

**EVALUATING THE IMPACT OF MARKET STRUCTURE IN MOBILE
TELECOMMUNICATIONS MARKETS: PANEL DATA ANALYSIS FOR
EMERGING ECONOMIES**

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Abstract

The mobile telecommunications industry continues to be at the epicentre for growth, innovation, and disruption for virtually all other industries. It is one of the keys to sustainable economic development especially in developing and emerging economies. Over the past two decades, the industry has been very dynamic, experiencing high growth rates. This paper uses econometric models to investigate the impact of market structure on market outcomes such as mobile prices and investment in emerging economies. This is done using quarterly panel data on fifteen emerging economies across four continents for the period between 2006 and 2015. The Herfindahl-Hirschman index (HHI) and the number of operators are used to proxy market structure and effective price per minute paid by consumers and capital expenditure per subscriber are used to proxy mobile prices and investment respectively. Empirical results indicate that increase in market concentration increases market prices. Results also indicate an inverted-U relationship between market concentration and investment. These results indicate that there is a trade-off between static and dynamic efficiency which means that competition in mobile telecommunications reduces both market prices and investments.

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1. Introduction

The mobile telecommunications industry continues to experience rapid growth. The industry registered a total of 3.6 billion unique mobile subscribers by the end of 2014 which accounted for approximately fifty percent of the world's population up from twenty percent ten years ago (GSMA, 2015). In addition to this, as at 2014, the GSMA (2015) estimates show that there were 7.1 billion global SIM and 243 million machine-to-machine (M2M) connections. The global mobile subscriber base increased by about 5% in 2014 with developed markets growing more slowly than developing and emerging economies as penetration rates approach saturation levels (GSMA, 2015). For instance, Europe and North America recorded unique subscriber growth below one percent in 2014 whereas sub-Saharan Africa which still remains under-penetrated recorded subscriber growth of about twelve percent (GSMA, 2015).

Emerging markets have witnessed the growth in the number of mobile subscriptions from around 500 million in 2002 to around 5 billion in 2013 (Edwards, 2014). Mobile operators' valuations have followed the same trend. Nonetheless, the building of mobile phone networks has created a large amount of value over the last 10 years. In many emerging markets, mobile industry is highly fragmented with some countries having five or more players with a market share of at least five percent (Edwards, 2014; GSMA, 2015).

The mobile telecommunications industry is a major driver of global economic growth and development as well as welfare. Investments in mobile telecommunications infrastructure is likely to provide a short-term boost to the economy and create a foundation for a long-term growth and employment perspectives. For instance, the mobile telecommunications industry generated 3.8% of global gross domestic product in 2014, which is equivalent to over 3 trillion US dollars of economic value across 236 countries (GSMA, 2015). Moreover, research findings indicate that mobile telecommunications industry investment impact go beyond the scope of the industry itself to explain up to one third of the economic growth by promoting growth in adjacent industries and creating new industries (Wieck & Vidal, 2011).

This paper looks at the effect of market structure on prices and investment decisions in mobile industry in emerging economies. Due to lack of reliable data on prices and investments, there is only scarce literature on this subject. This analysis is made possible by use of empirical approach by looking at quarterly data for the period between 2006 and 2015 for fifteen

emerging economies. A challenge in collecting a large panel dataset like this is to find relevant and comparable information across countries and over time. However, the dataset spans a time period long enough to capture changes in market structure that provide variation in the data to assess in a multivariate setting how market structure impacts on prices and investments.

Particularly, this paper focuses on how competition influences mobile service prices and investment decisions. In the literature, competition, for which there is no direct measure, is commonly approximated by market structure, which on the other hand is approximated by market concentration indexes. This study follows this practice. The Herfindahl-Hirschman Index (HHI) is the usual proxy for market structure and hence competition. Number of operators is used as an alternative measure of market structure. Empirical results indicate that increase in market concentration increases market prices. Results also indicate an inverted-U relationship between market concentration and investment. However, number of competitors in the market is found to have no significant effect on both prices and investment. These results indicate that there is a trade-off between static and dynamic efficiency. Competition in mobile telecommunications reduces prices but also results in lower investments as compared to more concentrated markets.

This paper follows the approach used by Genakos, Valletti and Verboven (2015) in their paper on mobile consolidation in mobile industry. They examine the effects of market structure on prices and investment in thirty three OECD countries in what they refer to as the first economically and statistically relevant assessment on dual impact market structure on prices and investment in mobile telecommunication. In their assessment, they use operator level end user prices, capital expenditure as a proxy for investment, mobile termination rates as instrumental variable and the Herfindahl-Hirschman Index (HHI) as proxy for market concentration. However, their study uses data on OECD countries, while this paper concentrates on fifteen emerging economies across four continents. To the best of my knowledge, this is the first paper which investigates the effects of market structure on prices and investments in mobile telecommunications industry in emerging economies.

The rest of the study is organized as follows: Section 2 relates this work to the existing literature. Section 3 describes data and provides information on market trends for the main variables. Section 4 illustrates the empirical framework followed to identify the causal relationship

between market structure, prices, and investments. Section 5 presents the main results and a discussion based on the results and finally section 6 concludes.

1.1 Mobile Telecommunications Industry Overview

The global mobile telecommunication industry has over seven billion users generating annual service revenue of over 960 billion US dollars. Most of this revenue is generated from traditional calls and texts (Vodafone, 2014). However, the industry has witnessed acceleration in the demand in the past few years and by 2014, around 28% of mobile revenue was from data usage, up from 13% in 2009. Vodafone (2014) estimates that emerging markets account for around 74 % of the global mobile subscription. Majority of the mobile subscribers are in regions such as Africa and Asia, indicating the effect of combination of large populations and poor fixed line infrastructure development especially in rural areas where there are lower income levels and less network coverage. However, these countries have lower mobile penetration rates compared to developed countries.

There has been strong growth in demand for mobile services. For instance, the global annual growth of mobile users was approximately 9% per year between 2010 and 2013 with global mobile penetration increasing from 69% to 98% between 2009 and 2013 (Vodafone, 2013). Most of the increase in mobile subscriptions has been from emerging economies due to favourable growth drivers such as young and expanding populations, low fixed line infrastructure penetration, low but rising mobile penetration rates, and faster economic growth. Other factors include better mobile networks and growth in data demand driven by increasing smartphone and tablet penetration (Vodafone, 2013).

By the end of 2014, unique mobile subscriber penetration in developed economies stood at 79% which shows that it is approaching saturation (GSMA, 2015). In addition, there has been a shift in technology from 2G to mobile broadband networks across the world with mobile broadband connections. This has led to acceleration in adoption of 3G and 4G technologies which accounted for about 40% of total connections at the end of 2014. While 2G still remains the dominant network technology globally today, there also been a considerable decline in investment in the technology (GSMA, 2015). For instance, 2G network connections accounted for 90% of the total connections in 2008 which dropped to around 60% by 2014. In absolute

terms, the number of 2G network connections peaked in 2013 and fell by 6% in 2014 (GSMA, 2015).

The mobile telecommunications industry is highly competitive with at least three to four mobile network operators in each country. There are also alternative mobile service providers which include mobile virtual network operators (MVNOs) and internet-based companies as well as software providers that offer alternative communication services hence this gives customers a wide range of mobile service providers to choose from. The industry is regulated and monitored by mostly independent regulators. Entry is regulated through licencing and regulator have to approve corporate actions such as mergers and acquisitions. Regulators continue to lower mobile termination rates (MTRs) and to limit the amount that operators can charge for mobile roaming services.

The mobile telecommunications markets are characterised by dynamic features. First, the industry experiences high pace of technological changes with short innovation cycles. These innovations include innovations on network, product and service differentiation and quality improvement. Secondly, the market is highly capital intensive. This has led to emergency of mobile virtual network operators which benefit from infrastructure sharing. The last characteristic is the economies of scale. Mobile telecommunications markets have few mobile network operators serving large number of subscribers making the markets oligopoly.

2. Literature Review

This paper draws literature from different streams of literature including: (i) studies on dual impact of market structure on prices and investment in mobile industry (Genakos, Valletti and Verboven, 2015); (ii) studies on the relationship between market concentration and prices (Singh and Zhu, 2008; Beckert and Mazzarott, 2010; Yan, 2013; Seim and Viard, 2011); and (iii) studies on the relationship between market concentration and investment (Alesina et al., 2005; Mackay and Akdogu, 2008; Ruiz-Porras and Lopez-Mateo, 2010; Grajek and Roller, 2012; HSBC, 2015).

2.1 Effect of Market Structure on Prices

Over the past decades, research that examines the relationship between market structure and prices has replaced studies that look at profit concentration. An advantage of using prices as opposed to profits is that they are not subject to accounting conventions, and they may be easier to obtain, often at a more detailed level of individual products sold by the firms (Genakos et al., 2015). Weiss (1989) provides a collection of a large number of price-concentration studies and argues that, since prices are determined in the market, they are not subject to Demsetz's critique¹. Moreover, the majority of the price-concentration studies use data across local markets within an industry, rather than across industries, which makes the comparisons easier (Genakos et al., 2015).

Economic theories on effects of competition on prices suggest that prices decline with an increase in competition (Singh and Zhu, 2008; Beckert and Mazzarott, 2010; Yan, 2013; Seim and Viard, 2011). For instance, Singh and Zhu (2008) used cross-sectional data on car rentals at the US airports and found prices in monopoly and duopoly markets are approximately thirty percent higher than in competitive markets with seven or eight firms. Their findings were supported by Beckert and Mazzarotto (2010) who found that higher numbers of cinema firms on average induce lower prices using data from the UK. Yan (2013) in his doctoral thesis on competition and price determination in diverse markets also suggests that prices drop quickly as the number of firms increase using data on US retail gasoline markets from 2006 to 2009.

In research which is more specific to mobile communications, Seim and Viard (2011) study the effect of market structure on cellular technology adoption and pricing. They found that entry induces firms to offer a greater number of tariffs with more evenly distributed plans. Entry leads to decline of prices, particularly for high-valuation consumers who benefit from steeper quantity discounts. In a more recent paper, Genakos, Valletti and Verboven (2015), use telecommunications panel data from thirty three OECD countries for the period 2004-2014 and find that a 10% increase in the Herfindahl-Hirschman Index, which is used as a proxy for market concentration, on average increases mobile prices by 20%. They also find that increasing market concentration by four-to-three symmetric merger increase mobile prices by 16.3% when compared with a situation in which no merger. On the number of competitors,

¹¹ Demsetz's quality critique: High concentrated market structure is linked to higher service levels, which as a result, are linked to higher prices

they find that one more competitor reduces mobile prices by 8.6%. However, mobile prices decrease by 15.9% more for an entry in a market with four operators compared with a market with two or three operators.

2.2 Effects of Market Structure on Investment

Economic theories on effects of competition on investment are vague. The Schumpeterian theory suggests that there may be greater incentives to invest and innovate if operators can maintain the resulting returns in a concentrated market (Elixmann et al, 2015). On the other hand, another economic theory suggests that there is investment stimulation in competitive markets as operators seek to leapfrog each other in order to gain competitive advantage (Mackay and Akdogu, 2008; Ruiz-Porras and Lopez-Mateo, 2010).

For instance, a report by HSBC (2015) claims to have found an inverted U-shaped relationship between investment and competition, in which the optimal level of competition is found to correspond to an EBITDA margin of 38% while Frontier for the GSMA (2015) study suggests that the level of competition measured through a number of operators does not have a clear influence on investment proxied by capex per subscriber. A further perspective combining both theories is that there is ‘turning point’ (inverted U-shaped curve) within which it is possible to identify an ‘optimal’ level of competition in order to spur investment (Elixmann et al, 2015). Aghion et al. (2005) suggest that competition discourages innovation by laggard firms but encourages neck-to-neck firms to innovate. They argue that competition reduces post-entry rents and hence reduces the equilibrium number of entrants.

The econometric assessments by Alesina et al. (2005), Mackay and Akdogu (2008), Ruiz-Porras and Lopez-Mateo (2010) and Grajek and Roller (2012) supports the findings by HSBC (2015) which links between market structure and investments. For instance, Alesina et al. (2005) studied the role that overall regulation, barriers to entry and public ownership play in investment for many non-manufacturing industries such energy, transports and communication in OECD countries. They used econometric models on economic data such as investment, capital stock and value added for 175 non-manufacturing industries in 21 OECD countries. They found that increasing regulation increases the cost of entry and the penalty of expanding production which results in less investment while competition-enhancing policies do promote investment. Grajek and Roller (2012) supports Alesina et al (2005) through their econometric

assessment on regulation on fixed-line operators in 20 countries between 1997 and 2006. They argue that regulation undermines incentive to invest both at industry and operator level.

Firms in monopolistic markets exhibit lower investment sensitivity and are slower to invest than firms in competitive markets as found by Mackay and Akdogu (2008). Using Tobin on data from manufacturing industries in United States of America between 1981 and 2000, they found that investment in monopolistic industries is half sensitive to changes compared to investments in competitive industries. This means that firms in high concentrated markets exhibit lower investment sensitivity and are slower to invest than firms in low concentrated markets. However, investment sensitivity and investment speed are highest in mid-concentrated markets which also experience less entry and exit than other industries. In another paper, Ruiz-Porrás and Lopez-Mateo (2010) suggest that the effect of market concentration on investment is felt more in medium and large firms based on empirical analysis of 182 manufacturing industries in Mexico. They however concluded that competition may promote investment.

In a work related to telecommunications, a study by Elixmann et al. (2015) supports the idea that there is no linkage between consolidation in mobile markets and an increase in investments. They used econometric analysis to study the effect of consolidation on investment in mobile telecommunication in eight European countries and four non-European countries. Using investment, profitability and market concentration data, they found no evidence to suggest that there is a linkage between higher market concentration and investment in mobile industry. However, their analysis suggests that investment levels in mobile markets may depend on a range of factors, which might include demand factors such as mobile video usage, cost drivers such as a high rural population or potentially auction dates and coverage obligations. For instance, investment in the UK is lower than in the US, while the extent of concentration as measured by the Herfindahl-Hirschman index is similar in both countries. Possible factors that could explain the higher investment in the US are earlier assignment of 4G spectrum, higher network deployment costs and higher demand for video services.

In a paper more closely related to this one, Genakos et al. (2015) find that an increase in the Herfindahl-Hirschman Index by 10 % on average increases operator investment by 24.1% in OECD markets. On the other hand, they find that an extra competitor increases operator

investment by approximately 10.7%. However, they find that investment per operator is lower by 18.3% in markets with four operators compared with markets with two or three operators and 25.3% lower in markets with five or more operators. A four-to-three merger would increase operator investment by 19.3%. They concluded that increase in market concentration generates a trade-off effect: increase in prices and increase in investment.

The best of my knowledge, there is no literature on the impact of market structure on prices and investments in the mobile telecommunications industry in emerging economies. This paper fills the gap by collecting and analysing a unique data on prices and investment in mobile telecommunication industry in fifteen emerging economies for the period between Q1 2006 and Q4 2015.

2.3 Theoretical Framework

This section outlines theoretical model which relates to this study and follows Davis & Garces (2010). The Economic theory predicts that market structure affects prices. Under general conditions, a reduction of the number of firms results in an increase in market prices.

Consider a Cournot model in which firms that entered the market compete in quantities of a homogeneous good. In such oligopolistic market, exit reduces the number of firms so that total market output tends to be reduced and at the same time it increases the amount that any incumbent firm will produce due to the shape of each individual firm's equilibrium supply function. The net effect on total output, and hence prices, is therefore potentially ambiguous (Davis & Garces, 2010). It depends on the relative effect of an increase in firm output and a decrease in the number of firms. In that case, price will rise following the exit of an incumbent firm and fall following entry of a new player.

Let aggregate market demand be given by:

$$Q = S(a - bp),$$

Where S is the size of the market, so that the corresponding inverse aggregate demand equation is;

$$p(Q) = \frac{a}{b} - \frac{1}{b} \frac{Q}{S}.$$

and a cost function with constant marginal costs, $C(q_i) = cq_i + F$. The firm solves the profit-maximization problem:

$$\max_{q_i} p_i(Q)q_i - cq_i - F_i.$$

And in a symmetric equilibrium, equilibrium prices and quantities can be described as follows;

$$p_i^* = \frac{a}{b} - \frac{1}{b} \frac{Nq_i^*}{S} \text{ and } q_j^* = \frac{S(a - bc)}{N + 1}$$

As in the previous section, the optimal quantity is substituted back into the profit equation:

$$\pi_i = p_i^* q_i^* - cq_i^* - F$$

This therefore gives;

$$\pi_i = \left(\frac{a - bc}{N + 1} \right)^2 \frac{S}{b} - F.$$

For the firm to break even, at least $\pi_i = 0$ is needed. The corresponding equilibrium number of firms is solved to obtain the following;

$$N^* = (a - bc) \sqrt{\frac{S}{bF}} - 1$$

The number of firms is therefore concave in market size S . The Cournot equilibrium derived above is special in that, to make the algebra simple, constant marginal costs are assumed.

Market structure is determined by the number of firms in a market. The number of firms is determined by entry or exit decisions of firms. These decisions are driven by expectations of future profits which as well as the nature of competition within the market. This paper investigates how competition affects prices and investment in mobile telecommunication industry. Number of operators and market concentration are used to proxy market structure in the estimations.

3. Data Description and Market Trends

3.1 Data Description

This paper uses quarterly panel data from fifteen emerging economies over the period from first quarter of 2006 to last quarter of 2015. It combines data on prices paid by end users of mobile services per minute, operators' market shares, investments and revenues. It also uses information on the time when an independent telecommunications regulator was established in

a country. The data comes mainly from Ovum² as well as other sources such as International Telecommunications Union (ITU), World Bank and International Monetary Fund (IMF).

3.1.1 Prices

Effective price per minute (EPPM) is used as a proxy for market price paid by end consumers. Ovum reports operator and country level quarterly information on the effective price per minute. It collects information on Minutes of Use (MOU) and Average Revenue per User (ARPU) data from mobile operators for both voice and data which are used to derive effective price per minute by dividing ARPU with MOU. This metric is obtained for all operators in the countries of the interest for the period between quarter Q12006 and quarter Q42015 and averaged. The information is provided in US dollars using market exchange rate. The quarterly average rate is used to remove the effect of exchange rate fluctuations. However, it is not clear whether some countries include non-service revenues in calculation of ARPU. Thus, the data should be interpreted with caution since there might be inconsistency of values across countries and operators.

In addition, the ARPU is also analysed since it is frequently discussed in policy debates. This metric represents the average revenue generated per subscription. The term is typically derived by dividing the revenue generated in a specific period and dividing this by the average subscription base of the operator during this same period. ARPU is reported as the average monthly amount generated per subscription during each quarter.

3.1.2 Investments and Profits

This paper uses operators' capital expenditure per subscriber as a proxy for investment. Capital expenditure is incurred when the operator spends money either to acquire fixed assets (investment) or to add to the value of an existing fixed asset with a useful life that extends beyond the taxable year (maintenance CAPEX) (Ovum, 2016). The index is obtained from Ovum as reported by the operator. There are however many missing observations on the operator level data and hence country level data is used, which are recomputed as follows; it is assumed that the operator capital investment is proportionate to its market share. Therefore, the total market investment at the country level is obtained by extrapolating capital

² Ovum is part of the Informa Group, one of the world's leading provider of business intelligence services. Informa delivers specialised information in all sectors to companies including telecommunications information.

expenditures for operators with missing data based on market shares and capital expenditures for operators with non-missing data. Next, capital expenditure for each operator is divided by its subscriber base at a specific period to obtain capital expenditure per subscriber then averaged to get the country level average.

Earnings before interest, taxes, depreciation and amortization (EBITDA), which is a good accounting metric for operators' profits is also used in the estimation. EBITDA index is also taken from Ovum as stated by operators in the period financial results and it is used in this paper as a proxy for profits. It is generally calculated as the difference between total revenues and operating expenses, excluding portions arising through tax, interest payment, depreciation and amortization of assets (Ovum, 2016). As operating expenses include some or all of these items, their totals are added back to the difference between total revenues and operating expenses to obtain EBITDA. This index is treated the same way as capital expenditure.

3.1.3 Market structure

Ovum provides data on the number of mobile network operators in each country and the total number of subscribers per operator. These two metrics are used to compute market shares, as well as the Herfindahl-Hirschman Index (HHI), which is the sum of the squares of market shares. Herfindahl-Hirschman Index is a measure of market concentration and it is most used as a proxy for market structure. Number of mobile operators in each country is used as an alternative measure of market structure.

3.1.4 Regulatory Variable

This paper uses regulator experience as a proxy for mobile telecommunications regulation. Information on when an independent regulator was introduced is obtained from ITU and time lapse in years since the regulator was introduced calculated. ITU reports only the year the regulator was introduced, thus the value is held constant for all quarters in a year.

3.1.5 Other Variables

Finally, GDP Per capita based on purchasing power parity information is collected from IMF to proxy market demand and population to proxy market size of each country is obtained from Ovum. Ovum primary source of population information is United Nations. For comparability all monetary values are given in US dollars based in purchasing power parity. This is achieved by dividing the market exchange rate monetary values with purchasing power parity conversion

factors based on the 2011 ICP round for specific countries obtained from World Bank. The ratio is the number of units of a country's currency required to buy the same amount of goods and services in the domestic market as a US dollar would buy in the United States (World Bank, 2015)³. It makes it possible to compare the cost of the bundle of goods that make up gross domestic product (GDP) across countries. The final dataset comprises fifteen emerging countries and includes 600 observations for the period Q1 2006-Q4 2015. The 15 emerging countries include: Brazil, Bulgaria, China, Czech Republic, Egypt, Greece, Hungary, Indonesia, Malaysia, Mexico, Pakistan, Poland, South Africa, Thailand and Ukraine.

3.1.6 Summary Statistics

Table 1 below reports summary statistics for the variables used in the analysis for the period Q1 2006-Q42015. The average number of mobile operators during this period is 4.6 which is higher compared to OECD average of 3.6 reported by Genakos, Valletti and Verboven (2015) for the period 2006-2014. Across the markets, the number operators range between two and nine operators. Countries with five or less competitors account for 52.8% of the total observations. The average years of independence regulator is 10 years with some periods having zero years of independent regulator while other periods having as high as 25 years. The average effective price per minute is \$0.13, with a standard deviation \$0.11 and prices varying between \$0.07 and \$0.57. Capital expenditure per subscriber which is the proxy for investment has a quarterly average of \$13.94 with values ranging between \$1.27 and \$82.49 million and standard deviation of \$11.36 million. This reflects variations across countries and over time.

Earnings before interest, taxes, depreciation and amortization (EBITDA) per subscriber mean is \$31.10 on quarterly basis with standard deviation of \$11.36 and values ranging from \$1.27 to \$82.49. The monthly average revenue per user (ARPU) values range from \$4.77 to \$81.42 with a mean of \$23.81 and a standard deviation of \$11.66. As indicated earlier, these values reflect considerable variations across countries and over time. GDP per Capita which is a control variable has an average of \$15,763 with a standard deviation of \$7,269 with values lying between \$3,821 and \$31,558. The Herfindahl-Hirschman index (HHI) values range between 0.12 and 0.63 with a mean of 0.35 and standard deviation of 0.10.

³ According to World Bank, the ratio of purchasing power parity conversion factor to market exchange rate is the result obtained by dividing the power parity conversion factor by the market exchange rate.

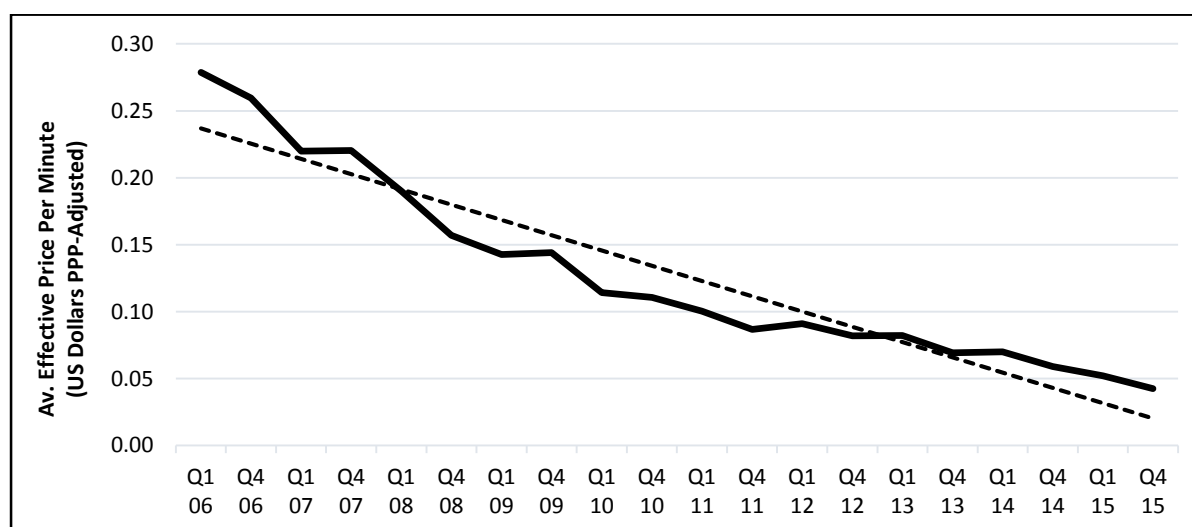
Table 1: Summary statistics

Variable	Obs.	Mean	STD	Min.	Max.
Num. of Operators (N_{ct})	600	4.632	1.7496	2	9
Regulator Experience (Regxp_{ct})	600	9.973	6.348	0	25
Mobile Price (P_{ct})	600	0.130	0.110	0.007	0.568
Capital Expenditure per Subscriber (Cpx_{ct})	600	13.943	11.361	1.270	82.491
EBITDA per Subscriber (EBITDA_{ct})	600	31.069	16.690	4.951	141.367
ARPU_{ct}	600	23.81	11.66	4.77	81.42
GDP per capita (GDPPC_{ct})	600	15762	7268	3821	31558
HHI_{ct}	600	0.346	0.102	0.122	0.630

Source: Authors' calculations based on the Ovum, ITU, World Bank and IMF datasets.

3.2 Mobile Telecommunications Market Trend

As shown in Figure 1, the average mobile service prices per minute for all the countries in this study have experienced a downward trend between Q1-2006 and Q4-2015. Overall, the average price declined by 84.7% during the period under consideration. This fall in mobile prices could be explained by increase in competition in the industry over time, increase in technological innovations as well as protection of consumers and smaller operators by regulators in terms of regulation of termination rates.

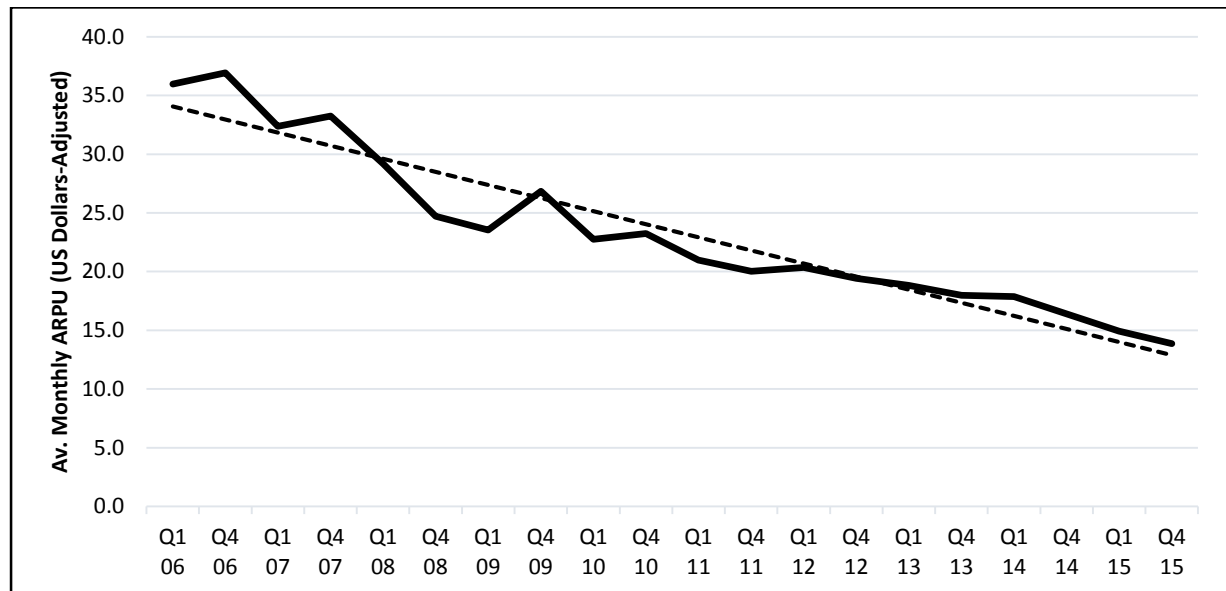
Figure 1: Mobile Services Average Price Trend, Q12006-Q42015

Source: Authors' calculations based on the Ovum and World Bank datasets.

Notes: Average effective price per minute is calculated by taking the summation of the average price paid by consumers for each operator in each country PPP-adjusted.

As shown on Figure 2, the average revenue per user (ARPU) also indicates a decline of around 61.4% between Q1-2006 and Q4-2015. The decline could be explained by increasing number of subscribers in emerging markets where there is still room for expansion and increased demand for mobile services.

Figure 2: Average Monthly Price per User (ARPU) Trend, Q12006-Q42015

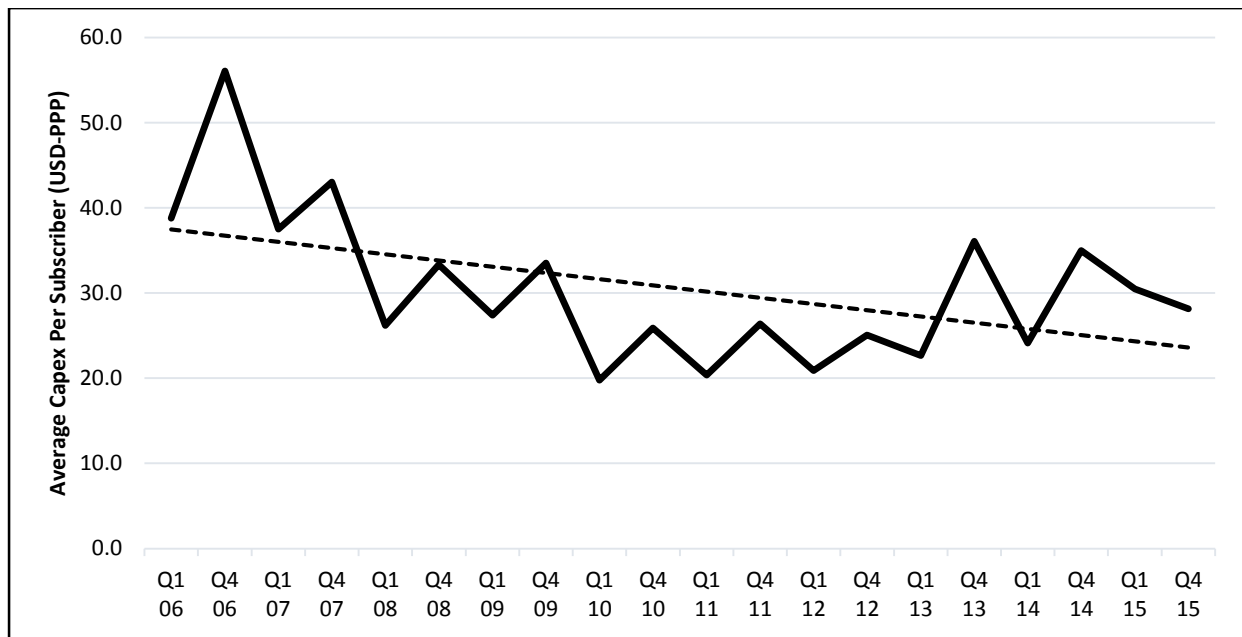


Source: Authors' calculations based on the Ovum and World Bank datasets.

Notes: Average monthly ARPU is calculated by taking the summation of the average operator ARPU in each country PPP-adjusted.

As average prices and ARPUs decline, average Capital expenditure (CAPEX) for all the country under consideration in this paper has experienced an increasing trend with seasonal peaks in the last quarter of each year. Between Q1-2006 and Q4-2015, average CAPEX grew by around 148% with an average compounded annual growth rate of 2.4% per quarter. Investment in telecommunications sector has increased as a result as expansion and rolling out new networks 3G and 4G networks. In emerging economies, penetration rates are still low hence there have been massive investments to tap the unpenetrated areas. However, as shown in Figure 3, the average capital expenditure per subscriber has declined modestly although the trend seems to change in the past few years. For instance, average capital expenditure per subscriber decline by an average compounded annual growth rate of 0.8% per quarter to register a total decline of 27% between Q12006 and Q42015. The decline can be explained by the rapid growth of subscriber base in the period under review.

Figure 3: Average Capital Expenditure per Subscriber Trend, Q12006-Q42005

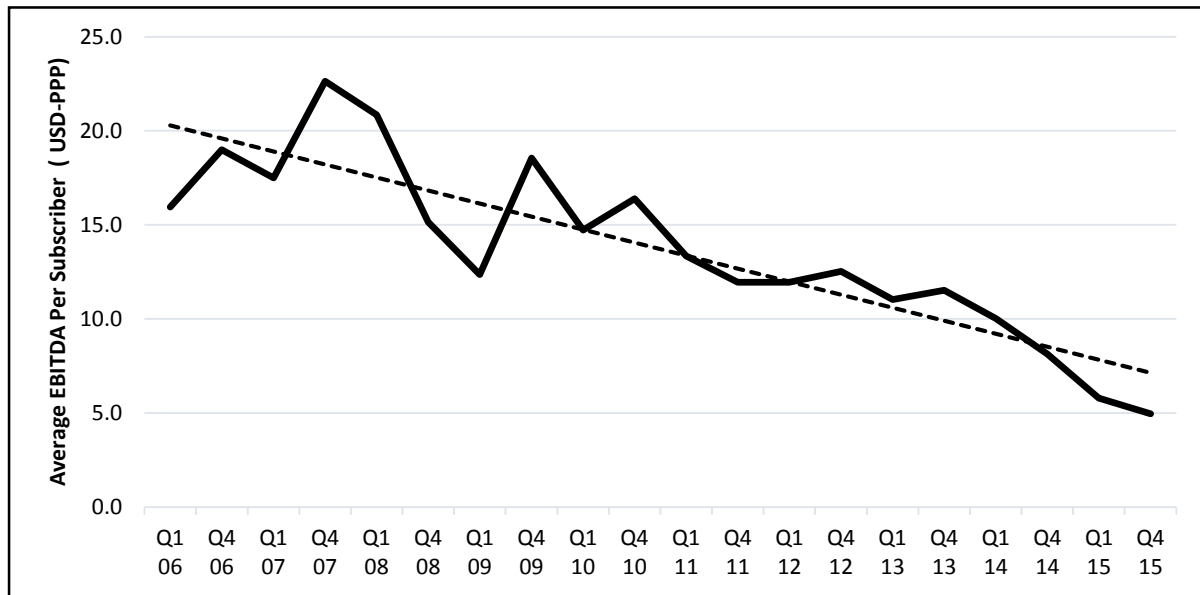


Source: Authors' calculations based on the Ovum and World Bank datasets.

Notes: Average Capex is calculated weighing the capex for an operator by its market share to estimate for the missing capex information and estimating the country total capex and calculating the average for all the countries under review.

Earnings before interest, taxes, depreciation and amortization (EBITDA) also registered a compounded annual growth rate of 1.0% to register an overall price increase of 52% for the period between Q12006 and Q42015. The earnings growth is majorly driven by data revenue in Africa and Asia complemented by subscription growth. For instance, in 2015, data revenue accounted for more than 10% of recurring revenues in many countries in Africa, and more than a third of revenues in more advanced countries such as South Africa (GSMA, 2015). The other drivers of profits included value addition services as well as mobile money as penetration of smart phones has enabled mobile based services. However, same as the average capital expenditure per subscriber, the average EBITDA per subscriber declined by an average compounded annual growth rate of 3.0 per quarter to register a total decline of 69% between Q12006 and Q42015 majorly due to rapid growth in subscribers.

Figure 4: Average Earnings before interest, taxes, depreciation and amortization (EBITDA) per Subscriber Trend, Q12006-Q42015



Source: Authors' calculations based on the Ovum and World Bank datasets.

Notes: Average EBITDA is calculated weighing the EBITDA for operators by their market shares to estimate for the missing capex information and estimating the country total EBITDA and calculating the average for all the countries under review.

As illustrated by the trends, there has been considerable changes in the main variables such as mobile prices and capital expenditure per subscriber. The variations cut across countries and over time as indicated in summary statistics Table 1. This provides the necessary information to study the impact of market structure on prices and investments. Nevertheless, this discussion also indicates that caution should be taken in accounting for general trends and fluctuations, as the interest is in identifying the impact of market structure over and above any historical trends, which is discussed in the next section.

Mobile communications industry is characterized by a few number of firms compared with other industries such as manufacturing. The industry also portrays characteristics of oligopoly. For instance, in oligopolistic markets, there are few number of firms selling identical products to large number of consumers and there is barrier to entry (Sorenson, 2002). In mobile communication industry, there are few number of mobile operators providing mobile services to large of subscribers. Licensing creates a barrier to entry in the market hence the market fits in oligopolistic market definition (Valletti, 2003). The oligopolistic nature of mobile communication markets can create a problem of imperfect competition as few firms have influence on the market outcomes. Table 2 below shows the number of mobile

operators and market shares of the two largest operators using data for fifteen emerging countries for selected periods.

Table 2: Number of Competitors and Market Shares

	Q4 2006	Q4 2009	Q4 2012	Q4 2015
Av. number of mobile operators	4.27	4.80	4.53	4.67
Markets with 2 competitors	1	0	0	0
Markets with 3 competitors	7	5	5	5
Markets with 4 competitors	1	4	4	3
Markets with 5 competitors	2	1	1	3
Markets with 6 competitors	1	1	2	1
Markets with 7 competitors	3	2	3	2
Markets with 8 competitors	0	2	0	0
Markets with 9 competitors	0	0	0	1
Av. market share of the 2 largest competitors	80.8%	76.0%	73.2%	71.2%

Source: Authors' calculations based on the Ovum dataset.

Notes: The average number is for all fifteen countries used in this paper. The Average market share for the two largest operators is calculated by taking the summation of the market shares of the two largest operators for selected period and finding the average for all the countries.

For the selected period in Table 2 above, the average number of mobile operators range between 4.27 and 4.80. Majority of the countries have between 3 and 7 operators for the selected quarters with only one country in the last quarter of 2006 having 2 operators and one country in the last quarter of 2015 having 9 operators. Generally, the number of mobile operators and competitors has not changed much over time. The average market shares for the two largest mobile operators has dropped by 9.6% from 80.8% to 71.2% between the last quarter of 2006 and the last quarter of 2015.

Table 3 gives a more specific information of the number of mobile operators in specific countries used in this study. It gives the number of the operators in each country in the last quarter of each year from 2006 to 2015. The changes in the number of operators is either by entry of the operator or exit mainly through mergers and acquisition. Generally, there has not been much activity in terms of entries and exits from the market in the countries under review.

Table 3: Number of Operators by Country

	Q4 2006	Q4 2007	Q4 2008	Q4 2009	Q4 2010	Q4 2011	Q4 2012	Q4 2013	Q4 2014	Q4 2015
Brazil	7	7	8	8	8	7	7	8	9	9
Bulgaria	3	3	3	3	3	3	3	3	3	5
China	3	3	3	3	3	3	3	3	3	3
Czech Republic	3	4	4	4	4	4	4	4	4	4
Egypt	2	3	3	3	3	3	3	3	3	3
Greece	4	3	3	3	3	3	3	3	3	3
Hungary	3	3	3	3	3	3	3	3	3	3
Indonesia	7	8	8	8	8	7	7	8	7	7
Malaysia	3	3	4	4	4	4	4	4	4	4
Mexico	5	4	4	4	4	4	4	4	4	3
Pakistan	7	7	7	7	6	6	6	6	6	6
Poland	3	4	4	4	4	4	4	4	4	4
South Africa	3	3	4	5	5	5	5	5	5	5
Thailand	6	6	6	6	6	6	6	5	5	5
Ukraine	5	8	8	7	6	6	6	6	6	6

Source: Authors' calculations based on the Ovum dataset.

Brazil had seven mobile operators by end of 2006 with Vivo, Tim Brazil and Claro Brazil dominating the market. Unicel Brazil entered the market in the third quarter of the 2008 and exited in the first quarter of 2011 after the regulator revoked its license for holding two operating licenses in the same geographical area (TeleGeography, 2013.).⁴ On-Telecom and Sky Brazil entered the market in quarter one 2013 and quarter one 2014 and by the last quarter of 2015, Brazil telecommunications market had nine mobile operators still dominated by Vivo, Tim Brazil and Claro Brazil. On the other hand, Bulgaria has had three operators since 2006 with Max Telecom and Bulsatcom entering the market in the second and third quarter of 2015 respectively to make it five with the three incumbent operators having market shares between 27% and 38%.

China Mobile has dominated the three-operator Chinese market since 2006 with market shares of over 60%. Chinese has had strict telecommunications market entry regulations hence it has not experienced any entry for the period under review. In the case of Czech Republic, Skylink Czech Republic exited Czech Republic mobile telecommunications market in third quarter of 2006 to close the year with three operators with O2 and T-Mobile leading the market with

⁴ The Brazilian telecommunications regulator Agencia Nacional de Telecomunicacoes (Anatel) prohibits telecommunication operators from holding two operating licences for the same geographic area

market shares of 39.9% and 38.5% respectively. Mobilkom entered the market in the second quarter of 2007 and since then there has not been any entry or exit. The entry of Etisalat Misr in the Egyptian telecommunications market in the second quarter of 2007 intensified the competition in originally two-operator market. Etisalat Misr has since its entry in 2007 increased its market share to 24% in 2015.⁵

Greece mobile telecommunications market has had three operators since the second quarter of 2007 after Q-Telecom was acquired by WIND Hellas (TeleGeography, 2006). Hungarian three mobile operators have maintained their positions in the market with small changes in market shares with T-Mobile dominating the market with 45% market share by end of 2015. Unlike Greece and Hungary, Indonesia has experienced a lot of activities in its mobile industry. 3 Indonesia entered the market in the last quarter of 2006 which brought the number of operators to seven. Smart Telecom Indonesia which entered the market in the third quarter of 2007 merged with Mobile-8 in the last quarter of 2010 to form Smartfren (TeleGeography, 2010). In the last quarter of 2013, Natrindo Telepon Seluler was acquired by XL Axiata and PT Internux entered the market the same period. Even with the seven operators in by end 2015, Telkomsel dominated the market with a market share of over 45%.

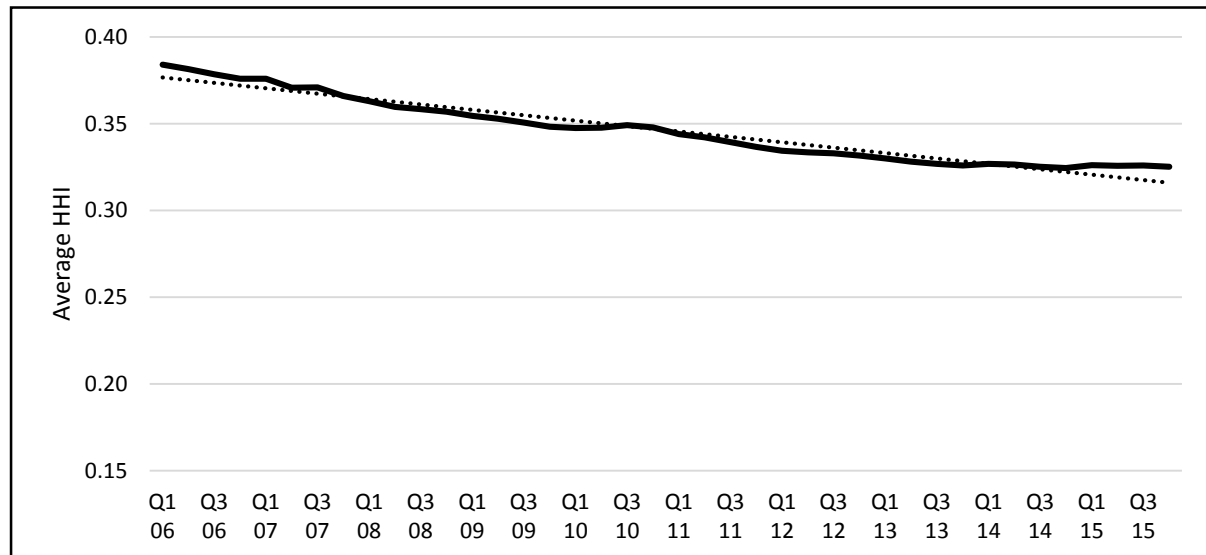
U-Mobile entered Malaysian telecommunications market in the first quarter 2008 to make the number of operators in the market four. Since then, U-Mobile has been able to compete effectively with the incumbent operators to close 2015 with a market share of 15% with the incumbents closing with markets shares between 27% and 30%. Mexican mobile telecommunications market has experienced an exit and an acquisition between 2006 and 2015. SPC exited the market in the second quarter of 2007 and Nextel Mexico was acquired by AT & T in the first quarter of 2015 to close with three operators in 2015 (TeleGeography, 2015). SCO entered Pakistan mobile telecommunications market in the third quarter of 2006 to close the year with seven operators. In the first quarter of 2010, the Pakistan telecommunications regulator terminated Pakcom license for failure to pay for its renewal in 2008 (TeleGeography, 2008).

⁵ ECMS and Vodacom shared the market equally before the entry of Etisalat Misr. Etisalat Misr has been able to compete effectively with the incumbents reducing their markets shares to 35% and 41% respectively by end of 2015.

Poland had three competing mobile operators until the first quarter of 2007 when P4 entered the market. By end of 2015, there was four operators with market shares ranging between 20% and 28%. On the other hand, South Africa had two entries between 2006 and 2015. In the last quarter of 2008, competition increased in South African mobile telecommunications market, with fixed-line operator Telkom launching its own cellular offering.⁶ Competition continued to increase after the entry of Neotel in the third quarter of 2009. Hutchison-CAT exited Malaysian mobile telecommunications market in the first quarter of 2013 to make the number of operators five dominated by AIS with a market share of 45% by end of 2015. In Ukraine, Telesystems, Intertelecom and Ukrtelecom entered the market in 2007 to make the number of operators eight by end of 2007. In its effort to maintain its market share, Kyivstar acquired Beeline and Ukraine Radio Systems in 2009 and 2010 respectively to close 2015 with 43% market share (TeleGeography, 2010).

Figure 5 below shows that mobile telecommunication markets in emerging economies are getting less concentrated over time. Between 2006 and 2015, the Herfindahl-Hirschman Index declined on average by about 15%.

Figure 5: Average Herfindahl-Hirschman Index



Source: Authors' calculations based on the Ovum dataset.

Notes: Average Herfindahl-Hirschman Index is calculated by getting the average index for all countries.

⁶ In the 1990s, South Africa started its mobile telecommunications service provisions through a partnership between Telkom and Vodafone which grew to be Vodacom. Telkom pulled out of the partnership in 2008 in preference for its own 3G network.

4. Empirical Framework

To analyse the effect of market structure on mobile prices in mobile telecommunications industry, the following equation is estimated:

$$\ln P_{ct} = \alpha_c + \alpha_t + \beta_1 MS_{ct} + \beta_2 CV_{ct} + \varepsilon_{ct}. \quad (1)$$

The dependent variable ($\ln P_{ct}$) in equation (1) is the logarithm of effective price per minute in US dollars based on purchasing power parity paid by customers in country c in quarter t . To control for global trends and for time-invariant usage-operator-country characteristics, country fixed effects (α_c) and time fixed effects (α_t) respectively are used. MS_{ct} , which is the main variable indicates the market structure for country c in quarter t . Two alternative measure of market structure are used in the estimation. First, the number of competitors in country c in quarter t is used. Secondly, the measure of market concentration, Herfindahl-Hirschman Index (HHI) is used as an alternative measure of market structure.

The term CV_{ct} includes several control variables that may influence prices and vary across markets. For instance, log of GDP per capita and log of population are included to capture market demand and market size respectively. Market regulation is captured by the number of years the market has experienced an independent regulator. ε_{ct} is the error term which captures the effect of other variables on price which are not captured in the equation.

The next step is to look at the effect of market structure on investment. For the analysis of the mobile telecommunication market investment, the following general equation is estimated:

$$\ln Cpx_{ct} = \alpha_c + \alpha_t + \beta_1 MS_{ct} + \beta_2 CV_{ct} + \varepsilon_{ct} \quad (2)$$

The dependent variable ($\ln Cpx_{ct}$) is the logarithm of average capital expenditure per subscriber in country c in quarter t . Country fixed effects (α_c) and time fixed effects (α_t) are included in the equation to account for systematic differences between countries and general trends especially seasonal effects respectively. As explained in price estimation equation, MS_{ct} captures the market structure for country c in quarter t and number of competitors and the Herfindahl-Hirschman Index (HHI) will be alternatively used. The squared values of HHI will also be included in the equation to test for quadratic relationship between market concentration and investment. CV_{ct} includes several control variables that may influence operator investment and vary across operators or countries. Log of GDP per capita, log of population and year of

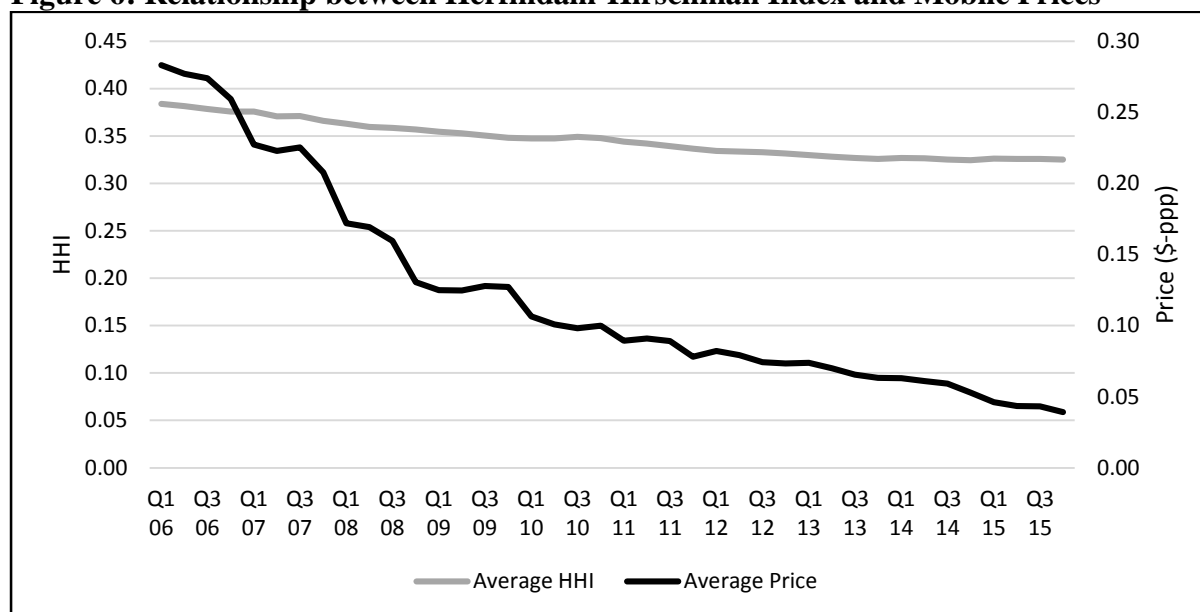
independent regulator experience are included as control variables. ε_{ct} is the normally distributed error term.

Logarithm of effective price per minute in US dollars based on purchasing power parity in equation (1) is replaced with alternative measures of performance of interest, which include logarithm of earnings before interest, taxes, depreciation and amortization (EBITDA) per subscriber and logarithm average revenue per user (ARPU).

The key empirical challenge faced in empirical studies like this is potential endogeneity of the number of operators and the Herfindahl-Hirschman Index (HHI). However, in mobile telecommunications industry, market entry is determined by the decision of the regulator and does not depend on market characteristics such as high prices and return on investment as in the case of markets with free entry (see Sarkar et al., 1999; Bijwaard et al., 2008; Fernández & Usero, 2009; Genakos, Valletti and Verboven, 2015). This is also supported by Hauge & Jamison, (2009) arguments that in mobile telecommunication industry, there are legal barriers to entry such as licencing, economic barriers such as high fixed costs as well as strategic barriers such as customer lock-in and high switching costs induced by the incumbent operators.

Eggers et al. (2011) test the assumption exogenously determined market entry in mobile telecommunications. More specifically, they test whether there is any significant difference in efficiency between entrants who acquired their network operation license through a clear awarding process and entrants who acquired their license through unclear means such as allotment of the national government. Their basic assumption in this test is that a more transparent the awarding process will lead to the most efficient operator obtaining the network operation license. They find that there is no statistically significant differences between early and late movers in the market depending on the license awarding process hence they interpret this as an evidence for the exogeneity of market entry in mobile telecommunications. Hence, in this paper the number of operators and HHI are assumed to be exogenous in mobile telecommunications sector. This is also evident from Figure 6 below which shows that the average HHI is not moving as much as average prices change for the fifteen countries used in this study This could be explained by the fact that in the mobile telecommunications industry, people may not be able to respond to periodical changes because of switching costs, which supports the conclusion in Eggers et al. (2011).

Figure 6: Relationship between Herfindahl-Hirschman Index and Mobile Prices



Source: Authors' calculations based on the Ovum dataset.

5. Results

This section presents results for effects of market structure on average market mobile price and investment as well as results for the alternative measures of performance discussed above. First, the price regressions are presented and discussed followed by investment results and finally the results for alternative measures of performance are presented.

5.1 Price Regressions Results

Table 3 shows the results from estimation the price equations using country level data for the period between Q1 2006 and Q4 2015. In the first estimation, market structure is approximated by the number of firms which turns out to be negative but insignificant. The theoretical derivation above suggests that there should be negative dependence between the number of firms and price, a result which was confirmed in Genakos, Valletti and Verboven (2015) for OECD countries. In the second estimation, market structure is approximated by the HHI index. As discussed earlier, due to regulated entry and character of mobile industry, the HHI is considered to be exogenous. Results show that an increase in the HHI has a positive and significant impact on average market mobile prices. These results are in line with results by Genakos, Valletti and Verboven (2015) for OECD countries.

The rest of the control variables in Table 3 are as follows; income levels proxied by GDP per capita do not have any significant effect on average market mobile prices when number of operators are used to proxy market structure. However, when the HHI is used, results indicate that higher income levels have positive and significant impact on mobile average market mobile prices. Results also indicate that larger markets have higher mobile average market mobile prices. Nevertheless, regulator experience has a negative and significant effect in mobile prices. Regulators tend to regulate average prices as a measure to protect consumers and smaller operators. Lastly, the time trend variable indicates that mobile prices have declined over time.

Table 3: The Effect of Market Structure on Average market mobile price

	(1)	(2)
Estimation method	FE	FE
Dependent Variable	lnP _{ct}	lnP _{ct}
Time Period	Q1 2006 Q4 2015	Q1 2006 Q4 2015
Number of Mobile Operators	-0.0360 (0.0226)	
HHI		3.9463*** (0.5116)
Log of GDP per Capita	-0.1246 (0.1658)	0.4853*** (0.1778)
Log of Population	1.7564*** (0.4805)	1.9689*** (0.4577)
Regulator Experience	-0.1164*** (0.0189)	-0.108*** (0.0180)
Time Trend	-0.0199 *** (0.0051)	-0.0211 (0.0049)
Constant	-30.780*** (8.272)	-41.982*** (8.013)
Observations	600	600
Prob>F	0.000	0.000
R ²	0.7993	0.8172

Source: Authors' calculations based on the Ovum, ITU, World Bank and IMF datasets.

Notes: The dependent variable is the logarithm of the average market effective price per minute paid by consumers adjusted for PPP. The standard errors are given in parenthesis below coefficients. ***, **, and * indicate significance at the 1, 5 and 10 percent levels respectively.

5.2 Investment Regressions Results

Table 4 presents the results from estimation the investment equations for alternative measures of market structure. Same as the price analysis, these results are based on the sample of all countries in this study for the period between quarter one 2006 and quarter four 2015. In the first estimation, the number of firms does not have significant impact on investment. In the second estimation, market structure is approximated by the HHI index as a quadratic specification. Since the linear term has a significant and positive impact and the quadratic term has a significant negative impact, it can be concluded that there is an inverted-U relationship between market structure proxied by the HHI and investment proxied by capital expenditure per subscriber in mobile communication industry in emerging markets. This result is in line with findings reported in HSBC (2015).

The control variables show that countries with lower incomes have higher capital expenditure per subscriber. For instance, investment significantly increases with the increase in GDP per capita when the HHI is used to proxy market structure. This is mainly because the population most emerging markets is high and still growing. Results also indicate that regulator experience has a positive and significant effect on capital expenditure per subscriber. Moreover, capital expenditure per subscriber has been decreasing over time as indicated by the time trend variable which signals the effect of the increasing population and mobile subscriber base in emerging economies. Quarterly seasonal effects are found to exist where investments are found to be highest in quarter four relative to quarter one.

Table 4: The Effect of Market Structure on Investment

	(1)	(2)
Estimation method	FE	FE
Dependent Variable	lnCpx _{ct}	lnCpx _{ct}
Time Period	Q1 2006 Q4 2015	Q1 2006 Q4 2015
Number of Mobile Operators	-0.0116 (0.0468)	
HHI		22.866*** (3.3573)
HH1²		-18.085*** (4.1411)
Log of GDP per Capita	-0.0252 (0.3725)	1.8183*** (0.3940)
Log of Population	-1.3818 (0.9992)	-1.6385* (0.9420)
Regulator Experience	0.00004 (0.0456)	0.1369*** (0.0468)
Time Trend	-0.0210* (0.0125)	-0.0564*** (0.0126)
Quarter 2 Dummy	0.0679 (0.0653)	0.1174* (0.0609)
Quarter 3 Dummy	0.1740** (0.0690)	0.2647*** (0.0650)
Quarter 4 Dummy	0.4528*** (0.0747)	0.5916*** (0.0712)
Constant	27.632 (17.079)	8.2473 (16.189)
Observations	600	600
Prob>F	0.000	0.000
R²	0.2664	0.3686

Source: Authors' calculations based on the Ovum, ITU, World Bank and IMF datasets.

*Notes: The dependent variable is the logarithm of the market capital expenditure per subscriber adjusted for PPP. The P-values are given in parenthesis below coefficients. ***, **, and * indicate significance at the 1, 5 and 10 percent levels respectively.*

Table 5 below gives results for additional price and investment estimations. The estimations are aimed to determine the behaviour of variable when restricted number of countries are used and the results compared to the results for all countries in this study. In this case, the sample is restricted to emerging economies in Africa and Asia only. One disadvantage of this restriction is that it makes sample less representative. Generally, results indicate that there is high

correlation between the results for the whole sample and the results for emerging economies in Africa and Asia only.

Column (1) in Table 5 below gives results that have been already presented in column (3) of Table 3. Column (2) shows the effect of the HHI on prices for markets in Africa and Asia only. As indicated, the HHI also has a positive and significant effect on mobile prices in African and Asian mobile telecommunication markets. Furthermore, the magnitude is higher for the restricted sample compared with the whole sample. Same as the market concentration, the effect of market power proxied by GDP per capita on mobile prices is higher in the restricted sample than the whole sample. Additionally, mobile prices are found to have higher sensitivity to market size in African and Asian markets compared with markets for the whole sample. Likewise, independence regulators weigh more on mobile prices in African and Asian markets compared to when the whole sample is used. However, on average African and Asian mobile telecommunications markets are found to have less years of independent regulator experience compared with the markets in other regions. Lastly, prices have significantly reduces over time in both samples with higher reduction in the restricted sample.

Column (3) and (4) in Table 5 gives investment results for the whole and restricted sample respectively. Just as it has been done with mobile price estimates, the model is restricted to emerging economies in Africa and Asia only. Column (3) gives results that have been already presented in column (3) of Table 4 and Column (4) gives the results for the restricted sample. As indicated earlier, there is a quadratic relationship between market concentration and mobile telecommunication market investment proxied by capital expenditure per subscriber. When the sample is restricted to African and Asian markets, this relation still exists. Results also indicate that market power has higher effect in the restricted sample. Market size has been found to reduce capital expenditure per subscriber with higher effect in African and Asian markets. This is majorly because emerging economies in Africa and Asia have higher population and population growth rates relative to the investment in mobile telecommunications industry compared with their counterparts in other parts of the world. Regulation has been found to have a positive impact on investment where the impact is higher in the restricted sample.

Capital expenditure per subscriber has been found to decrease over time with a higher magnitude for African and Asian markets compared with the whole sample. This decline can

be attributed to high populations and population growth rates in African and Asian countries which translates to higher mobile subscription rates leading to increasing subscriber base. Quarterly seasonal effects were found to exist with investment increasing from quarter one to quarter four with peaks in quarter four for both samples. However, although investment in quarter two was higher for the restricted sample compared with whole sample relative to quarter one, this is reversed in quarter four where restricted sample indicates lower investment compared to the whole sample.

Table 5: Additional Price and investment Estimations Results

	(1)	(2)	(3)	(4)
Estimation method	FE	FE	FE	FE
Dependent Variable	lnP _{ct}	lnP _{ct}	lnCpx _{ct}	lnCpx _{ct}
Countries	All	Africa & Asia only	All	Africa & Asia only
Time Period	Q1 2006 Q4 2015	Q1 2006 Q4 2015	Q1 2006 Q4 2015	Q1 2006 Q4 2015
HHI	3.9463*** (0.5116)	5.2995*** (0.6866)	22.866*** (3.3573)	24.070*** (3.8097)
HHI ²			-18.085*** (4.1411)	-17.934*** (4.8544)
Log of GDP per Capita	0.4853*** (0.1778)	0.7648*** (0.2884)	1.8183*** (0.3940)	2.5175*** (0.5553)
Log of Population	1.9689*** (0.4577)	6.2121*** (0.8838)	-1.6385* (0.9420)	-2.7768* (1.5442)
Regulator Experience	-0.108*** (0.0180)	-0.1458*** (0.0266)	0.1369*** (0.0468)	0.1528*** (0.0548)
Time Trend	-0.0211*** (0.0049)	-0.0247*** (0.0072)	-0.0564*** (0.0126)	-0.0662*** (0.0147)
Quarter 2 Dummy			0.1174* (0.0609)	0.1806** (0.0773)
Quarter 3 Dummy			0.2647*** (0.0650)	0.2914*** (0.0823)
Quarter 4 Dummy			0.5916*** (0.0712)	0.5571*** (0.0901)
Constant	-41.982*** (8.013)	-124.77*** (15.626)	8.2473 (16.189)	24.831 (26.750)
Observations	600	320	600	320
Prob>F	0.000	0.000	0.000	0.000
R ²	0.8172	0.7967	0.3686	0.5286

Source: Authors' calculations based on the Ovum, ITU, World Bank and IMF datasets.

Notes: The dependent variables are the logarithms of the average market effective price per minute paid by consumers and the market capital expenditure per subscriber adjusted for PPP. The

*standard errors are given in parenthesis below coefficients. ***, **, and * indicate significance at the 1, 5 and 10 percent levels respectively.*

5.3 Other Measures of Performance Regressions Results

Table 5 presents the results from estimation the other measures of performance equations for alternative measures of market structure. Same as the previous regressions, these results are based on the sample of all countries in this study for the period between Q1 2006 and Q4 2015. Results indicate that the number of mobile operators does not have any significant effect on market profits proxied by earnings before interest, taxes, depreciation and amortization (EBITDA) per subscriber. However, markets profits increase with increase in market concentration. In the case of revenues, results indicate that an increase in the number of mobile operators has a negative and statistically significant effect on market revenue proxied by average revenue per user (ARPU). Moreover, high concentrated markets have significantly higher revenues.

Specifically, column (1) in indicate that number of competitors does not have any significant effect on mobile telecommunications market profits proxied by EBITDA per subscriber. Columns (3) presents market profit proxied by EBITDA per subscriber results based on the HHI as a proxy for the market structure which indicates that market concentration has a positive impact on market profits. This results are in line with results by Genakos, Valletti and Verboven (2015) for OECD countries for the period between 2006 and 2014. A possible explanation for these results is that operators in high concentration markets have some degree of monopoly with limited competition and experience a more inelastic demand hence they are likely to influence the market outcomes for instance by increasing or maintaining high prices which in turn increases their profits. The control variables show that countries' income levels and market size have a statistically significant positive impact on market profits. On the other hand, market profits have been declining over time and with the independent regulator experience. Market profits are found to peak in quarter three relative to quarter one. There is no significant seasonal effect on market profits in quarter four profits relative to quarter one.

Unlike profits, an extra competitor has a negative and significantly effect on market revenues proxied by ARPU as shown in column (2). However, an increase in the HHI significantly increases market revenues. Again these results similar to results by Genakos, Valletti and Verboven (2015). This could be explained by the same explanation given for profits. On the other variables, market with high levels of income have higher revenues and there is an inverse

relationship between market size proxied by population and market revenues proxied by ARPU. This is to say that large markets have lower revenue per subscriber as revenues have to be distributed over a large number of subscribers. Number of years the market has had an independent regulator does not a significant effect on revenues and ARPU has declined over time.

Table 6: The Effect of Market Structure on Other Measures of Performance

	(1)	(2)	(3)	(4)
Estimation method	FE	FE	FE	FE
Dependent Variable	lnEBITDA _{ct}	lnARPU _{ct}	lnEBITDA _{ct}	lnARPU _{ct}
Time Period	Q1 2006 Q4 2015	Q1 2006 Q4 2015	Q1 2006 Q4 2015	Q1 2006 Q4 2015
Number of Mobile Operators	-0.0189 (0.0192)	-0.0634*** (0.0150)		
HHI			4.7420*** (0.4129)	2.9870*** (0.3396)
Log of GDP per Capita	-0.1033 (0.1528)	0.2348** (0.1102)	0.7223*** (0.1553)	0.6674*** (0.1180)
Log of Population	1.0979*** (0.4099)	-1.1980*** (0.3193)	1.3378*** (0.3694)	-1.1170*** (0.3039)
Regulator Experience	-0.0378** (0.0187)	-0.0154 (0.0126)	-0.0138 (0.0169)	-0.0132 (0.0119)
Time Trend	-0.0171*** (0.0051)	-0.0208*** (0.0034)	-0.0225*** (0.0046)	-0.0207*** (0.0032)
Quarter 2 Dummy	0.0471* (0.0268)		0.0605** (0.0242)	
Quarter 3 Dummy	0.0599** (0.0283)		0.0831*** (0.0256)	
Quarter 4 Dummy	-0.0038 (0.0306)		0.0334 (0.0278)	
Constant	-14.509** (7.006)	23.040*** (5.496)	-28.547*** (6.417)	16.114*** (5.320)
Observations	600	600	600	600
Prob>F	0.000	0.000	0.000	0.000
R ²	0.6316	0.7301	0.6996	0.7546

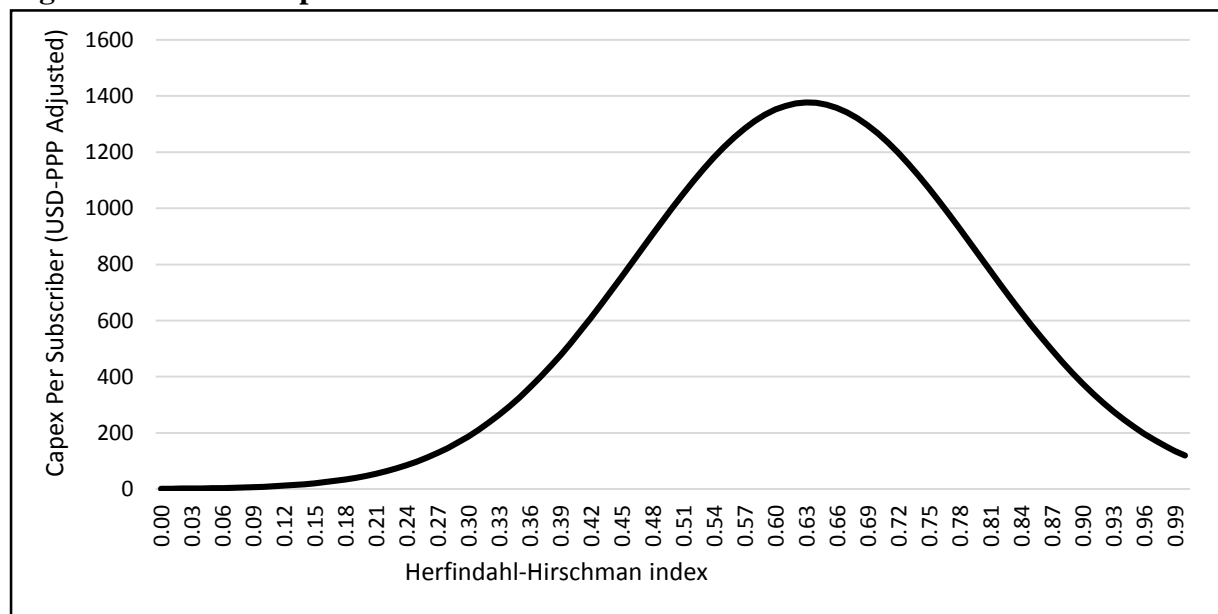
Source: Authors' calculations based on the Ovum, ITU, World Bank and IMF datasets.

Notes: The dependent variable is the logarithms of the market EBITDA per subscriber and ARPU adjusted for PPP. The P-values are given in parenthesis below coefficients. ***, **, and * indicate significance at the 1, 5 and 10 percent levels respectively.

In general, the number of operators in emerging economies telecommunications markets has not changed much and it was found to have insignificant effect on both market mobile prices and investment per subscriber. However, due to the current wave of market consolidations, the number of operators is likely to reduce hence influencing mobile prices upward. This mobile consolidation trend is also likely to lead to increase in market concentration which has been reducing slowly over the period under review. Since market concentrations is found to be positively correlated with mobile prices, the increase in mobile concentration is likely to further drive prices up. However, this is likely to increase profits and revenues.

On the other hand, market concentration has been found to have a quadratic relationship with investment proxied by investment per subscriber. Figure 7 below shows the inverted-U relationship between market concentration and investment. The investment values are given relative to when market concentration is zero meaning there is perfect competition.

Figure 7: Relationship between Investment and Market Concentration



Source: Authors' calculations based on the Ovum, World Bank datasets.

Although the number of operators is found to have insignificant effect on investment, the optimum level of investment is found at levels of the HHI between 0.6 and 0.7. This means that countries should strive to achieve such levels of market concentration. With the average HHI for the countries in this study being around 0.35, the regulators should strive to achieve higher market concentration levels in order to achieve optimum investment. However, this is likely to increase mobile prices since market concentration is found to have a positively correlation with prices. To avoid this trade-off, regulators should try to strike a balance between

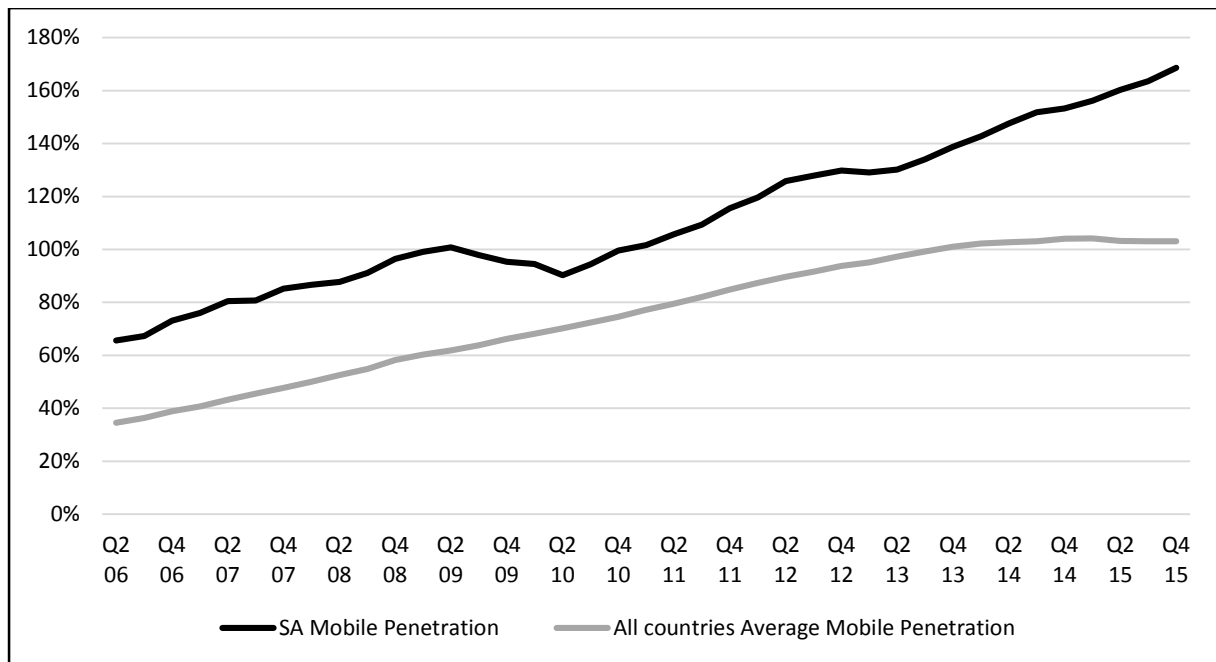
static and dynamic efficiencies in that as much as the regulators try to achieve the short-run efficient allocation of resources and minimise marginal costs of providing mobile services, the long-run progress is also be taken into account. This can be achieved by encouraging development of better technologies through research and innovation to improve efficiency of mobile service provision over time.

5.4 South African Mobile Telecommunications Market Case

This section discusses in details how South African mobile telecommunication market compares with the markets in the other countries in this study and the implications of findings of this study to the South African mobile telecommunications market. South Africa is chosen because of the availability of data for most of the variables. However, there is missing data on some variables especially for smaller mobile operators. South Africa has one of the most advanced telecommunication sector in Africa in terms of technology deployed and services provided. However, the industry growth has started to slow down after relishing years of robust growth and health profits. The industry is experiencing slower growth, lower mobile termination rates and price competition which has created the need for cost-cutting and consolidations which are set to transform the landscape of South African mobile telecommunications sector. The key regulatory matters currently shaping the market include the unbundling of the local loop and the reduction of interconnection rates, the licensing of WiMAX and LTE spectrum and digital dividend spectrum, and issues to do with market consolidation such as mergers and acquisitions.

South Africa has one of the highest mobile penetration rates among the emerging economies which increased from 66% in 2006 to 169% in by the end of 2015 (growth rate of 156%) as compared with an average penetration of 103% for the emerging economies under review by 2015. In this virtually saturated voice market, mobile networks operators are now competing for market share in the next growth wave, mobile broadband.

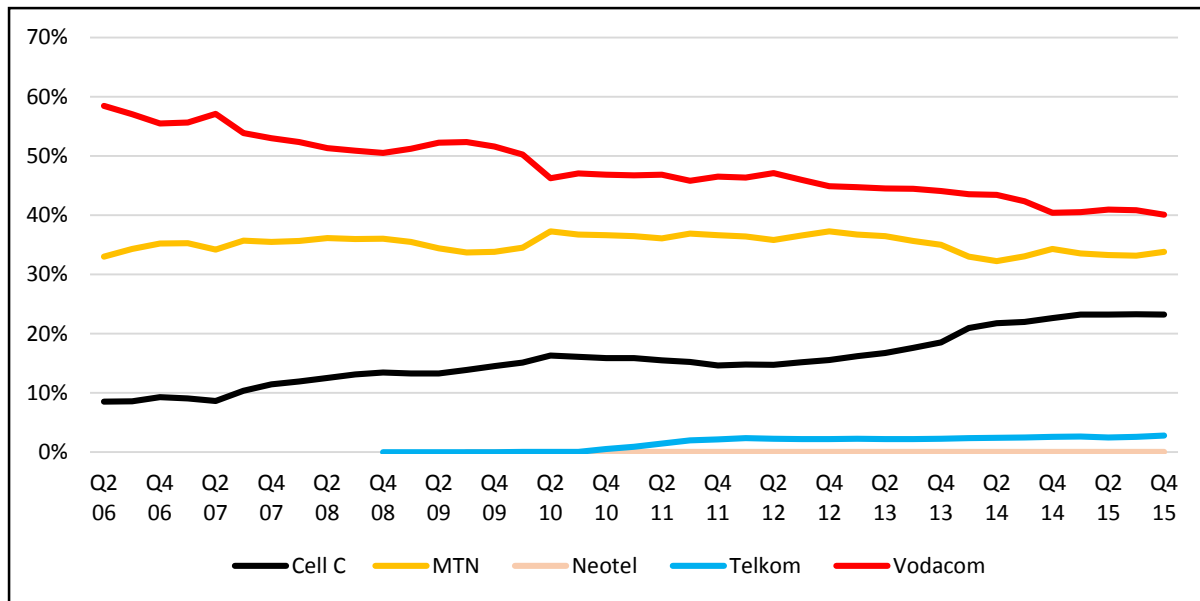
Figure 7: South Africa Mobile Penetration Rates



Source: Authors' calculations based on the Ovum dataset.

As indicated in Table 3, competition increased in South African mobile telecommunications market, after a fixed-line operator, Telkom launched its own cellular offering 2008 followed by the entry of Neotel in the third quarter of 2009 to make the total number of operators five. Together with MTN and Cell C, these two entries have effectively reduced the market share of the market leader, Vodacom, from 58% in 2006 to about 40% in 2015. The top gainer in the market is Cell C which has experienced the highest growth of the market share within the period of under review with Telkom also experience a positive growth. One of the main explanation for this could be because of the decision by South African telecoms regulator, the Independent Communications Authority of South Africa (ICASA) legislation to offer significantly lower asymmetry termination rates to smaller players such as Cell C and Telkom Mobile.

Figure 7: South Africa Mobile Operator Market Shares

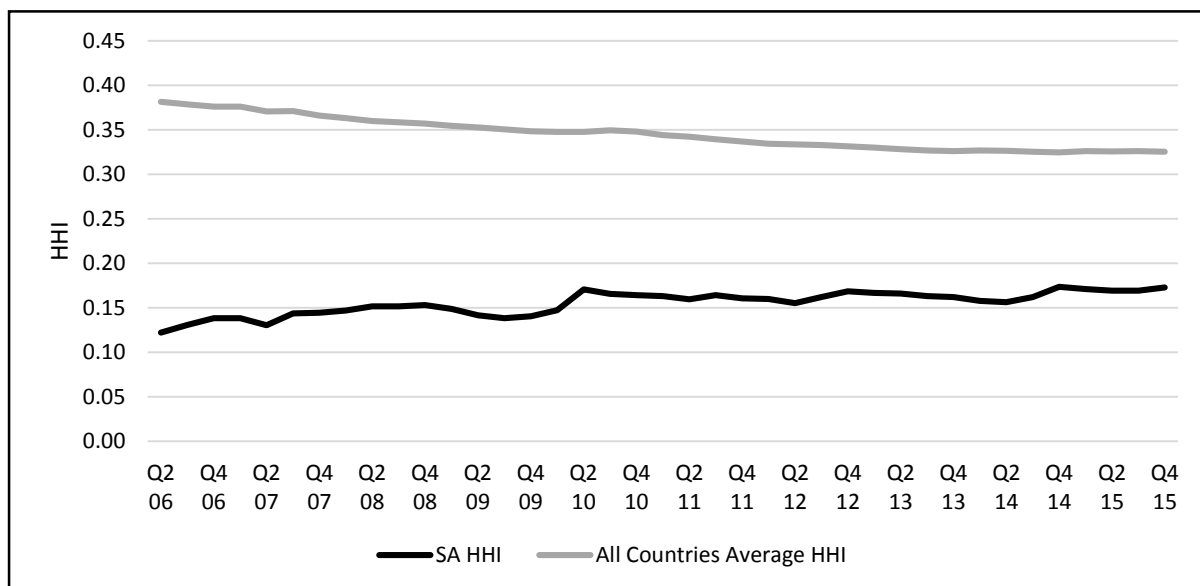


Source: Authors' calculations based on the Ovum dataset.

Even with losing the market share to its competitors, Vodacom still remains the leader of the market followed by MTN. Both Vodacom and MTN had a combined market share of 91% in 2006 which reduced to 74% by the end of 2015. The top gainer, Cell C, increased market share from less than 10% in 2006 to 23% by end of 2015.

South Africa mobile telecommunications market is one of the least concentrated markets among the emerging economies with Herfindahl-Hirschman index lower than the average of all the emerging economies under review as shown in figure 8 below.

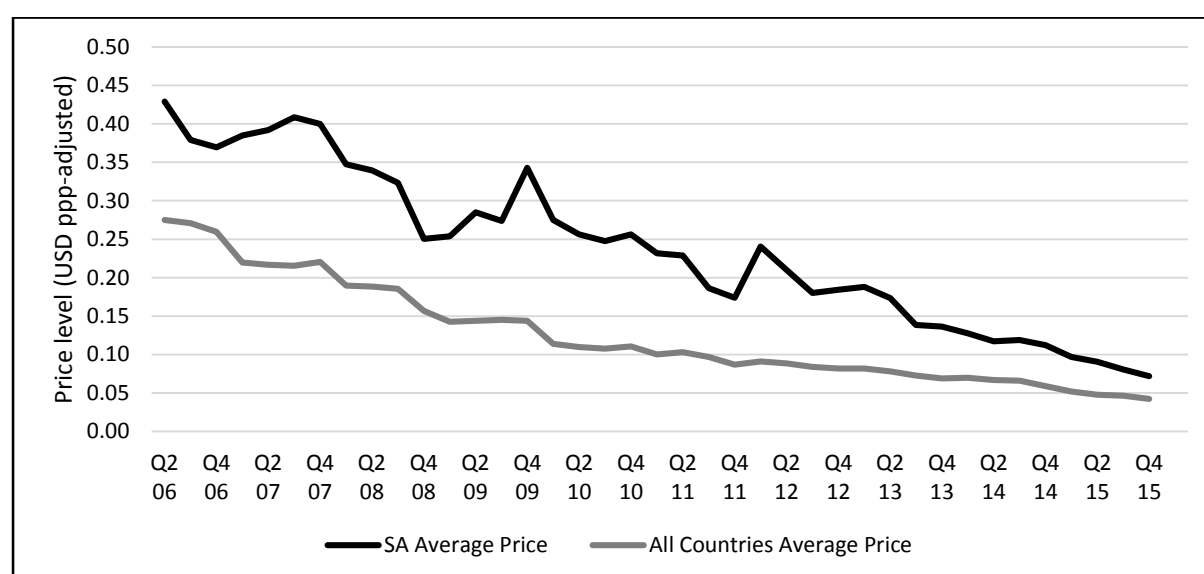
Figure 8: South Africa Telecommunication Industry Herfindahl-Hirschman index



Source: Authors' calculations based on the Ovum and World Bank datasets.

Besides low market concentration, South Africa has one of the highest end user mobile prices among the emerging economies under review. As shown in figure 9, South Africa average mobile prices are higher than the average for all countries in this study. However, the prices have experienced a downward trend partly because of the increased competition due to Telkom and Neotel entry into the market as well as regulator intervention to protect consumers and smaller operators.

Figure 9: South Africa Mobile Prices

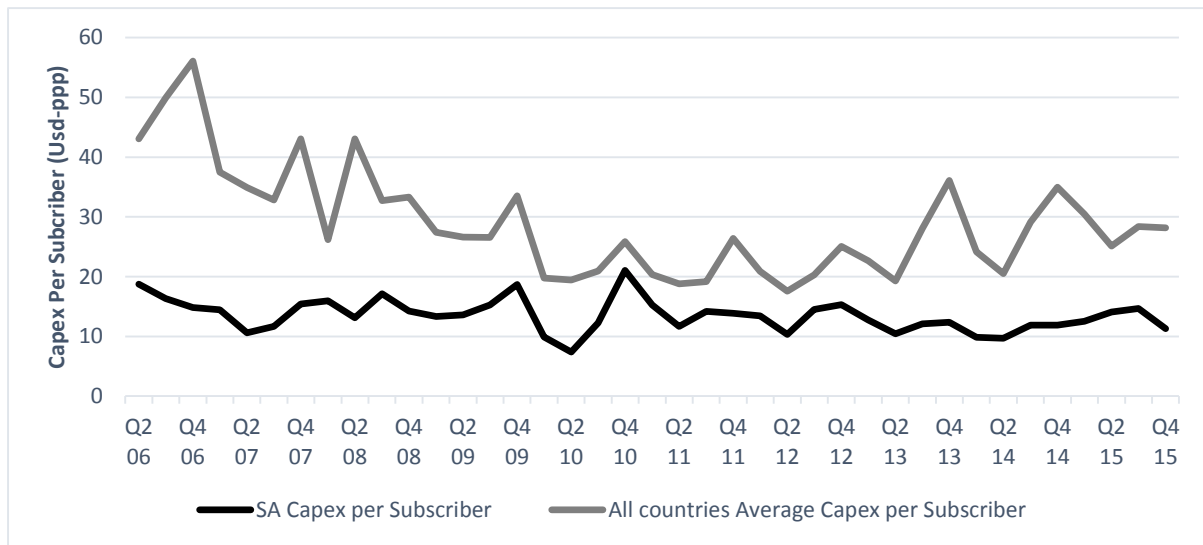


Source: Authors' calculations based on the Ovum and World Bank datasets.

Notes: Average effective price per minute is calculated by taking the summation of the average price paid by consumers for each operator in each country PPP-adjusted.

Even with one of the highest mobile penetration rates and mobile prices, South Africa has experienced lower capital expenditure per subscriber compared with the other emerging economies in this study as shown in figure 10. This could be partly explained by the fact that South Africa regulates foreign participation and ownership in telecommunications sector which affects the amount of foreign direct investment that is channelled to the sector.

Figure 10: South Africa Capital Expenditure per Subscriber



Source: Authors' calculations based on the Ovum and World Bank datasets.

Notes: Average Capex is calculated weighing the capex for an operator by its market share to estimate for the missing capex information and estimating the country total capex and dividing with subscriber base then calculating the average for all the countries under review.

From the findings of this study, it can be concluded that the South African mobile telecommunications market prices are likely to decline in a reduced rate, flatten or even rise given the rising market concentration. As indicated earlier, this could be fueled by ongoing market consolidations. Investment per subscriber is way below the optimum investment given the level of the market concentration. However, the trend seems to gain momentum as both the market concentration and the investment per subscriber have experienced a positive growth in the past few years.

6. Conclusion

This paper has analysed the impact of market structure on prices and investments in the mobile telecommunications industry. An empirical study has been conducted using a panel of fifteen emerging economies across four continents over the period 2006-2015. Detailed operator level information has been collected and aggregated to market level. The analysis has been done at country level.

Market concentration is found to have positive impact on mobile prices and a quadratic relationship with capital expenditure per subscriber. Optimum levels of capital expenditure per

subscriber relative to when there is perfect competition is found to be at market concentration levels of between 0.6 and 0.7. These results indicate that there is a trade-off between static and dynamic efficiency. Competition in mobile telecommunications reduces prices but also results in lower investments as compared to more concentrated markets. Market concentration is also found to have positive relationship with Earnings before interest, taxes, depreciation and amortization (EBITDA) per subscriber and average revenue per user (ARPU). Seasonal effects exist in investment and EBITDA where investment is found to peak in quarter four and EBITDA is found to be significantly higher in third quarter relative to the first quarter.

To the best of my knowledge, this is the first paper which analyses the impact of market structure on both prices and investments for emerging economies. The findings of this paper are therefore an important addition to the literature on market structure and market outcomes in mobile telecommunications and are useful to competition authorities as well. An open question that the study raises, but cannot answer due to data limitations, is an assessment of the impact of market structure at operator level mobile prices and investment in emerging economies.

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