DEMAND ELASTICITIES OF MOBILE TELECOMMUNICATION SERVICES IN KENYA

MUREGA TONY GITONGA

X50/69771/2011

A Research Paper Submitted to the University of Nairobi in Partial Fulfillment for the Requirement of the Award of the Degree of Master of Arts in Economics

2014

DECLARATION

This research paper is my original work and has not been presented for any award in any other university.

Signature…………………………………………….Date………………………….

Murega Tony Gitonga

Reg. no: X50/69771/2011

This paper has been submitted with our approval as university supervisors.

Signed…………………………………….date…………………………

Name: Professor Mureithi Leopold P.

Signed…………………………………….date…………………………

Name: Dr. George Ruigu

ACKNOWLEDGEMENT

I sincerely thank my supervisors Professor Leopord P. Mureithi and Dr. George Ruigu for their selfless help and guidance throughout the research paper project. I thank them for their advice and comments that have reshaped and refined my ideas giving me a clearer understanding of my research topic and their efforts to read through my draft proposals, without which this project would not have seen the light of the day.

I equally thank the board of post graduate studies and the School of Economics, University of Nairobi, for making my dream come true by awarding me a scholarship to pursue this Master's degree. The same gratitude extends to all the lecturers at the school of economics for the useful skills they have imparted on me for the last two years. I am a more skilled and a better intellectual because of their collective efforts.

I thank my parents Henry Murega and Celina Kigetu for their financial and moral support over the years and nurturing me to be the man I have become.

I thank my siblings Ronny Kimathi and Eddy Makandi for their encouragement and support in my studies. Their support has not been without sacrifice. Lastly I sincerely thank my fiancée Fridah Makena for her unrelenting support and her encouragement for me to remain focused.

ABSTRACT

The mobile telecommunication subsector has experienced exponential growth over the last decade which has been attributed to lower calling rates, subsidized handsets, increasing income among other factors. Lack of consensus in empirical literature on the importance of these variables, especially income and calling rates, as well as scanty Kenya specific studies on the same informed the need for this study.

The objective of the study was to estimate the price and income elasticities of demand and cross elasticity of demand for mobile telecommunication services using monthly panel data on the four mobile network operators for the period between June 2011 and March 2013. A static model was estimated using the feasible generalized least squares random effect model and robust estimates obtained. The coefficients estimated show expected signs and are statistically insignificant apart from income coefficient. The demand is price inelastic but income elastic. Marginal subscribers use less voice call while fixed line network complements mobile telephony. The dynamic model is estimated using the generalized method of moments used by Arellano and Bond (1991) and the results show presence of path dependence of elasticity of demand. Long-run price elasticity of demand is higher than the short-run elasticity.

The reduction of calling rates is therefore detrimental to the profitability of the firms as it may not result to higher usage of mobile services. This reduction can only negatively affect firm investment in network quality and stability. The firms should therefore focus on quality improvement and value addition as well as internet and mobile money transfer instead of seeking higher subscriber base by reducing prices. The reduction of termination rates may also not result into higher usage of mobile services.

LIST OF ACRONYMS

ARPU – Average

ATACS - Extended Total Access Communication System

BAK –Bill and Keep

CCP – calling party pays

CCK – Communication commission of Kenya

CDMA- Code Division Multiple Access

CPNP - Calling Party's Network Pays

FGLS –Feasible Generalized Least Squares

GDP –Gross Domestic Product

FGLS – Feasible Generalized Least Squares

GMM – Generalized method of moments

GSM - Global System for Mobile Communication

KNBS – Kenya National Bureau of Statistics

MoU – minutes of use

OLS – Ordinary Least Squares

SIM – Subscriber Identification Module

UK – United Kingdom

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE

1.1 INTRODUCTION

The total number of worldwide mobile phone use surpassed, for the first time, the number of fixed telephone network in 2002. Over the last decade the growth of demand for mobile telecommunication services has been most pronounced in Africa than in any other region of the world. In Kenya the penetration rate has been increasing steadily since the first license for mobile operation was issued in 1997. The number of mobile phone subscribers has increased to 30.4 million, representing a penetration rate of 77.2% by September 2012 (CCK, 2012), which is higher than the African average of 65%. The increase in Minutes of Use (MoU), during the same period indicates that subscribers were able to make longer calls or more calls. The fixed line subscriptions on the other hand have continued to record a decline and stood at 248,300 in September 2012 after a 5.5% decline from the previous quarter. The demand for mobile telecommunication services in Kenya has therefore been increasing exponentially over the last decade and it is imperative to understand the key drivers of this demand and their elasticity, especially due to the importance of mobile telecommunication services to the social, political and economic development.

Mobile phones have significantly reduced communication costs and this has enabled economic agents to obtain information quickly and cheaply on economic issues (especially on pricing), social and political issues. The reduction of these costs has improved agricultural and labor market efficiency and producer and consumer welfare. It has also enhanced firms' productive efficiency through better control on their supply processes, Aker and Mbiti (2009).

In a country like Kenya where the transport infrastructure is poor, the mobile telecommunication has considerably reduced information search costs thereby greatly improving the market efficiency. The mobile financial innovations have facilitated financial inclusion for the masses of the rural poor who could not have had access to conventional banking. According to Levine and Ross (1997), financial development is positively correlated with economic growth. Innovations such as mobile banking, money transfer and mobile based payments have a great impact on the economic growth.

These innovations, other than providing access to the financial system, have the potential to mobilize savings (MSHWARI, a mobile banking system facilitated by the partnership between the Commercial Bank of Africa and Safaricom, Kenya Commercial Bank M-Benki are some of the examples) and therefore deepen the financial sector enabling the intermediation process. By 2012 MPESA, a money transfer system developed by Safaricom, had more than 19 million customers exceeding almost by double, the number of account holders with the commercial banks. This has induced competition in the banking sector.

The demand for mobile telecommunication services has created thousands of jobs and new opportunities for businesses in Kenya (CCK, 2011). On the political environment, the mobile communication has been used to manage elections through the mobile transmission system of electoral outcomes and this has enhanced transparency thus reducing the political risk to the economy. Lyakurwa (2012) contends that democracy, which is epitomized by transparency, is important for economic growth in Africa. Bloom et al (1998) argue that one of the reasons for the poor economic performance in Africa is political instability. Thus mobile telecommunication plays an important role in the political stabilization of the country.

The question on the level of demand elasticities for the mobile telecommunications services therefore should be important to all the stakeholders. Economic theory identifies price, income and related products as the general factors that affect the demand for the goods and services. The mobile telecommunication industry, however, has unique characteristics that call for a deeper analysis. Firstly, the limitation of frequencies means that only a few operators can be licensed to operate in the market. This effectively makes the industry an oligopoly. Licensing is a barrier to entry and this makes the industry different from other service industries. The oligopoly nature of the industry implies that the firms exercise some level of market power.

Secondly, oligopolistic industries often have a tendency to collude. It is important to analyze the market participants conduct in these industries in more detail. Dewenter and Haucap (2007), assert that demand elasticity of the firm and that of the market is a gauge of the firms’ motivation to collude in the market.

They further argue that firms are more motivated to collude if the market demand is inelastic, since prices can be increased without affecting the market share. This conclusion concur with that of Laffont, Rey and Tirole (1998) who argued that firms may use interconnection agreements (where there is no regulation) to enforce collusive behavior. They however did not ascertain whether competition for subscribers would reduce this collusion. According to economic theory, where firms face a downward sloping demand curve they have an incentive to undercut and thus generate price competition. Understanding demand elasticity therefore becomes important to the firms in this industry as well as to the industry regulator in devising policies that promote competitiveness of the industry as well as promote consumer welfare. The remaining part of the chapter will provide a theory of network interconnection, the background, and statement of the problem, significance of the study, scope and limitations. The rest of the paper is organized as follows; review of relevant literature is done in chapter two, theoretical and empirical framework is developed in chapter three, estimation results are discussed in chapter four and chapter five summarize and draw conclusions.

1:2 THEORY OF NETWORK INTERCONNECTION

The mobile telecommunication industry unlike other service industries has a unique and deeper level of interrelationship, which may be exploited by the dominant and established firms to limit competition from the new entrants (weaker firms) or even completely push them out of the market. A mobile telecommunication provider has complete control over termination of calls originating from its competitors. A call originating from the competitor will be terminated by the firm and this means it must use the firm's network facilities for which a fee called termination fee must be paid by the network from which the call originates to the receiving (terminating) network. The cellular firms therefore essentially, compete for the right to terminate calls by competing for mobile phone subscribers, Dessen (2003). Firms, if unregulated will charge their rivals high termination fees to increase their cost and force them out of the market or create barrier to entry for the potential entrants. This is made possible by the interconnection fee charging regimes adopted by the mobile telecommunication providers. Most markets, Kenya included, use the Calling Party's Network Pays (CPNP) regime on wholesale markets and the Calling Party Pays (CPP) regime on retail markets.

This creates a wholesale cost barrier to retail pricing of off-net calls. Under these regimes, off-net calling rates cannot be lowered below the termination fees. The modern approach, though not popular, is the bill and keep (BAK) regime, under which, the interconnected networks charge a reciprocal termination fees of zero and therefore networks recover their costs only from their own customers rather than from the competitors. Although BAK regime removes the wholesale cost on pricing of off-net calls, it may also cause a disincentive to investment in the network quality. While CPNP is preferred in most countries, it does raise the problem of call interconnection fees and therefore introduce barriers to competition. Wright (2002) argues that, theoretically, competition for subscribers may decrease the access pricing (termination fee) but in reality, it may instead increase it and then pass it over to the customers. If a firm has a large subscriber base most of the calls are on-net and therefore it is a net receiver of the termination fees. For this reason, the firm has an incentive, if not regulated, to increase the termination fees the consequence of which would be to increase the cost of placing an off-net call by the competitors and since most of the calls are off-net, the competitor would be a net payer of the termination fees (which is a wholesale cost for the firm). This effectively increases the off-net call price of the competitor. Such a competitor (who is always a weaker firm or a new entrant) may make losses into the long-run and exit the market.

Marcus (2004) note that a high termination rate raises smaller rival’s cost making it difficult for them to compete aggressively with established ones on the basis of price. These views are shared by Armstrong (1998) and Laffont, Rey and Tirole (1998). The weaker competitor can only price the off-net calls above the termination fee so as to make a profit on the call while the dominant firm prices the on-net calls at a price lower than the termination fee. Rational subscribers would rather join the dominant firm so that they can make most of their calls on-net to avoid the high cost of the off-net calls. This limits competition in the market and in the event the weaker firm exits the market, the dominant firm would engage in monopoly pricing resulting into loss of consumer welfare. In many other emerging economies, the significant price differences between on-net and off-net prices have led many consumers to hold multiple SIM (subscriber identification module) cards of different operators to arbitrage on price differentials by calling using the service of the provider with the most favorable rates depending on whether the call is on-net or off-net, Haucap, et.al (2010). The monopoly over call termination constrains the consumer choices which impact on the responsiveness of their consumption behavior to changes in prices and income.

The reduction of the termination rates however may not reduce prices as firms result to subsidizing handset prices and engage in promotional activities instead of competing on prices. This results into a phenomenon that Genakos and Valletti (2009), in their seminal article, referred to as waterbed effect. This is because mobile firms keep termination rents instead of passing them to their customers and therefore they (firms) suffer if the termination rates are reduced. The network externality is therefore not eliminated by interconnectivity of the mobile telecommunication networks as is the case in other networks.

1:3 THE EVOLUTION OF MOBILE TELECOMMUNICATION SECTOR IN KENYA

1:3:1 Brief background

The mobile telephone services in Kenya started in 1992 with the analogue system known as Extended Total Access Communication System (ATACS). This system was commercially launched in 1993 but due to the problem of affordability, the total mobile subscribers were less than 20,000 by 1997, when the Global System for Mobile communication (GSM) technology was adopted, CCK (2008). Prior to 1997, a mobile handset was sold at an average of KSH 250,000 while the cost of monthly maintenance was way in excess of KSH 100,000. In 1997, the Kenya Post and Telecommunication Corporation formed Safaricom, as a department to provide wireless telephone services. Safaricom therefore had the monopoly on provision of mobile telecommunication services in Kenya up to the year 2000 when mobile telecommunication services licenses were issued to Safariom and Kencell communications limited. The licensing of the two mobile service providers set ground for competition for subscribers in a market that was initially controlled by a monopoly.

The two most common wireless phone technologies in use in Kenya are GSM (Global System for Mobile Communication) and CDMA (Code Division Multiple Access). On global scale, 14% of the worldwide market uses CDMA while 73% use GSM cell phone technology.

In 2000, the number of Safaricom subscribers was 50,000 and geographical coverage 20%. The firm had a market share of 40% by subscriber base in 2001, the tariffs were prepaid and the only value added service was voicemail. The Safaricom call price in 2000 was KSH 28/minute and by 2001 it reduced to between KSH 15-24 per minute. Even with this low number of subscribers Safaricom faced network congestion, lost connection and poor reception because of low level of investment in the network infrastructure amid surging demand. Kencell communications limited was launched in August 2000 using GSM 900 technology. In 2001 it had 74,000 subscribers making up a market share of 52% and 35% geographical coverage.

1:3:2 Regulation and Competition

Between 2002 and 2007 there were only two mobile network operators and the interconnection fees were not regulated occasioning high off-net calling rates. This may be the reason for low subscriber growth during this period as shown in Table 1:1. The number of mobile service providers in Kenya has since increased to four: Safaricom, Bharti Telecom, Telecom Kenya and Essar Telecom Kenya. The mobile infrastructure has improved covering all major towns and highways in the country. Safaricom holds 64% of the Kenyan Mobile Phone Subscription Market, Airtel 16.5%, Orange 10.5%, and Essar[1] Yu 9.0%, CCK (2012). The increased number of operators has intensified competition leading to price wars in the market.

Table: 1:1 Mobile telephone subscriber growth for the period 2002 to 2012

Year end	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Subscribers 'millions'	1.25	1.95	3.42	5.33	7.27	11.35	16.24	19.11	24.96	26.5	30.4

SOURCE: CCK

[1]Essar telecom has since exited the Kenyan market and sold its assets to Safaricom limited and Bharti Airtel Limited

The termination fees have been under regulation since 2007 and this reduced off-net calling rates occasioning growth of subscribers to 30.4 million by 2012 representing about 76% penetration rates. The most used tool of competition for the last 10 years has been prices as firms struggled to increase their market share. This has reduced call prices from an average of KSH 28 per minute (on-net) in 2000, to an average of KSH 3 per minute (on-net) by the end of 2012. The price of calls determine both the number of calls and subscribers allocated between mobile service providers and therefore competition exert a downward pressure on retail prices as firms undercut to increase their market shares, Laffont et.al (1998a, 1998b). Competition in the Kenyan mobile telecommunication market was further stirred by the Communication commission of Kenya in 2007 when it started regulation of the industry through the determination of call termination rates. This significantly reduced the on-net and off net call price differentials and ignited a price war, especially after the rate was reviewed downwards in July 2010. CCK 2012 through a statement notes that:

‘Interconnection constitutes one of the key drivers of competition in the telecommunication market. It serves as a critical policy tool for the proper functioning of a competitive communications market and hence it should be regulated’.

After a network cost study in 2010, the regulator developed new interconnection framework to promote competition, operational efficiency of firms and the growth of the sector. The framework was to be implemented following a glide path, reducing the termination price from KSH 4.41 in 2010 to KSH 0.99 by July 2014. This framework faced strong objection from Safaricom (net receiver of termination fees) because of the fear of losing revenue and market share. This may impact negatively on future investments in infrastructure.

Table: 1:2. Mobile termination rates and implementation date

Implementation date	22 /02/ 2007	1/07/ 2010	1/7/ 2011	1/7/ 2012	1/7/ 2013	1/7/ 2014
MTR(nominal KSH)	4.41	2.21	2.21	1.44	1.15	0.99

SOURCE: CCK

The implementation of this framework reduced the termination rates occasioned a mobile retail price competition that reduced retail off-net call prices from KSH 12 per minute in August 2010 to between KSH 5-3 per minute by November 2012. The on-net call prices reduced from KSH 7 to KSH 3 during the same period, CCK (November 2012). To compensate for loss of revenue from the voice calls, the service providers diversified into internet services, money transfer and SMS. Since the entry of the third and the fourth service provider, Safaricom, the market leader and the only player reporting profits, has gradually but consistently lost market share (based on subscriber base) from 80.7% in June 2010 to 64% by the end of 2012. The other operators' market share movements have been erratic over the same period. The price competition has reduced the overall profit of the industry but it has also increased the demand for the services by the low income earners as evidenced by the increase in the minutes of use by subscribers and the penetration levels. The reduction in the termination fees has resulted into narrowing of price differentials between on net and off net calls. Valletti and Cambini (2005) however warn that termination rates set below the marginal cost may discourage investment in the network infrastructure which negatively impact on the quality of the mobile telecommunication services in the long-run.

The mobile number portability introduced in April 2011 was meant to reduce switching cost and allow movement of subscribers between the service providers while retaining their phone numbers and thus compete for not only new subscribers but also existing subscribers. Buehler and Haucap (2004) asserts that lack of mobile number portability in the Turkish telecommunication market was a major barrier to entry and to growth of new entrants and this significantly increased the switching costs for consumers determined to leave the incumbent for the new entrants. In Kenya however, mobile number portability has had minimal impact as a result of delays in porting, reversals due to loss of value addition like money transfer and the problem of multiple SIM card ownership. The data on mobile number portability is provided in table 1:3.

Table: 1:3. Quarterly data on mobile number portability

Quarter	Mar-Jun 2011	Jun-Sep 2011	Sep-Dec 2011	Dec-mar 2012	Mar-Jun 2012	Jun-Sep 2012
No of ports	36,224	1,924	2,407	6,646	678	217

SOURCE: CCK

1:3:3 Pre-paid tariffs and low denomination calling cards

The majority of Kenyan population is in low income categories and cannot afford fixed contracts in post-paid tariffs. The pre-paid tariff (pay-as-you-go) is an innovative pricing strategy that has enhanced affordability and therefore increased the demand for mobile telecommunication services in Kenya. According to the CCK, quarterly reports, 99% of the total subscribers are prepaid customers. The trend is similar in most developing countries, Banerjee and Ross (2002). Availability of lower denomination airtime (as low as KSH 10 and KSH 5) and innovative products such as credit facility on airtime and flashback service has made it possible for the poor to call even with little money or on credit. The Value Added Tax (VAT) waiver on airtime increased the minutes of use available to subscribers at the same level of income. Airtime VAT was however reintroduced in the 2011/2012 financial year

1:3:4 Increasing Wealth and Subsidized Handsets

Over the last 10 years, economic well being has improved considerably. Ahn and Lee (1999), argue that the country's wealth is related (positively) with the level of demand for mobile telecommunications services. The GDP per capita, a measure of wealth, increased and the economy became more vibrant translating to more disposable incomes and booming businesses within the informal economy. This translated into affordability and demand for telecommunication services to support the increased economic activities. The growth in the informal economy propelled the growth for mobile money transfer services as a mode of payment thus enhancing financial inclusion for the unbanked. By the end of 2012 the mobile money transfer had over 19 million subscribers served by 54,409 agents (CCK 2012) Between the June and September 2012, the money transfer system had transacted over KSH 205 billion, a growth of 6.7% over the previous quarter.

The government waiver of duty on mobile handsets reduced their prices especially to low income earners. Mobile service providers have also been increasingly involved in subsidizing mobile handsets that are programmed to be compatible with only their SIM cards in an effort to eliminate accessibility problem. Cheap handsets and low denomination airtime has therefore significantly fuelled the demand for mobile telecommunications services in Kenya.

1:3:5 The Decline of fixed telephone lines and increased investment in mobile telecommunications infrastructure

Since the introduction of the mobile telephony in Kenya, fixed telephone lines subscriptions have been on the decline, consistently. The Communications Commission of Kenya attributes the decline to substitutability between mobile and fixed line telecommunication and vandalism of equipments and copper cables for the fixed lines. With cheaper, efficient and convenient mobile communication, subscribers are switching to the use of mobile phones. The efficiency in mobile communication has been brought about by massive investment in cost saving technologies like GSM and Third Generation (3G), network upgrade and subsidized handsets. The dilapidated fixed line infrastructure and stealing of copper cables increased the costs and reduced efficiency of fixed telephones. The decline in investment in fixed line network and increase in investment in the mobile network is shown in Table 1:4 below. Poor transport and communication infrastructure like roads and rail has further given impetus to the growth of mobile telecommunication services.

Table: 1:4. Annual investment in mobile and fixed line networks (KSH in millions)

Year	2001	2002	2003	2004	2005	2006	2007	2008
Mobile Annual investment	11,851	19,173	23,662	28,920	38,670	44,600	21,221	29,936
Fixed annual investments	35,499	37,447	36,430	35,416	12,568	5,533	-	-

SOURCE: CCK: (-) show missing values in the CCK quarterly reports.

1:3:6 Value Additions

In 2001, the only value addition to voice service was voicemail. The value added services have tremendously increased and become diversified and now include money transfer service and internet services. Sathish et.al (2011) finds value added services to be an important determinant of switching behavior in India. Value addition has had profound effects on demand for mobile telecommunication services since even at constant nominal prices, quality adjusted prices seem to be lower for subscribers. In Kenya, the money transfer service has become part of the financial system and has been widely accepted as mode of payment almost outperforming the banking system. This has boosted the subscriptions to the mobile networks. Some subscribers subscribe to a network simply because of the benefit of this service. Internet subscription has been on the rise and is the new frontier of competition and revenue generation in the telecommunication industry. With the introduction of inexpensive smart phones with multiple applications and the evolution of social media as well as other applications, demand for internet service has been on the rise over the last few years. The government policy has heavy bias towards Information Communication Technology (ICT) as evidenced by the support for the fiber optic cable, e-governance and the emphasis of ICT as an engine for growth. This factor, coupled with increased number of mobile application software supporting activities such as health, education and agriculture has added the impetus to the growth in demand of mobile telecommunications services in Kenya.

1:4 STATEMENT OF THE PROBLEM

The telecommunications sector is one of the most important sectors of the economy. In Kenya, this sector has expanded and developed considerably in the last 10 years. By 2012, 77 in every 100 Kenyans had access to a mobile phone, but despite this expansion of the market, mobile service providers continue to experience decline in profitability. Firms with the highest prices are losing the market share only marginally while those with competitive prices gain no substantial market share. To understand the demand for the telecommunication services, it is important to estimate the elasticities of demand for those services. Research in this area and especially in Kenya is still scanty.

Previous research has been on the relationship between the growth in mobile telecommunication and economic growth, the impact of MPESA and M-banking, few studies have attempted to quantify the significance of the variables affecting demand in terms of elasticity in a manner that can inform policy and firms' actions with more precision. Most of research done on demand elasticity is in European countries that have advanced telecommunication industry, over 100% penetration rates, mostly postpaid subscribers and high levels of income. Vibrant fixed telephone services in these countries make it difficult to generalize their results on complementarity or substitutability to developing countries.

The regulatory framework is developed and independent in most of the countries where similar studies have been carried out. Some, like the United States of America, have bill and keep regimes (where firms charge zero termination fees and recover termination cost from their own subscribers), close to 100% geographical coverage, developed transport and communication network and financial systems. In developing countries where Kenya belongs, income is low thus increasing price sensitivity, tariffs are predominantly prepaid (consumption pattern is thus more responsive to price change in the short-run), transport and communication network is poor, financial system is underdeveloped, network coverage and penetration rates are below 100% and the regulatory system is young and quasi-political. The on net and off net call price differentials are wide and thus problems of multiple SIM card ownership.

The scanty research on this area done elsewhere in Africa has not concentrated on demand elasticities but has rather dealt with it as a side issue without rigorous estimation. Further, they are based on cross-sectional data of several African countries (Hamilton, 2003) and not Kenya in particular. The network effects and effects of substitute services are key determinant of demand that has not been controlled for in the previous studies and this may have overstated the importance of the price variable in the demand for the telecommunications services. This study sought to estimate demand elasticities using country specific data, something not done before in Kenya.

The utility one derives from the use of a telephone service depends on the ability to talk to another person on the telephone; the more people one can talk to on the telephone, the higher the utility one derives from subscribing to the telephone network, hence the demand for the telephone services may increase with the size of the telephone network. The size of the telephone network is thus included as a regressor.

1:5 RESEARCH QUESTIONS

This study investigated the research problem already stated by attempting to provide answers to the following three questions:

What is the estimated level of short-run and long-run own price elasticity of demand for the mobile telecommunications services in Kenya? Is the difference significant?

What is the level of income elasticity of demand for mobile telecommunication services in Kenya?

Are fixed telephone services complements or substitutes for the mobile phone services?

1:6 RESEARCH OBJECTIVES

The general objective of this research paper was to provide quantitative estimate of the elasticities of demand for the mobile telecommunications services in Kenya. The specific objectives were to:

1) estimate own price elasticity of demand for mobile telecommunication services
2) determine the income elasticity of demand for mobile telecommunication services
3) evaluate the cross-price elasticity of demand for the mobile telecommunication services

1:7 JUSTIFICATION OF THE STUDY

Research on demand elasticities for mobile telecommunication services has been scantily undertaken in Kenya. Elsewhere in the world where it has been conducted, the industry characteristics are different from those obtaining in Kenya and therefore cannot be generalized. The research done on developing countries has been qualitative or used cross-sectional data rather than country specific data (Aker and Mbiti 2009, Hamilton, 2003).

Kenyan mobile service providers have been involved in fierce price war over the last 5 years. The overall effect has been a fall in the industry profitability, where only one firm is currently profitable. Despite the price reductions by Airtel, Essar and Orange Telecom, their combined market share is less than 40%. This has called into question the influence of own price elasticity and by extension the effectiveness of price wars in increasing firms market share and thus profitability. The firms would therefore benefit from understanding demand elasticities to inform among others, the pricing policies and assess whether price war is justified.

The extent of substitutability or complementarity between the mobile telecommunication and fixed line telecommunication in Kenya has not been studied. The growth of the telecommunications sector depends on the government understanding the relationship between the mobile and fixed line telecommunication and thus determining the level of investment to make in the fixed telephone network.

The regulatory authority (CCK) is seeking to enhance and deepen competition in the sector, increase efficiency and improve performance. This needs the understanding of the demand elasticities to assess the level of intervention essential to improve consumer welfare, through pricing regulation, adjustment of termination fees and avoidance of collusive behavior by the firms. While in developed countries price elasticity has been used to determine regulatory interventions, this has not been the case in Kenya. Network cost studies have been the only basis for reduction of mobile termination rates with an assumption that this will reduce off-net call prices and precipitate price competition. The anticipated changes induced by changes in call prices, however, would be better understood from the viewpoint of price elasticity of demand.

The tax revenue of a government depends on the demand elasticity. Where demand is price inelastic the tax burden is shifted to consumers and where elastic little tax is collected as the burden is shifted to firms thus reducing their profitability. The government needs to assess the price elasticity of demand before devising taxes on mobile telecommunication services. Estimation of demand elasticities is important in assessing consumer welfare positions for purposes of public policy. Little such research has been conducted in Kenya.

1:8 LIMITATION OF THE STUDY

In constructing a panel for the data to be used for the analysis, the values on some variables in some periods were not available resulting in unbalanced panel and this limited the extent of analysis. Telecommunication data, especially in Kenya, was difficult to collect or was in its raw form and inadequate to enable useful manipulations. Similar studies have used Average Revenue per User (ARPU) to proxy call prices. This is due to multiplicity of tariffs which cause measurement errors. In Kenya, revenue and ARPU are reported annually for only few mobile network operators and therefore this value could not be obtained. The number of subscribers may have been measured with error as data on prepaid and post paid subscribers is aggregated. Further, telecommunications being a technical area requires a level of expertise that may be lacking to the researcher and thus dependence on opinions of other parties whose complete validity or accuracy may have been difficult to ascertain with certainty. The time constraint limited the depth of analysis that went into this study. Steps taken to mitigate these limitations are discussed under data section in chapter three.

1:9 SCOPE OF THE STUDY

The study focused and used monthly data for the period June 2011 to January 2013 due to the limitation of data availability. The estimation or assessment of welfare loss or gain on account of demand elasticities estimated was left to future research. The range of mobile telecommunications services is too wide (and strongly related) to be incorporated in the demand equation. This study concentrated on prepaid voice call services. The mobile termination rate, theoretically, has a significant effect on demand of mobile telecommunication services (particularly voice calls) through its effect on the calling rates. Some studies have estimated its semi-elasticity as well as included it in the regression together with the prices. This study did not estimate the effect of this variable to avoid complicating the analysis.

CHAPTER TWO

LITERATURE REVIEW

Over the recent years, the area of demand for mobile telecommunication has generated immense interest as mobile telecommunication gained importance in the economy. Estimation of demand elasticities has particularly attracted interest from researchers because of its significance in assessing the effectiveness of industry regulation policies and their welfare effects as well as the level of industry competition. Recent studies have also been motivated by the improvements in dynamic panel data models that have greatly impacted the analysis of demand models using panel data. This section reviewed the most recent literature and highlighted the contribution of the study to the body of literature.

2:1 THEORETICAL LITERATURE REVIEW

Laffont, Rey and Tirole (1998a, 1998b), in their seminal articles analyzed network competition where there was non-discriminatory and discriminatory pricing. They contended that high termination charges led to high call prices and firms tended to undercut in order to increase the market shares. By lowering retail prices, firms attract additional subscribers and induce the network subscribers to make greater number of outbound calls thus increasing termination revenue. Where there is discriminatory pricing of calls the firm reduces the on net prices relative to off-net prices to increase the price of competitor and thus cause them to lose market share. The price differential between the off-net and on-net calls thus generates the network effect despite interconnection. This analysis is anchored on the assumption that the demand for the telecommunication services is price elastic. They therefore argue that entrants undercut the incumbents, that is, their on-net and off-net call prices are lower. This is calculated to gain market share and is only possible where demand is price elastic.

Wright (2003) postulates that to increase profits, a firm may increase the termination fees and reduce the on-net call price to attract customers. By increasing the termination charges they increase the price of the off-net calls of the competitors and thus reduce the demand for their services while increasing their own demand because of lower prices. He therefore assumes that the demand for the telecommunication services is price elastic

2:2 EMPIRICAL LITERATURE REVIEW

Ahn and Lee (1999) studied the determinants of demand for mobile services. They used cross sectional data of 64 countries for the year 1998 and estimated the demand for access based on the observed fact that the rate of subscription in a country is influenced by factors specific to that country. These factors included the existing tariff systems, the country's wealth, the level of technological development and industrialization, and fixed network facilities. They found out that the likelihood of subscribing to use a mobile telecommunications service was correlated (positively) with the GDP per capita and number of fixed telephone lines per person. They concluded that the likelihood of subscribing to mobile telecommunications services was weakly associated with the mobile telecommunications service price.

Growitch, et. al (2010) using a sample of 61 mobile service providers from 16 European Union member states and data from 2003 to 2008, evaluated the demand elasticity for mobile services, relationship between mobile termination rates and retail price and effects of change in Mobile termination rates on minutes of use. They estimated short run price elasticity of demand to be (-0.097) and a long run price elasticity of demand of -0.608 using the dynamic Generalized Method of Moments (GMM) panel estimator. The study further found out that mobile termination rates and retail price of calls moved in the same direction (10% increases in mobile termination rate leads to 7.1% increase in retail revenue per minute). When prices and mobile termination rates elasticity of demand were estimated together, there was an increase in demand elasticity in the short run (-0.133) and in the long run (-0.715). Because of the risk of high correlation between mobile termination rates and call rates, they identified the effects of mobile termination rate on demand over and above the price effect, which they found to be small. The coefficient on the number of subscribers was negative, which they concluded meant existence of a smaller demand of marginal subscriber of the mobile service provider.

Dewenter and Haucap (2008) analyzed price elasticities in the Austrian market for mobile telecommunication services using data on firm specific tariffs over the period from January 1998 to March 2002. They were the first to use dynamic panel regression to estimate short run and long run demand elasticities for business and private consumers with both postpaid contracts and prepaid cards. They found that business consumers had a higher elasticity of demand (-0.33) than private consumers (-0.14) and postpaid customers had a higher elasticity of demand than prepaid customers. The demand was generally higher in the long-run. Among the private consumers, the demand was more elastic on postpaid contracts (-0.22) than prepaid card customer where no statistically significant elasticity was found (they argue this could have been due to overstatement of active subscribers in the data). They concluded that the long-run elasticities computed were higher and roughly the same for business customers and private prepaid customers. The findings on the insignificance of demand elasticities of prepaid services defy intuitive reasoning. They further found subscriber bases to have a negative and statistically significant impact on demand per subscriber suggesting that late adopters used their mobile phones less than earlier adopters. Past month's traffic had a positive effect on current traffic numbers suggesting habitual consumer behavior. The study did not however estimate the income elasticity of demand or the cross-price elasticity of demand.

Similar conclusions were arrived at by Haucap et.al (2010) when they estimated demand elasticities for Turkish mobile telecommunications market. They used firm level data for five competitors for the periods between January 2002 and December 2006 and estimated dynamic panel data models including instrumental variables technique. Their quantity variable was mobile traffic measured by outgoing off-net traffic per subscriber. In carrying out the estimations, they separated the prepaid market from the postpaid market because of differences in the demand characteristics. They estimated the long run price elasticity of -0.72 for post-paid market and of (-0.33) for prepaid. The short run price elasticity was -0.36 for post-paid and -0.20 for prepaid. They also found evidence of fixed to mobile traffic substitution for consumers who use prepaid cards. The cross-price elasticity was not significant for the postpaid customers. They concluded that the short-run elasticities were smaller in postpaid markets because of fixed contracts while for the prepaid markets there was no significant difference between short-run and long-run elasticity since prepaid markets were flexible in the short-run (especially with multiple SIM cards). This study also did not control for the effects of income on demand.

Chris (2003) modeled UK mobile telephone price elasticity of demand and market penetration for the four mobile operators using pooled time series cross-sectional analysis on quarterly basis starting 1996 3rd Quarter to 1999 1st Quarter to develop a demand model. He found price elasticity of -0.49. All the coefficients had expected signs, that is, price (negative), GDP (positive), and subscribers (positive)

Afridi et.al (2010) conducted a systematic economic analysis of the rapid growth in the in UK telecom sector and demand for mobile services using data on the four cellular operators and fixed line services from 1999 2nd Quarter to 2006 4th Quarter. They found that the price elasticity of demand was (–0.52) -which was closer to be finding by Chris (2003). GDP and subscribers were both positively related to minutes of mobile telephone.

Genakos and Valletti (2009) using a panel of more than 20 countries over six years empirically showed existence and magnitude of waterbed effect on prices. The results show it is strong but not full. They concluded that regulation through mobile termination rate had negative and significant effects on prices. The magnitude of waterbed effect was estimated to be above one

Chabossom et.al (2006) used data from nationally representative survey conducted in 17 African countries to analyze mobile adoption and usage. The research found out that income variable was significant and variable in all the 17 countries. Nigeria had the highest income elasticity and Mozambique the lowest. They concluded that income elasticity seemed to be linked to relative cost of mobile usage. The study failed to estimate price elasticity and instead used qualitative data to conclude that there was negative relationship between call prices and demand for mobile telecommunication services. The majority of respondents in the study indicated their willingness to make more calls at lower prices.

Madden and Coble-Neal (2003) used a global telecommunications panel comprising 56 countries and annual data for the period 1995-2000 to estimate a dynamic demand model. Their study examined the substitution effect between fixed and mobile telephony while controlling for the consumption externality associated with telephone networks. They modeled optimizing economic agent behavior directly to derive mobile demand equations for estimation. They found that mobile network size had the greatest long-run impact on the mobile subscription, followed by the reduction of mobile telecommunications service prices. They further found evidence of significant substitution effect. Increased in the prices of the fixed telephone services raised the mobile telecommunications service subscriptions. Among the significant factors that affect mobile growth, they concluded that income was the least important.

This conclusion was also arrived at by Michael (2005) in a household survey conducted over the period 1999-2001 in the US. Christopher(2007), however, while estimating telecommunication demand model for residential mainland and mobile telephone services for developing countries for period 1996-2003 found cross elasticity of demand insignificant. Gruber (2001) on the other hand found a positive relationship between growth of fixed lines services and mobile services in eastern European countries.

Using sample data for several African countries, Hamilton (2003) investigated whether mobile services are substitutes or complements for fixed services. She found out that mobile services are substitutes in developing countries where fixed network access is either low or non-existent. She concluded that mobile telecommunications services act as a competitive force which compels the providers of fixed services to improve access to their networks. She further concluded that mobile and fixed services may be substitutes or complements, even where access to fixed networks is relatively low.

2:3 OVERVIEW OF LITERATURE REVIEW

Most of the research has concentrated on estimating the price elasticity of demand. The results are however varied. Some studies have found statistically significant elasticities of demand, while others have found the price elasticity of demand for the prepaid service to be statistically insignificant. This means that there is no consensus in the literature regarding the extent (significance) of own-price elasticity of demand for mobile telecommunication services. This study provides research backed evidence on the side of divide where Kenyan telecommunications market falls and therefore help build consensus.

The reviewed literature also show that very little attention has been given to the income elasticity of demand and none has attempted to estimate it. There is consensus that the coefficient of the income variable is positive but the extent of this relationship has not been quantified. This study attempted to fill that gap.

In the few studies that have attempted to incorporate the price of fixed line services, the results have been different with some showing the fixed and mobile services as complements while others find a substitution effect. There is no consensus on the effect of fixed line telephone services on the growth of demand of mobile telecommunication services in Kenya. This made the study important.

The tests of the effects of increased mobile subscriptions on demand of mobile telecommunications service (network effects) have generated mixed results, some with a negative coefficient on subscriber variable. The negative coefficient means smaller demand for the marginal customers. Other studies have shown a positive relationship. This study sought to establish the effect of incremental subscribers on total demand. Several studies find the mobile and fixed telecommunication services to be substitutes in African states and conclude that the mobile services demand influences the fixed network providers to improve their services. These studies however used cross-sectional data and therefore are not specific to any country. A country specific study was necessary.

CHAPTER THREE

3.0 METHODOLOGY

This chapter consists of three parts: development of the theoretical framework, discussion on the nature of data used and the empirical model specification.

3:1 THEORETICAL FRAMEWORK

The framework is based on the theory of consumer behavior. The consumer is assumed to maximize the utility derived from the consumption of a bundle of goods (use of telecommunication services in this case), Varian (1992, pp 98, 99). The consumer is faced with a utility maximization problem expressed as follows:

$$\text{Max } U(X); \text{ such that } PX \leq Y \text{ (budget constraint)} \qquad (1)$$

Where P is the price of X, X is the consumption bundle and Y is the consumer income. Assuming local non-satiation, the consumer's problem may be restated as follows;

$$V(P, Y) = \text{Max } U(X^*) \qquad (2)$$

Where, V (P, Y) is the indirect utility (maximum utility achievable at a given level of prices and income). X* is the demanded bundle that maximizes the consumer utility at the given level of prices and income (solves the consumer problem). The utility function can be restated as follows;

$$U^* = U(X^*) \qquad (3)$$

The demand function is that which relates the price and income to the demanded bundle and can thus be written as;

$$X^* = X(P, Y) \qquad (4)$$

Since the utility is derived from consumption of X* at given price and income, it therefore follows that the relationship can be demonstrated by the Roy's identity, Varian (1992, pp107)

$$V(P, Y) \equiv U[X(P, Y)] \qquad (5)$$

Equation (5) shows the relationship between the demand function and the utility function. Direct utility is not measurable but can be expressed as an indirect utility which is measurable and given the relationship expressed in (5), the consumer's objective of utility maximization can be modeled as a demand function. In the context of telecommunication services demand, the demand determinants can be extended and hence the following equation developed to model the demand.

$$Q_t = f\,(P_M, P_F, Y, S_B, Net, t) \qquad (6)$$

Equation (6) shows the demand for mobile telecommunications services at time (t) as a function of the mobile telecommunication service price (P_M), fixed telecommunication service price (P_F), income (Y), subscriber base (S_B) and network characteristics (Net), all at time (t). The subscriber base is meant to capture the network effect on demand for the mobile telecommunication service, while the network characteristic will capture effect of the quality of the service (network stability). The fixed network is assumed to be either a substitute or a complement to the mobile network.

3:2 VARIABLES AND DATA

3:2:1 Dependent variable

The outgoing minutes of use (MoU) per subscriber are the dependent variable estimated by dividing the total outgoing minutes of use for a mobile network operator (MNO) with the subscriber base for each period under consideration. MoU will be the proxy for the unit of service demanded (such that the unit of service demanded will be monthly MoU per subscriber).

3:2:2 Independent variables

Lagged dependent variable (lagmou)

The lagged dependent variable is used in the dynamic model to determine existence of path dependency of the price and income elasticity of demand or lack of it. This variable is also used in the static model since mobile telecommunications service consumption is habit forming.

Average price (rp)

Average price is the average mobile tariffs of the mobile prepaid voice call arrived at by averaging the on-net and off-net calling rates of the mobile network operators. The average takes into account the promotional tariffs extending for a period of not less than one month. The nominal price is divided by the consumer price index to obtain the real price that is used in the regression

Subscriber base (sbase)

Subscriber base is the number of customers subscribed to each mobile network operator per month. The subscriber base includes all the prepaid customers and excludes the post-paid customers due to unavailability of data on the post-paid tariffs. Subscriber base is the proxy for network effects. The postpaid subscribers were 1% of the total subscribers and therefore have no significant impact where aggregated with the prepaid subscribers

Subscriber income (y)

The Gross Domestic Product (GDP) per capita is the measure of individual income estimated by dividing the monthly GDP with the monthly population estimate. The expected sign of the coefficient is positive or negative.

Internet subscribers (net)

This is the measure of value addition on voice call service provided by the mobile service providers. However due to the evolution of social media (facilitated by internet connection), internet service may act as a substitute service.

Fixed line minutes of use (flmou)

Fixed line minutes of use is a measure of the demand for the fixed line network service. It is expected that the fixed network service may be either a complement to mobile telecommunications service or a substitute. Whichever way, it is expected to affect the demand for mobile telecommunications service.

3:2:3 Data

The study uses monthly data for the period June 2011 to march 2013. The data is provided on quarterly basis but due to unavailability of data relating to Minutes of Use subscriber's base and Average call rates for periods before June 2011 it became necessary to convert the data into monthly basis in order to generate enough data points for regression.

The Quarterly GDP, subscriber base, minutes of use (MoU), fixed line minutes of use and internet service subscribers have been converted into monthly estimates by use of statistical software MATLAB while the monthly population estimate is extrapolated by use of Ms Excel based on a population growth estimate of 2.8% (Kenya national bureau of statistics estimate) and the total population as at 2009 August (national population census).

The quarterly GDP was converted to monthly GDP, the consumer price index and the percentage growth estimates were obtained from the Kenya National Bureau of Statistics (KNBS). The Minutes of Use (mobile and fixed line), internet subscriptions and subscriber base data were obtained from the communication of Kenya quarterly reports while the mobile tariffs were obtained from company briefs and reports from the Business Daily over the entire period covered by the study.

3:2:3:1 Limitations of the data

The use average revenue per user (ARPU) would have been a better measure of the retail price of the prepaid calls but this data was unavailable and mobile network operators did not respond to request to avail such data or their own measure of average call rate. The choice of averaging tariff rates though inferior is appropriate because over the period covered all the firms had a single tariff for the prepaid subscriber in contrast to prior periods and countries covered in other studies. However ARPU would have provided monthly retail price of the call as opposed to price per minute as used in this study.

The use of money transfer service data would have most appropriately measured the value addition since it is not a substitute to voice call service. This data (on the number of subscribers to the service or the amounts transferred or the number of transactions carried out was not available). Data on base stations that could have been used to control for network stability could not be availed and thus this control variable was not included at the risk of exuberating the correlation.

3:3 EMPIRICAL MODELS

Two empirical specifications have been used in the literature. The study specifies the two models (static model and dynamic model) to establish the existence of path dependence in the elasticity of demand for telecommunications services in Kenya (or lack of it).

The first model (also used by Dewenter and Haucap, 2004) is a static simple log-linear specification of an iso-elastic demand function of the form:

$$q = p^{n} \quad \text{(7)}$$

Where n is the long-run own price elasticity of demand. Since the data used is of a panel nature, the equation specified is as follows:

$$Lnq_{it} = \beta_{it} + \beta_1 lnp_{it} + \sum_{k=3} \beta_k x_{it,\,k} + \varepsilon_{it} \quad \text{(8)}$$

Lnq_{it} is the average quantity demanded, p_{it} is the respective average price, $x_{it,\,k}$ are the additional explanatory variables and ε_{it} is the error variable. The β_s are the coefficients to be estimated. If β_{it} is fixed over time but differs over the cross-section units, the fixed effects model would be appropriate to estimate equation (8) but if it can be decomposed into a constant and a specific random variable, random effects model would be used. Ordinary fixed effects or random effects models may give biased results because of the endogeneity problems and therefore the panel instrumental variables method would be used. The first differencing or the fixed effects eliminates time-constant variable and does not solve the problem of time-varying omitted variables that are correlated with explanatory variable (Wooldridge 2004 p461). The method of instrumental variables (IV) can be used to solve the problem of endogeneity of one or more explanatory variables. The method of Ordinary Least Squares (OLS) is used where explanatory variables are uncorrelated with the error term. In the equation (8), price could be related with the error term such that:

$$Cov\,(p_{it}, \varepsilon_{it}) \neq 0 \qquad (9)$$

Where situation (9) obtains, OLS generates biased and inconsistent estimators. For the fixed effects model, the study will apply the Two Stage Least Squares (2SLS) 'within' estimator while the Two Stage Least Squares (2SLS) would be used for the random effects model. A robust Feasible Generalized Least Squares (GLS) random effects model will be used to take care of heteroskedasticity and produce robust standard error estimates.

The second model is the so called Houthakker-Taylor that has been used in many studies [Dewenter, & Haucap, (2004, 2007), Growitsch et.al 2010, and Haucap et.al 2010] because it takes into account the possible path dependencies of consumption. In this model, demand at time (t) can be expressed by the following equation:

$$q_t = q^a_{t-1}\, p^b_t \qquad (10)$$

Where b is the short-run price elasticity and $\frac{b}{1-a}$ is the long-run price elasticity of demand. Given the panel structure of the data for this study, the model specified is as follows:

$$Lnq_{it} = \beta_{it} + \beta_1 lnq_{it-1} + \beta_2 lnp_{it} + \sum_{k=3} \beta_k x_{it,\,k} + \varepsilon_{it} \qquad (11)$$

The possibility that prices may be endogenous and the inclusion of lagged endogenous variable (q_{it-1}), would lead to biased results if the usual panel techniques were used, hence a dynamic panel analysis would be appropriate. The use of lagged dependent variable is based on the economic assumption that due to the force of habits (inertia), people do not change their calling patterns immediately following a price decrease or an income increase because the process of adjustment may result into an immediate disutility (Gujarati, 2004, p662). Contractual obligations in the postpaid arrangements would also cause inertia. For this reason (response with a lag) we would expect the short-run price and income elasticities to be lower in the short-run than in the long-run. A first difference transformation on equation (11) will lead to:

$$\Delta lnq_{it} = \beta_1 \Delta lnq_{it-1} + \beta_2 \Delta lnp_i + \sum_{k=3} \beta k \Delta lnx_{it,\,k} + \Delta\varepsilon_{it} \qquad (12)$$

Equation (12) can be consistently estimated using a Generalized Method of Moments (GMM) approach that was proposed by Arellano and Bond (1991). The use of Ordinary Least Squares (OLS) would lead to biased and inconsistent estimators due to likely presence of autocorrelation between Δlnq_{it-1} and $\Delta\varepsilon_{it}$. The lagged dependent variable and the endogenous variables would then be instrumented by their lagged values to account for the possibility of existence of endogeneity problem. Since the variables in equations (8) and (12) are in the logarithmic form, the coefficients can then be interpreted as elasticities. The Hausman specification tests is be performed on the models to test to determine whether to use the fixed effects model or the random effects model. The Sargan test of over-identifying restrictions on the number instruments is be applied to test the validity (orthogonality) of the instrumental variables used in the dynamic models. The estimation procedure, results, discussion of results and interpretation is done in chapter four and summary and conclusion in chapter five.

CHAPTER FOUR

EMPIRICAL RESULTS AND INTERPRETATION

4:1. Descriptive Statistics

Table 4:1. Descriptive Statistics

Variable	mean	Std dev	Minimum	Maximum
lnMoU	4.818 (88)	0.011	2.773	5.858
Lnsbase	15.409 (80)	0.825	14.254	16.792
Lny	-4.610 (76)	0.098	-4.666	-4.630
Lnrp	-3.858 (80)	0.334	-4.494	-3.381
Lnnet	13.789 (88)	1.122	11.574	15.780
Lnflmou	17.610 (88)	0.402	16.982	18.458

Number of observations is given in parenthesis

Descriptive statistics are given for the following variables

LnMoU = logarithm of the variable monthly MoU per subscriber

Lny = logarithm of subscriber’s income given by the GDP per capita

Lnrp = logarithm of the real price of voice call service per minute

Lnsbase = subscriber base

Lnnet= the logarithm of the mobile internet subscribers

Lnflmou= logarithm of the fixed line minutes of use (total)

4:2.1 Static models regressed

Lnmou = sbase+ lnrp + lny +net + lnflmou+ e…………………….. (13)

Table 4:2 results of fixed effects and random (GLS) estimates

Dependent variable=lnMoU				
	Fixed effects model		Random effects model	
Variable	coefficient	p-value	Coefficient	p-value
Sbase	-3.030 (8.350)	0.001**	1.010 (2.280)	0.000**
Lny	14.112 (3.861)	0.001**	-9.460 (14.109)	0.503**
Lnrp	-0.0026 (0.1038)	0.980**	0.5246 (0.5223)	0.315**
Net	-6.310 (6900)	0.927**	1.830 (0.109)	0.005**
Lnflmou	-2.0517 (0.0719)	0.006**	0.109 (0.257)	0.567**
Constant	76.21 (18.99)	0.000**	-44.182 (66.53)	0.507**
	R-squared- Within-0.2658 -Between-0.2636 -Overall-0.2496 No of observations =76		R-squared-Within-0.0044 -Between-0.3578 -Overall-0.3336 No of observations =76	

Standard errors are in parenthesis. **is 5% significance level

The fixed effects model and random model are regressed on the data to estimate the equation (13) above. The demand for fixed line demand is incorporated by using the minutes for fixed line network. The coefficient of this variable is a measure of cross elasticity of demand while the lagged dependent variable is included in the independent variables in equation (14) as a measure of inertia by consumers of mobile telecommunication services. The models are regressed by use of STATA software.

Estimation of equation (13) whose results are shown in Table 4:2 above reveal high level correlation and low R-squared (0.25). This means that 75% of the changes in the dependent variable are explained by the error term which is correlated with the independent variables. This may also suggest the presence of heteroskedasticity. A robust estimation (FGLS) of the same equation shows R-squared of 0.9748 but the random effects robust estimates (FGLS) show negative coefficient for income variable. This is contrary to economic theory (mobile services are considered normal goods). Additional variable (lagged dependent variable) is included in the model to account for habit. Mobile usage is partly affected by lifestyle and thus is assumed to be habit forming. Equation (14) is estimated and the results are shown in table 4.3

Lnmou= laglnmou + lnsbase + lny + lnrp + lnnet + lnflmou + e………………… (14)

The estimation results in Table 4:3 below show low levels of correlation in the fixed effects model and a high R-squared for both random and fixed effects model. The fixed effects model estimates are robust (FGLS). The coefficients for the price and income have signs that are consistent with economic theory. The subscriber base and the fixed network demand variable coefficients have been found to take different signs in literature. Both models find coefficient for lagged dependent variable positive subscriber base and internet subscriptions negative. The fixed network coefficient’s sign is different for each model.

Table 4:3. Results of estimation equation 14

Dependent variable=lnMoU				
	Fixed effects model		Random effects model	
Variable	Coefficient	p-value	Coefficient	p-value
Laglnmou	0.868 (0.475)	0.000**	1.000 (0.121)	0.000**
Lnsbase	-0.528 (0.132)	0.000**	-0.0092 (0.021)	0.654**
Lny	5.049 (1.191)	0.000**	3.159 (1.545)	0.041**
lnrp	-0.1839 (0.0464)	0.000**	0.0219 (0.530)	0.679**
lnnet	-0.039 (0.033)	0.237**	-0.013 (0.011)	0.243**
lnflmou	-0.109 (0.028)	0.000**	0.004** (0.031)	0.899**
constant	34.015 (6.106)	0.000**	14.865 (7.566)	0.049
	R-squared = 0.9963 Adj R-squared = 0.9958 Root MSE = 0.0689		R-squared: within-0.7864 Between =0.9999 0verall =0.9922	

Standard error is given in parenthesis. ** is 5% significance level

4.2.2 Specification tests

In view of the different results generated by the fixed and random effects model, it is imperative to use a model that is superior and thus the need to carry out specification test. The Hausman test conducted on the fixed effects regression and the random effects GLS regression rejects the null hypothesis and thus the random effects model is the appropriate specification to use

4:2.3 Results of the random FGLS model estimated

The random model is estimated using the feasible generalized least squares (FGLS) method in order to generate robust estimates incase of presence of heteroskedasticity or autocorrelation. Therefore the standard errors generated are unbiased.

Table 4:4. FGLS Random effect results (robust estimates)

The dependent variable = lnMoU		
Variable	Coefficient	p-value
Laglnmou	1.000 (0.115)	0.000**
Lnsbase	-0.0919 (0.020)	0.637**
Lny	3.159 (1.468)	0.031**
Lnrp	-0.023 (0.050)	0.663**
Lnnet	-0.013 (0.013)	0.219**
Lnflmou	0.0039 (0.296)	0.894**
Constant	14.865 (7.189)	0.039**
N = 76 log likelihood =72.002		

The standard errors are in parenthesis. ** is 5% significance level

All the variables have the expected signs and are insignificant apart from subscriber income and lagged dependent variable. The F-test for both random and fixed effects model reject the null hypothesis that the variables are jointly equal to zero.

4:2.4 Dynamic panel data model

A dynamic panel data model of the form in equation (14) is estimated using Arellano-Bond linear dynamic panel-data estimation.

dlnMoU =l2dlnMoU + dlnsbase + dlny + dlnrp + dlnnet +dlnflmou+ e………….. (15)

Table 4:5. Estimation results for the dynamic model

The dependent variable = dlnMoU		
Variable	Coefficient	p- values
dlnMoU L1	1.189 (0.097)	0.000**
L2dMoU	-0.5171 (0.091)	0.000**
Dlnsbase	-0.257 (0.212)	0.225**
Dlny	7.906 (3.259)	0.015**
Dlnrp	-0.035 (0.026)	0.184**
Dlnnet	0.019 (0.037)	0.618**
Dlnflmou	-0.118 (0.054)	0.029**
Constant	0.010 (0.009)	0.265**
Sargan test	Chi2 (53)= 46.262 Prob>chi2 = 0.7320**	
Long-run elasticity	-0.5171	

Standard errors are in parenthesis. **-5% significance level

In the dynamic model, the regression using the first lags leads to the rejection of the null hypothesis of the Sargan test at 5% significance level. The regression is then done using the second lagged of the differenced dependent variable. The first lagged differenced dependent variable (and lagged dependent variable) inclusion in the long run regression leads to dropping of the variable due to collinearity and hence the use of the second lagged differenced dependent variable. The Sargan test of over-riding restrictions does not reject the null hypothesis and thus the instruments used are valid (orthogonal).

4:3. Interpretation of the results

The variables are expressed in logarithmic form and therefore the coefficients can be interpreted as elasticities and percentages. The coefficient of price is negative and therefore in agreement with the economic theory. The price elasticity of demand under the static model (Table 4:4) is inelastic (-0.023) and not statistically significant. This finding is consistent with the reality of the Kenyan telecommunications market. The Safaricom call prices are the highest yet its subscriber base and revenues have exponentially increased over the period covered by the research. The demand for the mobile telecommunication service is price inelastic. The subscriber income has the expected positive sign (3.159) and is statistically significant. This means the demand for the mobile telecommunication services is income elastic. The negative subscriber base coefficient means that additional subscribers in a network reduces the average minutes of use per subscriber meaning new subscribers have less usage of mobile telecommunications service especially the voice calls. The late adopters may be youths who are dependent on their parents and do not call but use more internet based social media (face book and WhatsApp) and short messaging as opposed to voice call. This is supported by the negative coefficient of the internet subscriptions variable (though the variable is insignificant).

The demand for internet services is a substitute (and not a complement as would have probably been for mobile money transfer) for the voice calls. This however does not mean the revenue base of the firm is declining since both services are offered by the same firm. The negative subscriber base may be explained by connections by elderly rural parents communicating and receiving money from children in urban centers. Affordability may be influencing the increase in subscription but without necessarily increasing the minutes of use. The coefficient for the lagged dependent variable is positive and significant. This means the present demand for mobile telecommunication services (voice call in this case) is significantly influenced by the demand of the previous period. This demand spillover, notwithstanding changes in other variables, suggests inertia (habit influence) by subscribers. The fixed line network demand coefficient is positive (0.0039) and insignificant. The coefficient measures the cross elasticity of demand for mobile telecommunication services. The positive sign of this coefficient means that in the short-run fixed line network service is a complementary service to mobile telephony service though the magnitude of the coefficient and significance suggest a weak complementary effect. There is joint influence of all the variables on the demand for mobile telecommunication service. This means the subscriber may not be influenced by the price individually, but would if the price is considered jointly with other variables

Table 4:4 shows that in the dynamic model, all the coefficients have the expected signs and are statistically significant apart from the coefficients for subscriber base, call price and internet subscriptions. The short-run demand is price inelastic (-0.035). The long-run price elasticity of demand is (-0.5171) and is statistically significant. This is higher than the short-run price elasticity meaning the subscribers are more responsive to the long-run price changes than the short-run effects of price changes. This also shows presence of path dependence of elasticities of demand. The long-run price elasticity of demand is expected to be higher as subscribers break the inertia and adjust their calling habits to the changed price regimes. In a market characterized by intense price competitions in pursuit of bigger market shares, consumers are exposed to short term promotional price reductions that do not last long enough to adjust habits and non-simultaneous price adjustments by the competitors and thus calling costs across networks remain unaffected by the price reductions in the short-run. This explains higher elasticity in the long-run as mobile network operators realign their prices. The income elasticity of demand is higher (7.906) and statistically significant as real cost of calls become apparent. The internet service complements voice call service in the long-run (0.019) while the fixed line network service becomes a substitute (-0.118) and is significant. The use of mobile phones reduces usage of fixed lines. However in Africa where fixed line connection was poor, lack of fixed line network may have influenced higher intake of mobile telephony services.

CHAPTER FIVE

SUMMARY AND CONCLUSION

5:1. Summary

The mobile telecommunication sub-sector has grown tremendously over the last decade contributing about 18% to the gross domestic product and providing employment directly and indirectly to thousands of people in Kenya. The number of mobile network firms has increased from two in 2000 to four by 2013. The number of subscribers has also increased exponentially to over 30million by 2012 accounting to penetration rates of 76% over the same period. This growth has been attributed to drastic reduction in calling call rates occasioned by increased competition and reduced termination rates, reduction in prices of the mobile handsets, increased incomes, innovative prepaid system, low denomination airtime cards and value addition among others.

The contribution of call price, fixed line telephone connection and income factors has no consensus in empirical literature. Economic theory considers these factors as determinants of demand. However, the effects of these factors on demand for mobile telecommunication services depend on their elasticity. This study set out to estimate the price elasticity of demand, income elasticity of demand and cross elasticity of demand. The study used monthly minutes of use per subscriber, subscriber income, real price of a call (per minute), internet subscriptions and subscriber base and fixed line network minutes of use. Static and dynamic models were estimated. The subscriber base and internet subscriptions are control variable in the estimated equations to account for network effect on quantity of service demanded per subscriber and effect of alternative service to the voice call (whether they are joint products or substitutes)

The static model was estimated using the fixed effects model and random effects model. The Hausman test rejects the null hypothesis and thus the random effect is more desirable. The random effects model is re-estimated using the feasible generalized least squares method to control for heteroskedasticity and autocorrelation thus generating robust estimates. All the coefficients have the expected signs but are individually statistically insignificant apart from the lagged dependent variable and income variable coefficients.

Internet service is a substitute in the static model and thus reduces the demand for call service while the fixed line service shows a weak complementary effect. The positive coefficient of lagged dependent variable shows presence of inertia (habit) in the use of mobile telephone use. The dynamic model estimated using the generalized method of moments recommended by Arellano and Bond (1991) show short-run price elasticity of demand that is lower than the long-run price elasticity of demand thus confirming presence of path dependencies of elasticities of demand for the mobile telecommunication services. The Sargan test of over identifying restrictions using first lags of first difference of variables (and second lag of dependent variable to correct collinearity caused by inclusion of first lag dependent variable as one of the independent variables) does not reject the instruments used.

5:2. Conclusion

The results show that the demand for mobile telecommunication services is price inelastic, demand elastic and complements fixed line network service in the short-run. The new subscribers are found to use less of voice call and thus reduce the average minutes of use per subscriber. This is attributed to use of short messaging and internet based social media tools that substitute voice call (and are not consumed jointly as would be the case for mobile based money transfer/ payment service). The price elasticity of demand is inelastic and both in the short-run and the long-run though higher and significant in the latter. The income of demand for mobile telephony services is elastic and significant. This means that increase in call rates would reduce the demand while increase in income would increase the demand. The variables jointly influence demand.

5:3. Recommendations

The price inelasticity of demand means that reduction of prices by the mobile telecommunication operators do not necessarily increase the minutes of usage and can only result in losses if it is the only strategy being relied on by the firm to increase revenue. Diversification into joint products or substitutes (money transfer, short messaging and internet) to mitigate the inevitable reduction in average minutes of use and reduction in call rates is imperative. The government policy of reducing the termination rates (which increase consumer welfare only through reduction in off-net call rates) may not increase the usage of mobile telecommunication services but would rather reduce the investments made by the firms in their network upgrade and stability and this may affect the quality of services offered. This is because firms would be reluctant to invest in their network for free use by competitors. The effect would be to eventually lower quality of services offered by the industry as well as cut down the overall industry expansion.

The mobile telecommunication service providers should concentrate their efforts on quality and diversification into non-voice services like internet short messaging and money transfer. The marginal subscriber demands less of the services and therefore subscriber base may not mean proportionate increase in the revenue from voice calls.

5:4. Limitation of study and areas of further areas of study

Lack of mobile telecommunications data has been the most constraining problem of research on mobile telecommunications sector. This study experienced the same problem to the extent that the average revenue per user that would have been the most appropriate measure of the retail price of a call was not available. The data on base stations that would have helped control for the effects of network stability on the demand for the services from a particular operator was not available. The mobile money transfer would have immensely benefitted this research by providing an appropriate joint consumption effect on the voice call.

In absence of complete, secondary data, further research, that rely on the primary data (based on the willingness of the subscriber to pay for a service) is necessary. This could possibly incorporate the effects of value addition, innovation and other qualitative data like level of education and gender. Complete data on short messaging service (SMS) as well as disaggregated data on money transfer service were not available and therefore the two variables were not included in this study. Further research is needed to establish the effect of these two services on demand for voice call service especially in light of the emerging argument that the Safaricom superior money transfer network gives the company unparalleled competitive edge over other operators and hence the call for opening up this network (Mpesa) to the competitors.

REFERENCES

Afridi A, Farooq S, Ullah M and Rahmani R (2010), 'The Analysis of Cellular Services and Estimating Fixed to Mobile Price Elasticities: A Case Study of United Kingdom', *European Journal of Scientific Research* Vol.40 No.3 pp.428-440.

Ahn H and Lee M H (1999), 'An Econometric Analysis of the Demand for Access to Mobile Telephone Networks', *Information Economics and Policy*, 11, pp297-305.

Aker J. and Mbiti M, 'Mobile Phones and Economic Development in Africa', Forthcoming, *Journal of Economic Perspectives.*

Arellano, M. and S. Bond (1991), 'some tests of Specification for Panel Data: Monte Carlo Evidence and Application to Employment Equations', *Journal of Econometrics* Vol.18, pp 47-82.

Banerjee A. and Ros J (2002), Drivers of Demand Growth for Mobile Telecommunications Service: Evidence from International Panel Data, *NERA Economic Consulting.*

Bloom E and Jeffrey (1998), 'Geography, Demography, and Economic Growth in Africa', *Brookings Papers on Economic Activity*, Vol. 1998, No. 2, pp. 207-295.

Chabossom A, Stork C, M Stork and Zahonogo P (2010), 'Mobile Telephony Access & Usage in Africa', *JEL Classification* L86– L96 – D12.

Chris D (2003), 'Demand Analysis and Penetration Forecasts for the Mobile Telephone market in the UK'.

Christopher G and Herbert G (2007) 'Demand for telecommunication services in developing countries', *Telecommunications Policy*, Vol. 31, June 2007, issue 5, pp 276-289.

Dewenter, R. and Haucap, J. (2004), 'Estimating Demand Elasticities for Mobile Telecommunications in Austria', *Discussion Paper No. 33, Universitaet fuer der Bundeswehr Hamburg Holstenhofweg 85 D-22043* Hamburg Germany.

Dewenter R and Haucap J (2007), ‘Demand Elasticities for Mobile Telecommunications in Austria’, *Ruhr Economic Papers* No. 17, Bochum.

Genakos, C. and Valletti, T. (2010), ‘Testing the "Waterbed" Effect in Mobile Telephony’, *forthcoming in the Journal of the European Economic Association.*

Growitsch C, Marcus J S and Wernick C (2010), **‘**The Effects of Lower Mobile Termination Rates (MTRs) on Retail Price and Demand’, *Communications & Strategies*, 80, 4th q. 2010, pp. 119.

Gujarati (2004), *Basic Econometrics* (4th edition) The McGraw−Hill Companies, West Point Military Academy.

Gruber, H. (2001) ‘The Diffusion of Mobile Telecommunications in Central and Eastern Europe’, Information *Economics and Policy*, 13, 2001, issue 7/8/9/10, pp 893-906.

Hamilton, J, (2003), ‘Are Main Lines and Mobile Phones Substitutes or Complements? Evidence from Africa’, *Telecommunications Policy*, 27, 109-133.

Haucap J, Heimeshoff U and Karacuka M (2010), Competition in Turkish Mobile Telecommunications Market: Price Elasticities and Network Substitution, *discussion paper* No 12.

Laffont, J.-J., Rey, P .and Tirole, J (1998a), ‘Network Competition: I. Overview and Nondiscriminatory Pricing’, *Rand Journal of Economics*, Vol. 29, pp. 1-37.

Laffont, J.-J., Rey, P. and Tirole, J.: (1998b): "Network Competition: II. Price Discrimination", *Rand Journal of Economics*, Vol. 29, pp. 38-56.

Levine and Ross (1997), ‘Financial Development and Economic Growth: Views and Agenda’. *Journal of Economic Literature,* **25** (June): 688-726.

Lyakurwa, (2012), ‘Prospects for Economic Governance in Africa: Achieving Resilient Pro-Poor Growth’, *Emerald Group of Publishers*, Vol. 11, No. 4, pp. 66-81.

Madden and Coble-Neal (2003), 'Economic determinants of global mobile telephony growth', *Information Economics and Policy*, Vol. 16, issue4, pp 519-534.

Marcus (2004), 'Call Termination Fees: The U.S. in global perspective', 4th *ZEW Conference on the Economics of Information and Communication Technologies*, Mannheim, Germany, July 2004.

Michael R W and Woroch G A (2005), 'Fixed-Mobile Subscription Substitution in the U.S' *Unpublished.*

Sathish M, Kumar S K, Naveen K J and Jeevanantham V (2011), 'A study on consumer switching behavior in cellular service providers: A study with reference to Chennai', *Far East Journal of Psychology and Business,* Vol. 2, No. 2.

Sheikh T. A and Masatsugu T (2010), 'The Determinants of the Global Mobile Telephone Deployment: An Empirical Analysis', *Informatica Economică* Vol. 14, no. 3/2010 Pp 21-33.

Varian H R (1992), *Microeconomic analysis,* 3rd Edition. WW Norton, 500 Fifth Avenue, New York.

Wooldridge J (2004), *Introductory Econometrics, A Modern Approach*, 2nd Edition. MIT press.

Wright, J., (2002), 'Access Pricing under Competition: an Application to Cellular Networks,' *Journal of Industrial Economics*, 50: 289-316.

APPENDIX 1: TABLES AND FIGURES

Average mobile tariffs

Year	2004	2005	2006	2007
Charges to same network	20.18	19.23	18.89	16.17
Charges to another mobile network	32.38	27.37	26.69	22.63
Charges to fixed network	28.76	27.51	25.52	22.63
International call charges	99.79	99.79	98.25	93.95
SMS same network	5.00	5.00	5.00	3.86
SMS to another network	5.00	5.00	5.00	5.00
International SMS	10.00	10.00	10.00	10.00

SOURCE: CCK

Mobile traffic

Year	2004	2005	2006	2007
Mobile to fixed traffic (Minutes)	286,011,379	274,983,217	71,391,346	18,867,044
Total local mobile traffic (Minutes)	-	3,268,961,952	4,955,485,330	4,905,583,043
SMS sent	152,939,270	355,080,351	255,827,772	445,141,504

SOURCE: CCK

Mobile coverage

Year	2004	2005	2006	2007
Number of BTS	626	1,144	1,606	1,924
Population coverage	52%	62%	65%	77%
Land coverage	11%	13%	19%	27%

SOURCE: CCK

Mobile investment and revenue

Year	2001	2002	2003	2004	2005	2006
Mobile Annual revenue(Millions)	7,674	16,322	22,239	28,393	37,627	46,456
ARPU	13,115.02	12,316.43	13,979.89	11,151.32	7,148.43	6,328.88
Mobile annual investment(Millions)	11,851	19,173	23,662	28,920	38,670	44,600

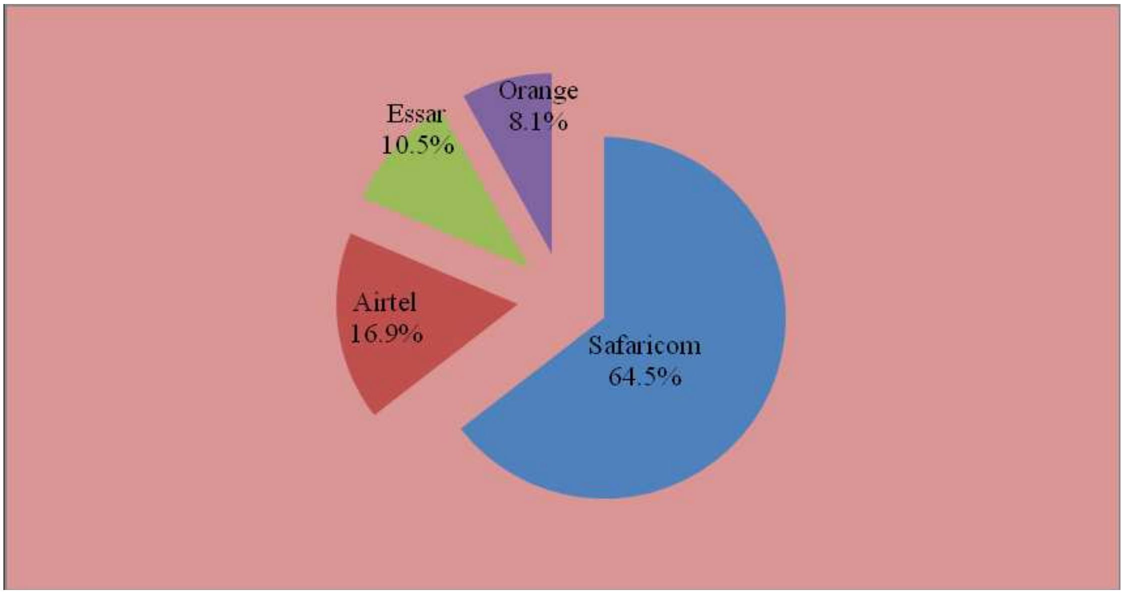
SOURCE: CC

Mobile and Fixed line annual revenue and expenditure

Year	2001	2002	2003	2004	2005	2006	2007	2008
Mobile Annual revenue	7,674	16,322	22,239	28,393	37,627	46,456	57,998	72,625
Mobile Annual investment	11,851	19,173	23,662	28,920	38,670	44,600	21,221	29,936
Fixed annual revenue	22,901	24,098	20,916	20,540	17,657	49,211	-	-
Fixed annual investments	35,499	37,447	36,430	35416	12,568	5,533	-	-

SOURCE: CCK (-) indicates omitted values because Fixed and Mobile were combined

Market shares of operators for year 2012



SOURCE: CCK

APPENDIX II: REGRESSION OUTPUT

Random effect (FGLS) Estimation results of equation (14):

Lnmou= laglnmou + lnsbase + lny + lnrp + lnnet + lnflmou + e………………… (14)

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares

Panels: homoskedastic

Correlation: no autocorrelation

Estimated covariances = 1 Number of obs = 72

Estimated autocorrelations = 0 Number of groups = 4

Estimated coefficients = 7 Time periods = 18

Wald chi2(6) = 10003.20

Log likelihood = 72.00234 Prob > chi2 = 0.0000

lnmou	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
laglnmou	1.000036	.011477	87.13	0.000	.9775411	1.02253
lnsbase	-.0091931	.0195035	-0.47	0.637	-.0474193	.0290331
lny	3.158537	1.468132	2.15	0.031	.2810515	6.036022
lnrp	-.0219271	.0503189	-0.44	0.663	-.1205504	.0766962
lnnet	-.0130716	.0106392	-1.23	0.219	-.0339241	.0077809
lnflmou	.0039329	.0294676	0.13	0.894	-.0538226	.0616884
_cons	14.86487	7.188896	2.07	0.039	.7748924	28.95485

Fixed effects estimation results for equation (14):

Lnmou= laglnmou + lnsbase + lny + lnrp + lnnet + lnflmou + e………………… (14)

```
xtreg lnmou laglnmou lnsbase lny lnrp lnnet lnflmou, fe

Fixed-effects (within) regression          Number of obs      =        72
Group variable: firm                       Number of groups   =         4

R-sq:  within  = 0.8763                    Obs per group: min =        18
       between = 0.7292                                   avg =      18.0
       overall = 0.7331                                   max =        18

                                           F(6,62)            =     73.21
corr(u_i, Xb)  = 0.1899                    Prob > F           =    0.0000

------------------------------------------------------------------------------
       lnmou |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    laglnmou |   .8681694   .0475732    18.25   0.000      .773072    .9632668
     lnsbase |  -.5282416   .1323004    -3.99   0.000    -.7927063   -.2637768
         lny |   5.049173   1.191147     4.24   0.000     2.668104    7.430242
        lnrp |  -.1839361   .0463706    -3.97   0.000    -.2766296   -.0912425
       lnnet |  -.0396106   .0331696    -1.19   0.237    -.1059156    .0266944
     lnflmou |  -.1089987   .0277304    -3.93   0.000    -.1644309   -.0535665
       _cons |   34.01506   6.106277     5.57   0.000     21.80879    46.22133
-------------+----------------------------------------------------------------
     sigma_u |  .63537543
     sigma_e |  .06891265
         rho |  .98837326   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(3, 62) =    19.38              Prob > F = 0.0000

. estimates store fe_effects
```

Random-effects GLS regression estimation results for equation (14)

Lnmou= laglnmou + lnsbase + lny + lnrp + lnnet + lnflmou + e………………… (14)

```
.xtreg lnmou laglnmou lnsbase lny lnrp lnnet lnflmou

Random-effects GLS regression                Number of obs      =       72
Group variable: firm                         Number of groups   =        4
R-sq:  within  = 0.7864                      Obs per group: min =       18
       between = 0.9999                                     avg =     18.0
       overall = 0.9929                                     max =       18
                                             Wald chi2(6)       =  9030.67
corr(u_i, X)   = 0 (assumed)                 Prob > chi2        =   0.0000
------------------------------------------------------------------------------
       lnmou |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    laglnmou |   1.000036   .0120792    82.79   0.000     .9763608     1.02371
     lnsbase |  -.0091931   .0205269    -0.45   0.654     -.049425    .0310388
         lny |   3.158537   1.545164     2.04   0.041     .1300709    6.187002
        lnrp |  -.0219271   .0529591    -0.41   0.679    -.1257251    .0818709
       lnnet |  -.0130716   .0111975    -1.17   0.243    -.0350183     .008875
     lnflmou |   .0039329   .0310138     0.13   0.899     -.056853    .0647188
       _cons |   14.86487   7.566095     1.96   0.049     .0355966    29.69414
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .06891265
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
. estimates store re_effects
```

Hausman specification test results for equation (14)

. hausman fe_effects re_effects

---- Coefficients ----

	(b) fe_effects	(B) re_effects	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
laglnmou	.8681694	1.000036	-.1318661	.0460141
lnsbase	-.5282416	-.0091931	-.5190485	.1306983
lny	5.049173	3.158537	1.890636	.
lnrp	-.1839361	-.0219271	-.162009	.
lnnet	-.0396106	-.0130716	-.026539	.0312224
lnflmou	-.1089987	.0039329	-.1129316	.

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 60.86

Prob>chi2 = 0.0000

(V_b-V_B is not positive definite)

Arellano-Bond dynamic model estimation results for equation (15)

dlnMoU =l2dlnMoU + dlnsbase + dlny + dlnrp + dlnnet +dlnflmou+ e……….. (15)

xtabond dlnmou l2dlnmou dlnsbase dlny dlnrp dlnnet dlnflmou

Arellano-Bond dynamic panel-data estimation Number of obs = 60

Group variable: firm Number of groups = 4

Time variable: month

Obs per group: min = 15

avg = 15

max = 15

Number of instruments = 61 Wald chi2(7) = 252.92

Prob > chi2 = 0.0000

One-step results

dlnmou	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dlnmou						
L1.	1.189325	.0965259	12.32	0.000	1.000138	1.378512
l2dlnmou	-.5171132	.0907842	-5.70	0.000	-.6950471	-.3391794
dlnsbase	-.2571734	.2118214	-1.21	0.225	-.6723357	.1579889
dlny	7.906223	3.259328	2.43	0.015	1.518058	14.29439
dlnrp	-.0351415	.026454	-1.33	0.184	-.0869903	.0167073
dlnnet	.0186155	.0372803	0.50	0.618	-.0544525	.0916836
dlnflmou	-.1184637	.0541294	-2.19	0.029	-.2245553	-.0123721
_cons	-.010424	.0093524	-1.11	0.265	-.0287544	.0079064

Instruments for differenced equation

GMM-type: L(2/.).dlnmou

Standard: D.l2dlnmou D.dlnsbase D.dlny D.dlnrp D.dlnnet D.dlnflmou

Instruments for level equation

Standard: _cons

Sargan test for equation (15)

. estat sargan

Sargan test of overidentifying restrictions

H0: overidentifying restrictions are valid

chi2(53) = 46.26194

Prob > chi2 = 0.7320

APPENDIX III: DATA SOURCES

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report first quarter of the financial year 2012/13 July- September 2012.

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report third quarter of the financial year 2011/12 January - March 2012.

Communication Commission of Kenya (CCK), Quarterly sector statistics report fourth quarter of the financial year 2011/12 (April- June 2012)

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report 1st quarter July-Sept 2011/2012.

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report 2nd quarter October-December 2011/2012.

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report third and fourth quarter 2010/2011.

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report 2nd quarter Oct-Dec 2009/2010.

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report 4th quarter Apr-Jun 2009/2010.

Communication Commission of Kenya (CCK), Quarterly Sector Statistics Report 3rd quarter Jan-Mar 2009/2010.

Communication Commission of Kenya (CCK), Sector Statistics Report April-June 2008/09 august 2009.