9% in Mozambique (see (ResearchICTAfrica, 2008)). Hence, many consumers are connected to two or more operators with low demand for porting numbers. We estimate the price elasticity of demand to be on average -0.27. We use the estimate of price elasticity to approximate the average market conduct parameter in the selected African countries, which takes value of 1.29.

The remainder of this Chapter is as follows. Section 2 discusses theoretical and empirical literature on MNP and MTRs. Section 3 provides an overview of MNP, regulation and termination rates. Section 4 presents our data. Section 5 introduces the empirical model. Section 7 presents estimation results and finally Section 8 concludes.

2 Literature Review

There is a large theoretical literature on switching costs.[5] Among the few empirical studies that estimate the existence of switching costs in the telecommunication industry, Grzybowski (2008b) uses a multinomial logit and a mixed logit approach based on stated preferences to estimate switching cost in the UK mobile telephony market. His findings suggest that the UK telecommunications market is characterized by significant switching costs. In a later study, Grzybowski & Pereira (2011) use a series of multinomial and mixed logit techniques on a panel data of Portuguese subscribers to test the existence of switching costs in the mobile phone market. Similar to Grzybowski (2008b), they find that switching costs are an important element

[4] Although in Botswana the population is estimated to be around 2 million, the number of active SIM cards is about 3.5 million. For statistics on active SIM cards see www.itu.int. Popular use of multiple SIM cards from different operators has delayed the implementation of MNP, with the authority not convinced of the facility's economic benefits (see www.budde.com.au).

[5] See, for instance, Klemperer (1987a,b), Beggs & Klemperer (1992) and Chen & Rosenthal (1996).

of mobile telecommunications market structure. However, these studies do not consider the impact of MNP on switching costs.

Another strand of literature study switching costs in the context of number portability. Some of these studies use individual level data to examine the effectiveness of MNP. These studies find that the implementation of MNP significantly lower switching costs ((Shy, 2002; Lee et al., 2006)). However, these studies do not provide evidence on how MNP affects market outcomes. To fill this gap in the literature, Lyons et al. (2006) use international time-series and cross-section data to test the impact of MNP on switching costs. They find that MNP reduces switching costs when the switching process is rapid. In countries where the switching process is slow, MNP does not reduce switching costs. However, this study does not control for country specific porting charges and uses a five day cutoff for MNP to be considered effective, which is arbitrary. Sánchez & Asimakopoulos (2012) investigate the effectiveness of MNP in thirteen European countries using yearly country level data for years 2000-2009. Similar to Lyons et al. (2006), they show that MNP effectiveness is determined by both porting time and charges.

The aforementioned studies do not provide evidence on how prices and consumer welfare changes in the presence of MNP. Shi et al. (2006) presents a theoretical model for testing the impact of MNP on price and market concentration, and provide empirical evidence. In support of other empirical studies, they find MNP has a negative impact on prices. On the contrary, Shi et al. (2006) find that rather than helping small firms grow, as intended, the introduction of MNP accelerates the process of market concentration. This finding can be attributed to price discrimination across on-net and off-net charges. A paper by Viard (2007) analyzes the impact of reducing switching costs when there is a large proportion of new consumers. Using data on the toll-free service market, he finds that a reduction of switching costs leads to less competition in the market. The study concludes that the reduction of prices after the implementation of MNP implies less competition.

Focusing on European mobile telecommunications, Cho et al. (2013) examine the impact of MNP on price and market concentration. Using quarterly data for 47 mobile operators in 15 countries between 1999-2006 they conclude that MNP reduces market concentration by tightening price range and reduces large firms' market share. Moreover, when MNP is introduced smaller firms reduce prices more than large firms.

Nevertheless, Cho et al. (2013) state that prices of mobile phone services have been declining over the past years. It is, therefore, hard to determine whether the introduction of MNP contributed to this. They do not control for any other factors which might have caused this decline. In this study we control for some factors that could have led to this decline. Among the factors that could have contributed to a decline in mobile prices is the reduction of MTRs, which are the main component of marginal costs. Over the past decades, a number of regulatory authorities intervened in the MTRs market as a way of reducing mobile retail prices. However, existing literature that examines the impact of MNP on prices fails to account for MTRs in the empirical analysis.

Another branch of literature which relates to our study is the literature that examines the impact of mobile termination rates on prices. Using panel data of mobile operators' prices and profit margins, Genakos & Valletti (2011) test the waterbed effect in the mobile telecommunication market. They find a negative relationship between fixed-to-mobile termination rates and mobile retail prices. In a later study, Genakos & Valletti (2015) re-evaluate the existence of the waterbed effect in the mobile phone market. Contrary to their initial finding, their results predict a positive relationship between mobile-to-fixed termination rates and mobile retail prices. They attribute this result to changing telecommunication industry characteristics such as the reduction of fixed-line market share. The focus of these two studies is on fixed-to-mobile termination rates.

Other studies focused on mobile-to-mobile termination rates. Using data on mobile termination rates from 2001-2003, Dewenter & Haucap (2005) examine the effect of regulating termination rates when networks have asymmetric sizes. They find that in markets where consumers are ignorant about MTRs, smaller networks charge higher MTRs. They also find that asymmetric regulation of larger operators induces smaller operators to increase their termination rates. Their study, however, does not provide clear evidence on how regulation of MTRs might affect retail prices and consumer welfare.

Cricelli et al. (2012) examine the economic justification of regulating MTRs. They find that symmetric MTRs decreases lead to a reduction in retail prices and enhance consumer welfare. Andersson et al. (2016) show that the increase in one operator's MTR increases its profitability, but when firms offer bundles with fixed-line an identical change in all MTRs does not affect firms' retail prices or profits. The shortcoming of this paper is that, it does not provide evidence on whether reduction in MTRs will be an effective instrument to reduce prices.

Grzybowski (2005) study is similar to ours in that it studies the impact of regulatory policy including MNP on mobile retail prices in Europe. This study considers price as a function of market power and marginal costs, where MNP is considered to influence market power and other regulatory policies affect marginal costs. However, this analysis does not include MTRs as a determinant of marginal costs, but relies on a set of country specific dummy variables instead.

The contribution of this chapter is as follows. For our empirical analysis, we focus on selected African countries for years 2010-2014. The most distinguishing part of our study from prior work on MNP is that we estimate a demand and supply model which includes MTRs and MNP among explanatory variables. We model MNP as a policy that affects switching costs, while MTRs affect marginal costs.

3 Telecommunications Policy in Africa

3.1 Mobile Number Portability

As of 2012, 73 countries have implemented MNP.[6] The first county in Africa to introduce MNP was South Africa in 2006. Table 1 shows the timing of MNP adoption in nine African countries.[7]

In contrast to industrialized countries, MNP has not reached its potential and its performance has not been effective in Africa, with Ghana as the only exception. Although Ghana launched its MNP scheme in 2011, until 2014 the number of successfully completed ports amounted to 1,655,404. Among these ports a total of 832,202 were completed in 2014. As of 2014, after only

[6] see mcclist.com

[7] The first country to adopt MNP is Singapore in 1997. However, this facility was only call forwarding (see, (Bühler & Haucap, 2004)). To use the facility, one had to have two mobile phone numbers at the same time. A more structural MNP based on a centralized data base was introduced in the UK , Hong Kong, and the Netherlands as early as 1999 (Cho et al., 2013). Singapore adopted a structured MNP in 2008 ((Cho et al., 2013)). The benefits of MNP has been widely seen in Turkey. Since the implementation of MNP in 2008, Turkcell has been consistently loosing its subscribers to rivals Avea and Vodafone. Turkcell attributed this trend to the fact that its competitors continued to push for lower prices and offered high incentives through bundled packages which in combination with the ease of switching operators via MNP led to the operator's market share declining from 56% in 2008 to 51% in 2013 (see gsmaintelligence.com)

Table 1: African Countries with MNP

Country	**Time**	**Country**	**Time**
Egypt	07/04/2008	Nigeria	01/01/2007
Ghana	07/07/2011	South Africa	10/11/2006
Kenya	01/07/2011	DRC	30/09/2009
Morocco	01/01/2007	Sudan	01/11/2012

Source: mcclist.com
Notes: Table 1 presents African countries with mobile number portability. In column (1), we present the date at which number portability was implemented in each country.

3 years, the total number of completed ports stood at 6% of the total active mobile numbers. For comparison, it has taken 7 years for South Africa to reach 5% porting rate.

A number of factors differentiate the MNP implementation in Ghana from the rest of the African countries, which includes the speed of processing requests and the time allowed to do another port after completing the previous one. By 2014, on average it took 4 minutes and 16 seconds to complete the porting process. For comparison, in Nigeria, the process took 48 working hours. In Ghana, the implementation of MNP has brought changes in market shares. In particular, between 2011 and 2014, MTN, the largest operator, lost 402,244 subscribers (a net loss of 3%), while the smaller operators Tigo and Vodacom, gained 249,725 (6.2%) and 228,183 (3.4%) subscribers respectively.

In Sub-Saharan Africa, the MNP is only available in large markets, namely, South Africa, Kenya and Nigeria. In Kenya, MNP policy was implemented in 2011 with the objective of reducing Safaricom's market power, which controlled more than 75% market share at that time. Since the uptake of MNP has been low since inception, some market specialists have labeled it a failed policy. The request for porting peaked in January 2012, but thereafter declined to reach its lowest level in November 2013. A gradual increase in demand for ports was later registered in January 2014. However, the policy had an impact on operators' market shares. By 2014, small companies gained substantial market share from the dominant operator, Safaricom. The market share of Safaricom subsequently reduced from 79% to 68%, with the other three companies owning the remaining 32%.

A number of factors contribute to unsuccessful performance of MNP in Africa. For instance, in South Africa the regulator awarded the licence of operating MNP to a company owned by one of the operators. As such, the results of porting is prone to being unduly influenced by that operator. The Nigerian MNP is also far from being a success. The poor performance of the policy in Nigeria could be due to long porting time and the fact that consumers are not allowed to port again for the next three months. Though Nigeria has a much larger subscription base, the number of ports amounted to 115,000, compared to 363,000 ports in Ghana.[8]

3.2 Mobile Termination Rates

Termination rates are prices that carriers charge for terminating or completing calls on each others' network. These charges form part of operators' cost of providing calls to its customers. These rates may be commercially negotiated or may be regulated. In some countries, the regulator only facilitates termination negotiations but cannot set termination charges. The regulator only set termination rates when operators fail to reach an agreement.

The approach to regulating MTRs adopted by most regulatory authorities allows for total cost recovery based on fully allocated cost models (Harbord & Pagnozzi, 2010). In Kenya, for instance, the authority regulates termination charges using a pure-long-run incremental cost (pure-LRIC). In Botswana, the authority uses long-run incremental charges plus (LRIC+). This approach has been adopted by Ofcom in the UK. In both schemes, the regulators set cost by comparing calculated costs to a hypothetical efficient new entrant. The difference between these two approaches is in the calculation costs with the pure-LRIC considering the marginal costs while under the LRIC+, the regulator sets termination rates based on detailed costs which include common costs.

The main reason regulating termination rates is to avoid a welfare distortion in the structure of price. If left unregulated, operators might be incentivized to exploit their monopoly power in call termination to gain excessive profits. These profits may in turn be used to subsidize subscriber acquisition costs (Harbord & Pagnozzi, 2008). This is an issue that is frequently discussed in the waterbed effects theory, whereby an increase in termination rates leads to a decline in retail prices (Armstrong & Wright, 2009).

[8] All the African number portability statistics come from this article : www.balancingact-africa

However, a number of regulatory authorities have been taken to court over termination rates. In South Africa, for instance, Cell C summoned the regulator to court claiming that the way Independent Communications Authority of South Africa (ICASA) set termination rates is an acknowledgement that the duopoly that exists in South Africa is acceptable and should be allowed to continue.[9] Cell C's proposition was that, the regulator must implement an asymmetric termination rates system in which the two largest operator (MTN and Vodacom) terminate Cell C calls at a price lower than what Cell C charges.

In 2009, MTN Uganda through court proceeding, blocked the regulator from imposing new reduced termination rates. Their argument was that the regulator should only facilitate discussion, but not impose an outcome on the companies. MTN argued that the only time the regulator should intervene is when the operators themselves cannot come to an agreement. As of 2011, MTN Uganda threatened to stop accepting phone calls from its network to Uganda Telecom (UTL) over claims of unpaid bills for termination charges.[10]

4 Data

We estimate demand and supply specifications using a unique quarterly time series data between 2010:Q4 to 2014:Q4 for eight African countries: Botswana, Ghana, Kenya, Mozambique, Nigeria, South Africa, Tanzania and Zambia. The sampled countries were selected based on market characteristics, wholesale regulatory policies and availability of data. For instance, all countries in the sample have adopted a glide path termination rates policy. We do not include North African countries in our sample due to their differences in the market industry characteristics. North African countries adopt the Arab telecommunication standards and in some instance their calls are terminated in other countries such as France.

Countries with monopoly and those that have licensed only two operators were also not considered in the sample on the basis that they are less likely to adopt MNP. To be precise, countries with one operators, such as Ethiopia and Swaziland, cannot adopt MNP, while those with two operators are likely not to implement this facility due to high costs. The cost of operating an MNP facility are likely to be higher than the benefits to subscribers in markets

[9] http://www.moneyweb.co.za/uncategorized/icasa-finalises-new-call-termination-rates/

[10] http://www.cellular-news.com/story/Operators/48234.php

with a small number of operators. Furthermore, our sample is also determined by the availability and consistency of data. For instance, MTRs data is very scarce and were able to collect MTRs for nine countries. We could not include Uganda in the sample due to price data inconsistencies.

The data was constructed by aggregation of firm level information for 35 mobile operators which are active in the selected countries. Data on pre-paid retail prices was gathered from Research ICT Africa (RIA), while operators' pre-paid subscriber base and population were obtained from World Cellular Information Services (WICS). Fixed line subscriptions were obtained from the International Telecommunication Union (ITU). We used different data sources to gather termination rates data. The data sources are presented in Table 3.

The variables used in the study can be grouped into regulatory and non-regulatory. The regulatory variables include: country-level mobile termination rates (MTRs) in US$PPP and a dummy variable for the implementation of mobile number portability (MNP)in a country. The non-regulatory variables are pre-paid mobile subscriptions (Subs), population (Pop), GDP per capita (GDP) in US$PPP, mobile retail prices for pre-paid services in US$PPP and fixed penetration (Fixed). We transform the variables Subs, Pop, GDP and Fixed using logarithms. They are then used as explanatory variables in the demand equation. These variables were also used in previous studies, see for instance Gruber & Verboven (2001) and Grzybowski (2005). Table 2 presents summary statistics of the above discussed variables.

Table 2: Simple Statistics

Variable	N	Mean	Std.Dev.	Min	Max
Price	136	5.272	3.224	1.299	16.86
Pop('000000)	136	48.100	49.700	1.978	181
rates	136	0.099	0.040	0.038	0.203
Subscr('000000)	136	34.300	34.300	2.456	137
GDP('000)	136	5.800	4.778	0.895	15.991
$1/N$	136	0.254	0.068	0.167	0.333
Fixed	136	2.451	3.346	0.100	9.450
Price*MNP	136	1.541	2.162	0	7.308
time	136	9	4.917	1	17
MNP	136	0.441	0.498	0	1

An important variable when estimating demand in the mobile industry is subscriptions. One of the main short coming of the existing empirical literature is on its inability to distinguish subscribers. For instance, Parker & Röller (1997) use the total number of cells in a given network to proxy for subscriptions. Recent studies use mobile penetration or total subscriptions to proxy subscriptions (see, for instance (Grzybowski, 2005; Cho et al., 2013)). The problem with these measures is that penetration rate does not distinguish between pre-paid and post-paid subscribers. Hence, the results of these studies might be biased given the fact that these plans have different pricing structure. Furthermore, the use of penetration rate or number of cells per network tends to capture registered subscribers who might not be active.

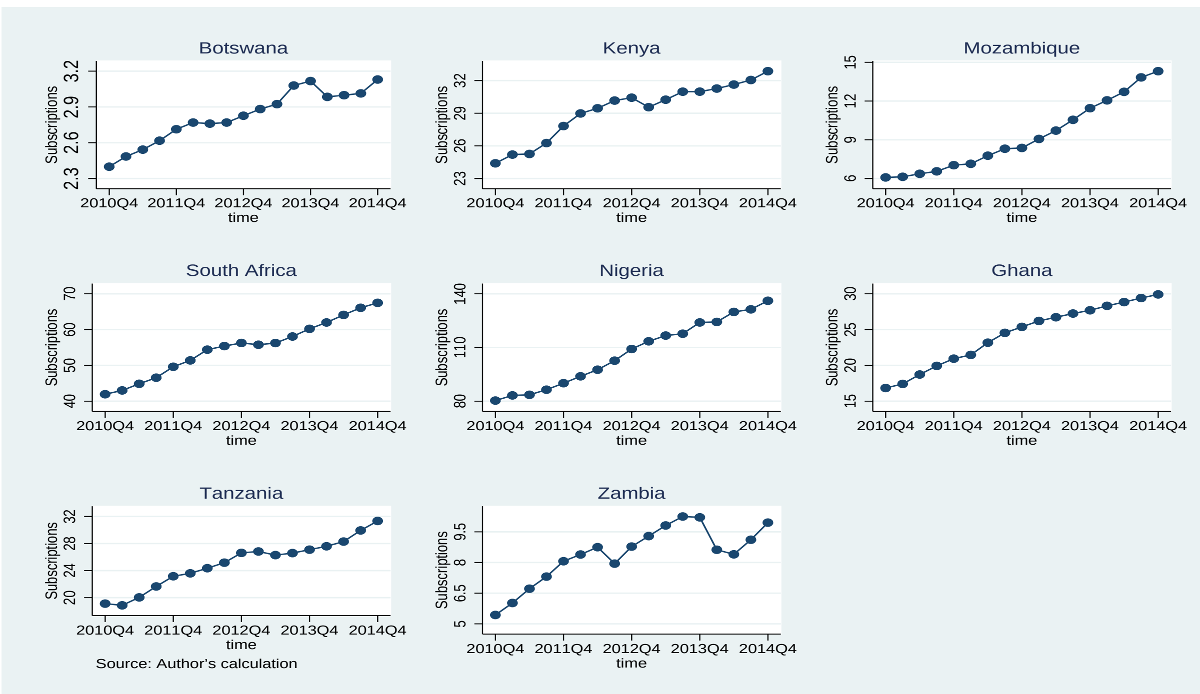
Our data is interesting as it uses new and unique subscriptions data, which is generally not available for African countries. The data contains firm-level subscriber information, which is disaggregated into pre-paid and post-paid plans.[11] In contrast to developed economies, mobile subscriptions in Africa are largely pre-paid. For instance, while in North America and North-

[11] Generally, mobile operators offer two types of subscription plans, pre-paid and post-paid. Pre-paid subscriptions require pre-payment and does not require a contract. The post-paid allows post-payment for services which requires a contract for a minimum of one month.

western Europe the share of post-paid subscriptions is 75%, in Africa, only 4% of subscribers are on post-paid.[12] Our study uses information on pre-paid mobile subscriptions in the demand estimation.

The frequency of mobile phone service usage is very critical when analysing subscriptions. For instance, the use of total registered subscriptions, which merely relate to the total number of connections that have been registered with an operator, might be misleading since some of the registered connections might be inactive. In contrast to the existing studies, we use the total number of active connections in regular use on a network as subscriptions. Figure 1 shows trends of total active pre-paid subscription for each country for the period of the study.

Figure 1: Pre-paid Mobile Subscriptions for Selected African Countries (millions)



Over the period of the study, the pre-paid subscriptions were growing rapidly. Innovations within the industry has led to development of new services, such as mobile banking, mobile Internet and the provision of over the top services, such as Voice over Internet Protocol (VoiP) and Skype. These changes were mainly supported by technological shifts, such as movements from second generation (2G) to third generation (3G) and recently to fourth generation (4G)

[12]see www.globalrewardsolutions.com

or the long term evolution. To account for these technological advances, we use a common time trend variable (Time). This variable can be interpreted as a constant upgrade in the quality of service, the rising range of available services, as well as enhanced performance of mobile telecommunication services.

Table 3: Termination Rates Data Sources

Country	Data source
Botswana	www.bocra.co.bw ; www.emeraldinsight.com
Ghana	www.itu.int
Kenya	www.standardmedia.co.ke
Mozambique	www.researchictafrica.net ; http://researchictafrica.net
Nigeria	www.itu.int; www.techcentral.co.za
South Africa	www.helgilibrary.com
Tanzania	www.telegeography.com
Zambia	news.idg.no; www.mediastudies.co.za

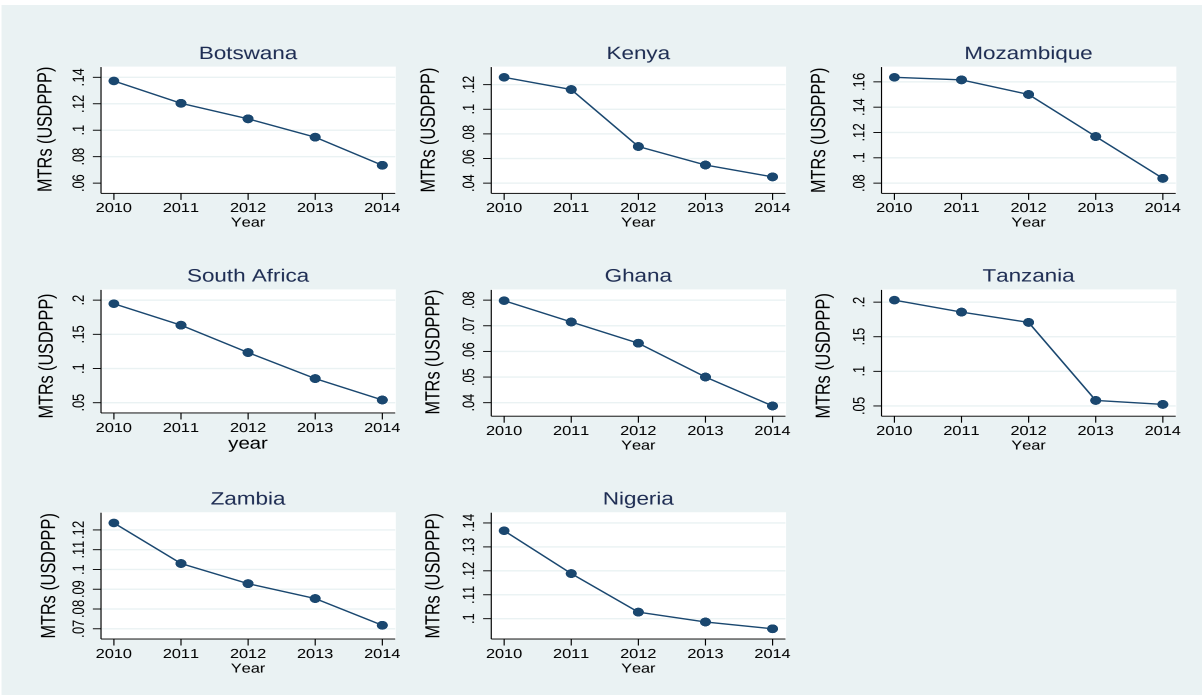
Note: Table 3 presents data sources for termination rates. Due to lack of a single data set, data for African mobile operators' termination rates was extrapolated from a number of data sources.

On the supply side we use two types of explanatory variables to explain the prices of mobile pre-paid calls (Prices): (i) exogenous determinants of markup and (ii) determinants of marginal cost. As for the exogenous price shifters we use MNP, which is expected to have a negative effect on price. This is because MNP is expected to reduce switching costs and, thereby, increase consumer responsiveness to price. To capture the impact of MNP on markup, we interact it with the inverse of number of operators. The inverse of the number of firms variable comes into the supply function through our derivation of the supply equation, as shown in subsection 5. Grzybowski (2005) also uses the inverse of the number of firms and MNP as explanatory variables, but he does not attribute MNP to the market power component.

Another important determinant of price is the marginal cost. Data on marginal cost is in general not available to researchers. A number of studies turn to proxies for it using bond rate, labour costs and electricity costs (see, for instance, (Grzybowski, 2005)). However, some of these proxies are not specific to the telecommunication industry. In our study, we use the mobile termination rate, which is a better proxy for telecommunication marginal costs and is expected to have a positive effect on prices.

In order to obtain homogenous comparisons of termination across the selected countries, we collected average rates per minute calls. We further transformed the rates from local currencies to US$ PPP using the World Bank PPP conversion factor. Figure 2 shows evolution of termination rates in the selected countries. The figure reveals that in all the countries considered in this study, MTRs are falling. This is because the countries considered in this study have adopted glide path termination rate policy. This policy requires operators to reduce termination rates.

Figure 2: Mobile Termination Rates for Selected Countries, 2010-2014.



4.1 Mobile Pricing

Pricing telecommunication services needs careful consideration due to its complexity. Mobile phone consumers face different tariff plans. For instance, customers are billed based on destination and timing of their calls. The phone calls can be made on- or off-net and during peak or off-peak hours. In addition to voice communication, consumers can use a wide range of other services including SMS, data, and so on.

A number of studies propose different measures for prices of mobile phone services. For instance, Shy (2002) uses average revenue per user (ARPU), while Grajek (2010) uses the lowest average customer bill. On the other hand, Fuentelsaz et al. (2012) and Cho et al. (2013) use price per minute. Price per minute measure is computed by dividing ARPU by the average monthly minutes of usage (MOU).

The problem with the approach used by Shy (2002), Grajek (2010), Fuentelsaz et al. (2012) and Cho et al. (2013) is that it does not take into consideration the different timing and destinations of phone calls. Other studies construct a price for mobile phone services using information on usage profiles (see, for instance, (Grzybowski, 2008a; Doganoglu & Grzybowski, 2013)). These studies assume that a representative user makes a certain number of phone calls per month, which are distributed across time and networks according to certain assumptions. The cost of the usage basket represents the price of mobile services. We take a similar approach to these studies and use as price the cost of pre-paid mobile phone service usage basket, which was constructed by RIA using the Teligen Ltd approach.[13] Table 4 presents the assumed distribution of minutes and messages for pre-paid services according to destination and time of the day.

[13] For more details on the basket see www.oecd.org

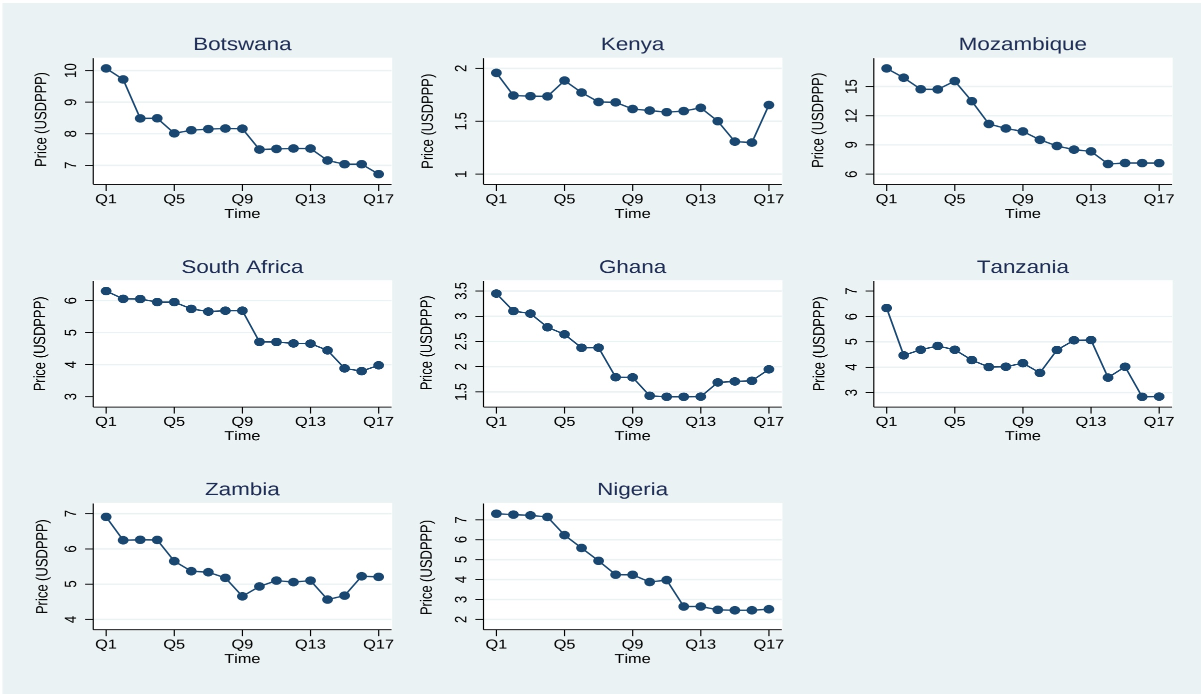
Table 4: Distribution of minutes and SMS depending on time and destination network

Timing	Minutes (1)	Proportion minutes (2)
On-net-peak	12.55	0.60
On-net-off-peak	7.91	0.50
Off-net-peak	6.82	0.40
Off-net-peak	6.26	0.50
Off-net-off-peak	3.94	0.40
Off-net-offoff-peak	3.40	0.60
Fixed peak	4.42	0.50
Fixed off-peak	2.78	0.40
Fixed offoff-peak	2.40	
On-net peak SMS	18.02	
Off-net-peak SMS	31.02	
Off-net-off-peak SMS	15.98	
Total basket minutes	50.48	
Total SMS	100	

Source: ResearchICTAfrica
Notes: The number of minutes depending on time and destination network, which were assumed to create price for voice call services. Column (1) shows the number of minutes/SMS and column (2) presents the the share of minutes that are charged at subsidized prices.

We construct price by weighting the price of each firm by its market share. We use average weighted price per country to proxy the price of pre-paid mobile phone services. Prices are measured in US$ PPP. We show price trends for each country for the period of the study in Figure 3. Similar to the MTRs, prices for mobile phone services have been falling over the period of the study.

Figure 3: Mobile Prices for Selected Countries, 2010:Q4-2014:Q4



5 Econometric Model

We assess the impact of MNP and MTR on mobile retail price using the equilibrium model proposed by Green & Porter (1984) and later, used by Parker & Röller (1997) and Grzybowski (2005) in the application to telecommunications industry. We assume that firms produce homogenous products and compete in quantities. This assumption is supported by the fact that the telecommunication output is constrained by spectrum availability, and as such firms strategically set subscriptions to sell. Subject to certain conditions, the capacity constrained price game yields the same output as the Cournot quantity game as shown in (Kreps & Scheinkman, 1983).

Following Grzybowski (2005), we assume that mobile operators are faced with the following inverse demand function:

$$p_{ts} = f\left(\sum_{i=1}^{N} q_{its}, X_{ts}, \epsilon_{ts}\right), \tag{1}$$

where $i = 1, ..., N$ is the mobile operator subscript, $s = 1, ..., S$ is the country subscript ,

$t = 1, ..., T$ is the time subscript, N_{ts} is the number of mobile operators in country s at time t, p_{ts} is the average price of pre-paid mobile phone service in country s at time t, q_{its} is total active subscriptions of mobile operator i in country s at time t, X_{ts} represents observable and ϵ_{ts} the unobservable demand shifters. Firms are assumed to have the following similar cost structure as follows:

$$TC_{its} = FC_{its} + VC(q_{its}), W_{ts}, \omega_{ts}), \tag{2}$$

with FC_{its} representing firm specific fix costs changing over time and across countries. Variable costs, $VC(q_{its})$, depend on the number of network subscriptions and some other country-specific cost drivers W_{ts}. Unobservable cost shifters are captured by ω_{ts}. Given such demand and cost specifications, a firm's profit function can be expressed as:

$$\pi_{its} = p_{ts}(.)q_{its} - VC(q_{its}, W_{ts}, \omega_{ts}) - FC_{its}, \tag{3}$$

this provides the first order conditions in the form:

$$\lambda_{its} \frac{\partial p_{ts}(.)}{\partial q_{its}} q_{its} + p_{ts}(.) - MC_{its}(.) = 0, \tag{4}$$

where $MC_{its}(.) = \frac{\partial VC_{its}}{\partial q_{its}}$ is the marginal cost function for firm i in country s and $\lambda_{its} = 1 + \sum_{j \neq 1}^{N} (\frac{\partial q_{jts}(.)}{\partial q_{its}})$ represents conjectual variation (degree of collusion). The conjectual variation formulation might be interpreted as the firm's expectations about the reaction of the other firms to a change in quantity (see (Bresnahan, 1989; Grzybowski, 2005)). Summing up FOCs (4) over all firms within the industry and dividing by the number of firms N_{ts} to get the average industry supply equation in the form:

$$\frac{\lambda_{its}}{N_t s} \frac{\partial p_{ts}(.)}{\partial Q_{ts}} Q_{ts} + p_{ts}(.) - \frac{1}{N_{ts}} \sum_{i=1}^{N} MC_{its}(.) = 0. \tag{5}$$

Three basic cases can be considered: $\lambda_{ts} = 0$ in the perfect competition case, $\lambda_{ts} = 1$ corresponds to Nash equilibrium and $\lambda_{ts} = N_{ts}$ implies joint profit maximization.

In the estimation, we assume that MTRs affect prices through marginal costs and MNP is assumed to influence prices by affecting price elasticities and firms' market power. This is because MNP is expected to give consumers an opportunity to switch without losing their mobile numbers which reduced switching costs. Based on the above assumption, we estimate the following demand specifications:

$$Q_{ts} = \exp(-(\alpha_0 + \alpha_1 R_{ts})p_{ts} + X_{ts}\beta + \epsilon_{ts}), \tag{6}$$

where Q_{ts} is the sum of mobile subscriptions of all operators in country s at time t , p_{ts} represents the price of pre-paid services, $X_{ts} = [1, Fixed_{ts}, GDP_{ts}, Pop_{ts}, Time_t]$ is a set of exogenous explanatory variables and ϵ_{ts} represents the unobservable demand shifters. Given the above demand specification we get $\frac{\partial p_{ts}(.)}{\partial Q_{ts}} = \frac{1}{-(\alpha_0+\alpha_1 R_{ts})Q_{ts}}$. Hence, the supply side equation becomes:

$$p_{ts}(.) = \frac{1}{N_{ts}} \frac{\lambda_{ts}}{(\alpha_0 + \alpha_1 R_{ts})} + MC_{ts}(.)\gamma + \omega_{ts}. \tag{7}$$

where $R_{ts} = [MNP_{ts}]$ is an exogenous regulatory variables which affects market power. In this specification, $MC_{ts} = [MTR_{ts}, Time_t]$ and N_{ts} is the number of firms in country s at time t. We assume that the telecommunication market is similar across African states with the same collusion parameter λ_{ts} and ω_{ts} are the unobservable cost shifters. This is a strong assumption which we make due to limitations in our data. We do not have enough data points to estimate country-specific parameters. However, this assumption is not far-fetched there are similarities in the African telecommunication markets. For instance, first-movers tend to dominate the mobile telecommunication market. In terms of ownership, the government have ownership in incumbent operators. In terms of regulation of MTRs, regulatory authorities follow a glide path. Furthermore, the African mobile telecommunication markets have similar firms. For instance, MTN provides its networks in the following countries: Botswana, Ghana, Tanzania, Uganda and Zambia. Airtel operates in Ghana, Kenya, Zambia, while Orange operates in Botswana and Kenya. The pricing equation is nonlinear in parameters. The price elasticity of demand for the demand function in equation 6 is given by:

$$\eta_{ts} = \frac{\partial Q_{ts}}{\partial p_{ts}} \frac{p_{ts}}{Q_{ts}} = -(\alpha_0 + \alpha_1 R_{ts})p_{ts}. \tag{8}$$

6 Identification

An important factor when examining the impact of a policy on an outcome is to understand the motivation behind the introduction of such a legislative initiative. As for our case, understanding the motivation behind the implementation of MNP and the glide path in termination rate policy are critical as we seek to tease out the impact of these policies on price. If the implementation of these policies were endogenous to market characteristics, the unbiased impact of these initiatives on prices will be hard to estimate.

Similar to other empirical studies that examine the impact of MNP on price, we consider the introduction of MNP as an exogenous policy to reduce switching costs. In practice, the authorities stipulate stringent implementation dates, and mobile telecommunication agents (consumers and operators) consider it as a given external shifter of market condition (see, for instance, (Bühler et al., 2006; Park, 2011; Cho et al., 2013)). As long as pricing strategies developed by mobile carriers do not influence the implementation of MNP, we can treat the policy as an exogenous factor with respect to operators' pricing decisions. We present this in greater detail here by discussing the background of MNP adoption.

In most countries, the regulator's decision to implement MNP is based on the motive to facilitate market competition by decreasing market power of the incumbent. For instance, in South Korea, the authority adopted MNP because the regulator assessed that the incumbent was exploiting excessive profits by introducing a 3-digit identification prefix, an appealing point and a differentiated value ((Cho et al., 2013)). In terms of MNP adoption in African countries, however, the major difference from other countries is that the regulator's decision on whether to adopt MNP or not cannot be attributed to market characteristics. For instances, most African authorities did not implement MNP even though the telecommunications market is dominated by incumbent operators. The decision not to implement MNP in Botswana and Uganda, for example, was based on the costs of implementing the facility.[14] Hence, the adoption of MNP in Africa is likely to be based on external conditions rather than on internal market conditions.[15]

We also consider the setting of termination rates to be influenced by external factors and not

[14](see www.budde.com.au, www.cellular-news.com)

[15]For instance, in countries where MNP is implemented, market agents (operators and subscribers) do not have any influence in its adoption. Instead, this was at the discretion of the regulator.

to be endogenous to retail prices. In practice, the mobile sector is made up of two markets: the wholesale or upstream and the retail or downstream market. In the upstream market network providers sell termination services. In setting termination rates, regulators generally assume that call termination on each individual mobile network is a separate market and each operator in that market is a monopoly. To prevent market distortions, regulators impose remedies by requiring operators to set cost-oriented prices for call termination. For instance, when implementing the glide path termination rate policy, the regulators used a cost-based model assuming, a hypothetical efficient entrant. In addition, the rate at which the termination reduces is determined by the regulators and the operators take it as given. Furthermore, what makes this policy exogenous is that after realizing that mobile operators are setting termination rates that are not cost-orientated, the regulators mandated the operators to reduce termination charges over time, rather than mandate a one-off shock which will reflect market conditions. Hence, the setting of termination rate is not endogenously determined and remains a discretion of the regulator until that point where they are equated to cost-orientated MTRs.

7 Results

We estimate the demand and supply sides separately using panel data random effects techniques. This estimation strategy relies on the assumption that the unobserved product-level errors are uncorrelated with explanatory variables. However, this assumption may not hold due to endogeneity of price and quantity variables. We perform a Durbin-Wu-Hausman test of endogeneity, which does not allow rejecting endogeneity of price in the demand estimation. A standard way of solving this problem is to use instrumental variables estimation. The literature suggests using cost variables as instruments for price (see, for instance, (Berry, 1994)). Hence, in this study we use termination rates, which are the main components of operators' marginal costs, to instrument for retail prices. The use of panel data techniques require testing whether the error term are correlated with the regressor. We perform a Hausman test, which allow us to reject the null hypothesis of random effects in favour of panel data fixed effects technique. However, our model estimation requires inclusion of a country-level inverse of number of firms variable in the supply side. Hence, using panel data fixed effects model omits this variable. The results of panel data fixed and random effects techniques are practically similar for the demand estimation (see Table

8).

Another concern might be that the use of random effect model might lead to biased results. Using procedure developed by Altonji et al. (2005), we formally compare the extent and direction of bias between the fixed and random effects model. In both cases, the estimated bias is negative. This implies that the use of these models slightly over estimates the effect of MNP. In fact the estimated bias is approximately zero in both cases (see Table 5).[16] This gives us a reason to discuss the results from a panel data random effects techniques.[17]

Table 5: Estimated bias

Model	Bias
Fixed effect	-0.001
	(0.0007)
Random effect	-0.006
	(0.0005)

Notes: Standard errors in parentheses.

Tables 6 and 7 present the result of estimating the supply side and demand formulations respectively. On the supply side, N represents the number of firms in a country, MNP/N is the interaction of MNP with the inverse number of firms. *rates* represents mobile termination rates and time is the time trend measured in quarters. In column (1) of Table 7, we present the results of estimating a demand equation using standard panel random effects, while column (2) presents the result of estimating the same model with instrumental variable techniques. We interpret the results in column (2).

[16] We are grateful to Prof. Todd Elder of Michigan State University for sharing the Stata routines for estimating the potential size of any bias on the estimated coefficient of the weighted price variable due to unobservable selectivity.

[17] One way of solving this problem is to use simultaneous equations techniques. Unfortunately our data cannot handle this type of estimation as we do not have enough exogenous variables to identify parameters. Though our estimation strategy might not be efficient, our results are consistent. Furthermore, our strategy have an advantage over system estimation in the sense that if one equation is misspecified, it would not spill over and contaminate the estimation results for the other equation.

Overall, the demand estimation has a much better fit than the supply estimation. Significant exogenous variables in the demand estimations explain about 86% of the variation in subscriptions, while on the supply side they only explain 46% of price variation. These results show that there is much more unexplained noise in the pricing policies than in the consumers' decision to purchase mobile phone services. Much of these unexplained variations might be attributed to the fact that the model used assumes static interactions, while firms in this industry apply dynamic strategies. Moreover, some other variables such as regulatory issues are unobservable or difficult to approximate and implement in the model. Furthermore, each country seems to have a specific competitive environment.

In the supply side specification, MTRs have a positive and significant impact on mobile retail prices, which suggests that lowering the MTRs leads to a reduction in mobile retail prices. A decline in average MTR of 10%, decreases average mobile retail prices by 2.5%.[18] This result contradicts the findings of the waterbed effect in the mobile telecommunications industry by Genakos & Valletti (2011), which is not confirmed for selected African countries. Our results are in support of the glide path termination rate policy. Moreover, our study finds that there is no significant impact of MNP on retail price, which opposes the hypothesis that MNP reduces price by reducing switching costs. We attribute this result to African industry characteristics such as ownership of multiple SIM cards (see, (Aker & Mbiti, 2010; Jentzsch, 2012)). Subscribers in developing countries adopt multiple SIM cards to overcome poor network coverage and to avoid network congestion. Subscribers also connect to multiple operators to save money by making on-net calls and also to benefit from discounted or bundled tariffs for voice calls or for data (see (Sutherland, 2009)). In markets with multiple SIM cards, there is no need for porting numbers since consumers subscribe to more than one operator. Moreover, as we discussed earlier, the speed of processing a request for porting is very low in the countries considered in this analysis. We also find MNP to be insignificant in the estimation of the demand equation. This coincides with the supply side estimation.

[18] We calculate the impact of MTRs on retail price as $\frac{\partial p_{ts}}{\partial rates_{ts}} \frac{rates_{ts}}{p_{ts}} = \gamma \frac{rates}{p_{ts}}$

Table 6: The Supply Side

VARIABLES	Price
$1/N$	24.397***
	(4.221)
MNP/N	-0.962
	(2.076)
Rates	10.677**
	(5.371)
Time	-0.155***
	(0.038)
Constant	-0.532
	(1.299)
Observations	136
R- square	0.45

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Results based on panel data random effects estimation.

Our model specification requires the inclusion of inverse number of firms (1/N) in the supply side formulation. The coefficient of this variable is interpreted as market conduct divided by the coefficient of price. The inverse number of firms variable has a significant and positive effect on price, which implies that as the number of firms in the market increases, market power is reduced and prices decline. The market conduct parameter is estimated around 1.27, which is calculated as 24.39 multiplied by 0.05. The value of this parameter in the proximity of one implies Cournot competition conduct. Thus, the average market conduct in sub-Saharan African countries during the period of the study is approximated by the Nash equilibrium.

Similar to Grzybowski (2005), we include a time trend in our analysis of demand and supply. The coefficient of this variable should be interpreted as the effect of technological progress. The coefficient of time trend in the supply equation is negative and significant. This result suggests that technological progress leads to a reduction in prices. We find a significant positive effect of time trend on subscriptions. This result shows that technological progress increases customer valuation of mobile phone services.

On the demand side, population has a significant positive effect on mobile subscriptions across the selected African countries, which implies that demand for mobile services is greater in populated countries. We find insignificant impact of GDP per capita and fixed penetration on demand for mobile phone services. The demand for pre-paid mobile telephone service is inelastic with respect to price. The price elasticity of demand for pre-paid mobile telephone services is -0.27, which agrees with estimates from other countries.

Table 7: The Demand Side

VARIABLES	1	2
Price	-0.056***	-0.052***
	(0.007)	(0.006)
Price*MNP	0.024	-0.006
	(0.015)	(0.035)
ln(Pop)	0.800***	0.202***
	(0.029)	(0.064)
ln(Fixed)	0.008	-0.021
	(0.013)	(0.025)
Time	0.015***	0.015***
	(0.002)	(0.003)
ln(GDP)	0.307***	0.210
	(0.055)	(0.174)
MNP	0.070	0.087
	(0.052)	(0.088)
Constant	0.632	11.870***
	(0.723)	(1.900)
Observations	136	136
R-square	0.83	0.87

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Results based on panel data random effects estimation in column (1) and based on instrumental variables random effects estimation in column (2). We use mobile termination rate and mobile termination rate interacted with MNP as instruments. The dependent variable is logarithm of mobile subscriptions.

8 Conclusions

This chapter examined the impact of mobile number portability and mobile termination rate on mobile retail price in selected African countries. MNP reallocates property rights of mobile phone number from carriers to customers. By doing so, it allows consumers to keep their numbers when changing operators. Theory relating to switching costs suggest that prices can increase or decrease when switching costs reduce. Termination rates, on the other hand are charges which operators set for terminating calls on each others' network. These charges are not observed by customers, but they directly affect retail prices. Existing theory suggests that a decrease in MTR is more likely to increase mobile retail prices and reduce fixed-line prices. This phenomenon is called the waterbed effect.

We use a Nash equilibrium model proposed by Green & Porter (1984) to examine the effect of regulatory policies on mobile retail prices. Firms are assumed to produce a homogenous good and use static interactions. Using a unique quarterly dataset for 35 mobile phone operators in eight African countries for the period 2010:Q4 to 2014:Q4, we estimate demand and supply structural formulation separately using random effects panel data techniques.

First, we find that mobile termination rates (MTR) have a statistically significant positive impact on mobile retail prices, a result that rejects the waterbed effect in support of the glide path termination rate policy. This result contradicts the study by Genakos & Valletti (2011), which was used by one of the largest firms in the UK, Vodafone, to argue against regulatory authority policy of reducing termination rates. Vodacom cited the paper and argued that reduction of termination rates will lead to an increase in mobile retail prices and reduction in subscriptions. Our results show that a decrease in termination rate will lower mobile retail prices. It thus supports the glide path termination rate policy.

Second, our results oppose the hypothesis that MNP reduces prices and firms' markups. Both on the demand and supply side we find that MNP is insignificant. Although this policy might have an effective impact in industrialized countries, the same might not be true for developing countries. For instance, the African mobile telecommunication market is characterized by multiple SIM card ownership and the existence of dual SIM card mobile phone devices. Hence consumers are connected to at least two operators meaning that there is little demand for porting numbers.

Our study come with some limitations. The constructed data set does not allow us to determine whether MNP reduces switching costs or not. We were unable to determine how firms' market share evolve after the introduction of MNP. This is because we use aggregated data.

Furthermore, we were unable to get firm level termination rates, which could have allowed us to evaluate the impact of regulating termination rates on small and large firms. Future research must evaluate the effect of MNP and on market concentration and price demand elasticities.

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9 Appendix

Table 8: The Demand Side

VARIABLES	1	2
Price	-0.051***	-0.052***
	(0.007)	(0.006)
Price*MNP	-0.012	-0.006
	(0.038)	(0.035)
ln(Pop)	-0.014	0.202***
	(0.082)	(0.064)
ln(Fixed)	-0.003	-0.021
	(0.027)	(0.025)
Time	0.017***	0.015***
	(0.005)	(0.003)
ln(GDP)	0.113	0.210
	(0.354)	(0.174)
MNP	0.102	0.087
	(0.092)	(0.088)
Constant	16.222***	11.870***
	(2.964)	(1.900)
Observations	136	136

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Results based on instrumental variables fixed effects estimation in column (1) and based on instrumental variables random effects estimation in column (2). We use mobile termination rate and mobile termination rate interacted with MNP as instruments. The dependent variable is logarithm of mobile subscriptions.