The Impact of Regulations on Investment in Mobile Telephone Infrastructure in Southern African Development Community Countries

Albert Makochekanwa

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The Impact of Regulations on Investment in Mobile Telephone Infrastructure in Southern African Development Community Countries

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Contents

List of tables

Abstract

The main objective of the study was to investigate the impact of policy regulations on investments in mobile telecommunications network infrastructure in all the 15 member countries of the Southern African Development Community (SADC) region. The research employed panel data econometrics to achieve its stated objective. Estimated results shows that the coefficient of gross domestic product (GDP) per capita is positive and statistically significant, implying that an increase in this variable results in increase in demand and this in turn motivates infrastructure investment in mobile telephone. The coefficient on the previous level of mobile telephone infrastructure investment variable (Invkt-1) was found to be positive and statistically significant. This means that there is a systematic positive association between the previous level of mobile telephone infrastructure investment and the current. The coefficient of the main variable of interest representing mandatory unbundling (Regkt) was found to be positive and statistically significant. This implies that, overall, mandatory unbundling access regulation boost infrastructure investment in mobile telecommunication. Regression estimates shows that the coefficient on one of the variable of interest, political constraint (POLCON) has a negative and statistically significant impact on determining the level of mobile telephone infrastructure investment in SADC countries. Whilst this result is against expectations, one possible explanation may be presence of high level of rent seeking behaviour.

1 Introduction

"In 10 short years, what was once an object of luxury and privilege, the mobile phone, has become a basic necessity in Africa"[1]

The use of the mobile telephone as a mechanism for reducing information asymmetry, especially in developing countries is considered to be an important factor which contribute positively to economic growth and market development. Empirical studies, for example, Garbade and Silber (1978); DuBoff (1980); Hardy (1980); Nathaniel (1984); Norton (1992) have confirmed this relationship. Nevertheless, several factors, many of which are determined institutionally and/or by regulatory laws, need to be available in their respective optimal levels if investment in mobile telecommunications infrastructure is to lead to growth. Since mobile telecommunications are fast becoming the foundation of the knowledge economy, a reassessment of the relationship between investment in mobile telecommunications infrastructure and regulations is needed.

Current literature on regulation and investment in the mobile telephone sector is categorized into two, namely incentive regulation and access regulation. According to some authors (Armstrong and Sappington, 2006, Cave et al, 2002), incentive regulation (also termed retail-level regulation), which is premised on the cost recovery theory (like rate of return; – RoR), provides investors in mobile services infrastructure with the opportunity to retain as profit additional revenues or cost savings which occur, within a specified period, as a result of their own efforts. Increased retail competition over time will result in the regulators' focus shifting from retail regulation to access regulation (also termed wholesale regulation). Access or wholesale regulation deals with access to both existing and future infrastructure in the mobile sector. Economides (1996) categorizes access or interconnection into two components, namely "one-way" access and "two-way" access, where, according to Cave et al (2002) 'one-way' access means that (new) entrants into the mobile telephone sector need to purchase vital inputs from the incumbent but not vice versa. Two-way access means that entrants will purchase vital inputs from the incumbent, and also the incumbent needs to purchase some vital inputs from the entrants. This study is concerned with one-way access as defined in this section.

The upsurge in the number of mobile telephone subscriptions over the past decade in Southern Africa (among other African regions) has defied all predictions. The region remains the market with one of the highest mobile telephone subscription

growth rates in recent years. Trend data from the International Telecommunication Union (ITU)[2] shows that the Southern African Development Community (SADC) region had just 9.6 million mobile subscriptions in 2000; five years later (by end of 2006) the figures rose to 62.1 million mobile subscriptions, before closing at 160.6 million by the end of 2011. In SADC countries, the overall population covered by mobile telephones rose from around 25% in 2000 to around 58.5% in 2008 before peaking at 60.2% by end of 2011. According to ITU (2009) the high ratio of mobile telephone subscriptions to fixed telephone lines and the high mobile telephone growth rate suggest that the SADC region (along with other African regions) has taken the lead in the shift from fixed to mobile telephony, a trend that can be observed worldwide. This trend is also buttressed by recent studies on the impacts of telecommunications on economic growth which emphasize mobile telephones as opposed to fixed telephones. These figures point to one fact: the SADC region is a growing market for mobile telephone usage and Internet use, and as such it is a potential market for mobile handset producers and mobile telephone network service providers.

The impressive growth in mobile telephone subscriptions in SADC countries has been necessitated by investments which have been done by players in this sector over the recent years. These investments have also happened at a time when the current generation of consumers have been appetized to like to use high technology devices, as globalization diffused technology use across the globe. Whilst all countries want investments in their respective territories, investments in the mobile sector, like any other sector, have been regulated. Friederiszick et al (2008) argues that the major reason for regulating the telecommunication markets is to ensure optimal competition, which is widely thought to improve efficiency, ultimately resulting in improved social welfare. Grajek and Röller, (2012) indicate that in a static environment competition reduces market power of producers, which lowers margins and prices and results in a higher consumer surplus. Availability of competition in the same industry also disciplines producers in their use of scarce resources, thereby promoting efficient use of inputs and minimizing waste. The relationship between regulation and welfare is, however, different and more complex in a dynamic setting. According to Laffont and Tirole (2000) and Newbery (2002), a regulation which lowers access prices might increase competition in the short run, but the same regulation is tantamount to undermining incumbents' incentives to invest in the network. However, higher access prices provide stronger incentives to invest but impede the use of incumbents' infrastructure by entrants, thereby reducing competition.

Policy makers and economists share the view that an advanced, widespread, and reliable telecommunications infrastructure is a key driver of economic and social growth. Well-developed infrastructure and telecommunications networks in particular, nurture productivity advancements in the downstream sectors (Nadiri and Mamuneas, 1994; Greenstein and Spiller, 1996; Roller and Waverman, 2001).

Although the relationship between policy regulations and network investments is still unsatisfactorily understood by theories; empirical evidence is even poorer. In other words, whereas most experts argue that regulation benefits consumers and business users in the price dimension, the effects of the same regulations on investment in mobile telecommunication activities by firms are far less clear (Garrone, 2004). The dynamic efficiency of regulations is, to some extent, an infant area of research; this holds true for both tangible and intangible investments in "de-regulated" sectors (see Calderini et al, 2003, on research and development (R&D)). To this end, the main objective of the study was to investigate the impact of policy regulations on investments in mobile telecommunications infrastructure in SADC countries. The study hypothesized that sound telecommunications investment policy regulations will encourage investments in the mobile telecommunications network infrastructure in the SADC region.

Background to mobile activities in SADC region

Trends in Africa's mobile phone subscriptions and investment

Trends in the mobile phone penetration rates[4] in SADC for the past 12 years are depicted in Table 1. The rapid growth in mobile phone penetration rates is evidenced by the jump from an average of 4.3% in 2000 to 57.4% by the end of 2011. Most countries have witnessed significant growth in penetration rates, with Seychelles and Botswana being the main leaders, with rates growing from 32.1% and 13.5% in 2000 to 139.1% and 156.5% in 2011, respectively. The four countries which still have relatively low penetration rates are Democratic Republic of Congo (DRC), Malawi, Mozambique and Madagascar, with each having penetration ratios of less that 40% of their respective populations by the end of 2011.

The spectacular growth in mobile subscriptions is a direct function of, among other factors, the various investments which were made in the telecommunications and mobile sectors in these respective countries. Table 2 tabulates the per capita annual investment in telecommunications, where a larger share (more than 90%[6]) of these investments were made by the private sector and were in the mobile phone sector. As statistical data shows, South Africa has been the leading country, with an average annual per capita investment of close to US$38 per person between 2000 and 2011. Mauritius followed with an average annual per capita investment of above US$33 per person (although it had virtual zero investments in three years, namely 2000, 2005 and 2006). Overall, these average annual per capita investments in the telecommunications mobile sector indicate that this sector is one of the more profitable industries within SADC countries, and potential investors are willing to continue to invest and take advantage of the growing market of these services in the region.

Table 1: Mobile telephone penetration rates in SADC countries[5] (%)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	Angola	0.2	0.5	0.9	2.2	4.6	9.7	17.9	28.3	37.6	43.8	46.8	48.4
2	Botswana	13.5	20.0	19.8	26.2	30.5	32.6	47.2	65.1	83.1	103.5	129.1	156.5
3	DRC	0.0	0.3	1.0	2.2	3.4	4.5	7.1	10.2	15.0	13.8	16.8	21.6
4	Lesotho	1.1	3.0	7.2	6.5	10.1	12.7	19.1	24.2	31.2	34.6	51.2	54.1
5	Madagascar	0.4	0.9	1.0	1.6	1.8	2.7	5.5	11.3	23.9	30.3	36.2	37.3
6	Malawi	0.4	0.5	0.7	1.0	1.7	3.1	4.4	7.3	10.2	16.3	19.8	23.9
7	Mauritius	15.2	22.8	28.7	37.8	44.4	52.8	61.6	73.4	81.4	85.2	93.0	100.4
8	Mozambique	0.3	0.8	1.4	2.3	3.7	7.7	11.7	15.1	21.2	28.2	33.5	35.7
9	Namibia	4.5	5.8	8.1	11.8	14.9	22.9	30.6	39.5	50.9	57.9	72.4	114.1
10	Seychelles	32.1	45.3	53.9	59.3	66.3	70.9	82.8	90.9	107.4	127.2	130.7	139.1
11	South Africa	18.7	24.0	30.1	36.6	44.9	72.4	83.7	87.5	92.0	93.9	100.8	126.5
12	Swaziland	3.1	5.0	6.2	7.7	13.0	17.8	22.0	33.0	45.5	56.1	61.5	65.2
13	Tanzania	0.3	0.8	1.7	3.6	5.3	7.9	14.7	21.2	32.7	43.1	50.7	60.9
14	Zambia	0.9	1.1	1.3	2.1	4.0	8.1	13.8	21.4	28.0	34.1	41.1	60.1
15	Zimbabwe	2.2	2.6	2.8	3.0	3.5	5.2	6.8	9.8	13.2	31.7	61.2	73.2
Regional average		4.3	5.7	7.4	9.6	12.2	19.3	24.8	29.6	36.4	41.1	47.6	57.4

Note: DRC = Democratic Republic of Congo.
Source: ITU Online Ddatabase

Table 2: Total investment in telecoms (US$ per capita)

	Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	Angola	0	5	0	5	7	0	15	11	18	19	28	7	7
2	Botswana	10	10	10	10	10	11	10	16	29	48	32	29	15
3	DRC	1	1	3	2	1	1	1	4	5	2	2	6	5
4	Lesotho	1	15	16	6	6	2	3	3	5	6	6	7	14
5	Madagascar	0	0	0	0	1	0	0	6	8	4	6	6	4
6	Malawi	0	0	2	0	0	0	2	3	4	5	7	28	3
7	Mauritius	0	283	23	1	21	0	0	3	10	16	20	20	19
8	Mozambique	0	0	0	4	2	1	1	3	3	4	4	23	3
9	Namibia	5	5	5	5	0	0	0	4	0	0	0	17	17
10	Seychelles	86	84	88	88	95	180	0	0	0	0	0	9	0
11	South Africa	41	41	43	41	38	25	29	42	39	48	42	34	31
12	Swaziland	5	3	4	3	8	3	0	3	17	21	13	10	0
13	Tanzania	1	5	2	2	2	3	5	8	12	13	15	10	13
14	Zambia	3	2	2	3	2	6	20	11	10	9	47	9	4
15	Zimbabwe	1	0	0	0	4	1	2	0	10	16	15	22	15

Note: DRC = Democratic Republic of Congo.
Source: World Development Indicators (WDI) Online Database

Main players in SADC country mobile sectors

Mobile activities in the SADC region involve both private players and government entities in the respective countries. However, private operators dominate the sector in most countries in the region. Using data from ITU (Online Database), Table 3 provides a summarized typology of mobile activities in each of the SADC countries, where the various operators in each country are presented. The information includes the respective subscriber base and ownership structure of these operators. Broadly, the ownership structure can be divided into two: countries where all operators are privately owned, and countries in which both private and public ownership coexists. The countries that fall in the former scenario (i.e., where all operators are privately owned) are: DRC, Lesotho, Madagascar, Malawi, Seychelles and Swaziland. The countries which belong to the second category are Angola, Botswana, Mauritius, Namibia, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe.

Table 3: Main players in the mobile sector

Country	Operator (% market share as at March 2013)	Subscribers (millions)	Ownership[7]
Angola Estimated penetration rate was 63.7% over a population estimate of 13.3 million as at September 2010)	Movicel	2.5 (Sept 2010)	In 2010, various private companies bought 80% of the company''s capital and the State retained 20%
	Unitel	7.0 (Nov 2011)	Privately owned by Mercury (Sonangol group) (25%), Group GENI (25%), Vidatel (25%), Portugal Telecom (25%)
Botswana (The penetration rate was estimated at 118.8% over a population estimate of 2 million as at September 2011)	Mascom (MTN)	1.509 (Q3,2011)	Privately owned by Mascom Wireless (Pty) Limited and South African owned MTN (53%)
	Orange	0.988 (Q3, 2011)	Privately owned by Orange S.A. (69%), Mosokelatsebeng Cellular (local investors, 26%), local individuals (5%)
	Be Mobile	0.491 (Q3, 2011)	Wholly owned by (BTC) Botswana Telecommunications Corporation (100%). However, it is in the process of being privatized and the government intends to remain the major shareholder if the privatization process is completed.

continued next page

Table 3 Continued

Country	Operator (% market share as at March 2013)	Subscribers (millions)	Ownership[7]
DRC (Penetration rate was estimated at 14.74% over a population estimate of 71.7 million as at September 2010)	Airtel	5.0 (Aug, 2012)	Privately operated by Bharti Airtel
	Vodacom	6.24 (June,2012)	Privately operated by Vodacom (51%) and Congolese Wireless Network (49%)
	Tigo	2.3 (Sept, 2010)	Privately owned by Millicom International Cellular (MIC)
	Orange	2.3 (Nov, 2012)	Privately operated by Orange S.A.
	Supercell	0.028 (covers Kivu only)	Privately owned by MTN
	Africell	2.0 (March 2013)	Privately owned by Lintel Limited
Lesotho (The penetration rate was estimated at 45.77% over a population estimate of 1.9 million as at September 2011)	Vodacom	0.966 (June 2012)	Privately owned by Sekha-Metsi Consortium (12%), Vodacom (South Africa) (88%)
	Econet Ezi-Cel		Privately owned by Econet EziCel Lesotho (Pty)
Madagascar (The penetration rate was estimated at 29% over a population estimate of 23 million as at end of 2013)	Airtel	2.56 (April ,2013)	Privately and wholly owned by Bharti Airtel
	Telma Mobile	1.98 (April ,2013)	Privately owned by Distacom Group, Telma SA
	Orange	1.85 (April ,2013)	Owned Orange S.A.
Malawi (The penetration rate was estimated at 19.32% over a population estimate of 15.9 million as at September 2010)	Airtel (formerly Zain)	1.6 (June 2009)	Privately and wholly owned by Bharti Airtel
	TNM	2.0 (July 2013)	Privately owned by Malawi Telecommunications Limited and Telekom Malaysia
	G-Mobile		Privately operated by Globally Advanced Integrated Networks, Beryl (South Africa)
	Lacell		Privately operated by La Cell Private Limited
	G-Expresso		Privately operated by Expresso Telecom Group Limited

continued next page

Table 3 Continued

Country	Operator (% market share as at March 2013)	Subscribers (millions)	Ownership[7]
Mauritius (The country had 0.78 million subscribers in total, or a 60% penetration rate as at September 2007)	Orange	0.628 (Dec 2009)	Privately owned by Mauritius Telecom group and Orange S.A.
	Emtel	0.437 (Dec ,2009)	Privately owned by MIC (50%) and Currimjee
	MTML	0.008 (March, 2008)	Publicly owned by Mahanagar Telephone Mauritius Limited (MTML)
Mozambique (The penetration rate was estimated at 27.19% over a population estimate of 22.95 million as at September 2010)	mCel	3.8 (end 2009)	Partially State owned
	Vodacom	2.7 (June 2012)	Privately owned by Vodacom
	Movitel		Privately owned by Viettel (70%) and SPI (30%)
Namibia (The penetration rate was estimated at 85.53% over a population estimate of 2.15 million as at September 2010)	MTC	1.855 (Sept, 2011)	Owned by Namibia Post and Telecommunications Holdings (66%) and Portugal Telecom (34%)
	TN Mobile (formerly Cell One, Leo)	0.300 (Dec. 2010)	Publicly operated by Telecom Namibia Ltd (100%)
Seychelles (The penetration rate was estimated at 245% over a population estimate of 0.09 million as at September 2010)	Airtel		Privately owned by Bharti Airtel
	Cable and Wireless (Seychelles) Ltd		Privately owned by Cable and Wireless

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Table 3 Continued

Country	Operator (% market share as at March 2013)	Subscribers (millions)	Ownership[7]
South Africa (The penetration rate was estimated at 99.6% over a population estimate of 49 million as at September 2010)	Vodacom	23.873 (Q3 2010)	Privately operated by Vodafone
	MTN	17.772 (Q3 2010)	Privately owned by MTN
	Cell C	6.7 (June 2009)	Privately owned by Oger Telecom
	Telkom	6.7 (June 2009)	Privately operated by Telkom
Mobile Virtual Network Operators (South Africa)			
	Hello Mobile (using Cell C)	Foreign People	Privately operated by Hello Mobile and Cell C
	Virgin Mobile (using Cell C)		Privately operated by Virgin Group and Cell C
	Telkom Mobile (using MTN)		Operated by Telkom SA
	Red Bull Mobile (using Cell C)		Privately operated by Red Bull
Swaziland (The penetration rate was estimated at 49.55% over a population estimate of 1.37 million as at September 2010)	MTN	0.788 (March 2012)	Operated by MTN

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Table 3 Continued

Country	Operator (% market share as at March 2013)	Subscribers (millions)	Ownership[7]
Tanzania (The penetration rate was estimated at 58.6% over a population estimate of 47.78 million as at September 2013)	Vodacom	10.023 (Sept, 2013)	Owned by Vodacom
	Airtel	8.772 (Sept. 2013)	Privately owned by Bharti Airtel (60%)
	Tigo	6.217 (Sept 2013)	Privately owned by MIC (100%)
	ZANTEL	1.798 (Sept 2013)	Privately owned by Etisalat (51%) and Zanzibar Telecom Ltd
	TTCL Mobile	0.211 (Sept 2013)	State owned
	Benson Informatics	0.0005 (Sept 2013)	Privately owned
	Sasatel		Privately owned by Dovetel
	My Cell		Privately owned by My Cell Company Ltd
	Excellentcom		Privately owned by Hits Telecom
	Egotel (Lacell)		Privately owned by Bitmap (65%), J&AK Group (35%)
Zambia (The penetration rate was estimated at 62% over a population estimate of 13.9 million as at December 2011)	Airtel	4.2 (Dec 2011)	Owned by Bharti Airtel
	MTN	2.7 (Dec 2011)	Owned by MTN
	ZAMTEL	1.2 (Dec 2011)	State owned by Zambia Telecommunications Company Ltd
Zimbabwe (The penetration rate was estimated at 74.7% to 9.037 million subscribers as at December 2011)	Econet	5.686 (Feb, 2012)	Privately owned by Econet Wireless (Private) Limited
	Telecel	1.875 (Feb, 2012)	Owned by Orascom Telecom (60%)
	Net One	1.456 (Feb, 2012)	NetOne Cellular (Pvt) Ltd (Government)

Source: http://www.itu.int/

Nature of regulators

Mobile communications, by nature involves regulation. Information from ITU Online Database shows that all countries in SADC except Seychelles have at least a separate telecommunication regulatory authority (See Table 4). This means they adopted

the "first wave" policy reforms which require sector liberalization, establishment of national regulatory authorities and investment from private sector as well as the public sector. In some countries such as Angola, Botswana, Mozambique, Namibia, South Africa, Swaziland and Tanzania, regulation of the mobile sector remains a dual responsibility of both an independent regulator, and the ministry (or government department) responsible for telecommunications. Assuming all things remain constant, in countries where there is a regulator the assumption is that the same regulator will execute its mandate independent from the government. However, in countries where the government is involved in regulatory activities, some government control is likely in the way the sector will be regulated.

Table 4: Mobile regulatory entities in SADC countries

Country	Regulator (independent versus State)	Primary activity
Angola	InstitutoAngolano das Comunicações (INACOM).	Regulator
	Telecomunicações Ministério das Telecomunicações e Tecnologias	Ministry
Botswana	Botswana Telecommunications Authority	Regulator
	Ministry of Communications, Science & Technology	Ministry
DRC	Autorite de Regulation de la Poste et de Telecommunications	Regulator
Lesotho	Lesotho Communications Authority	Regulator
Madagascar	Office Malagasy d\'etudes et de Regulation des Telecommunications (OMERT)	Regulator
Malawi	Malawi Communications Regulatory Authority (MACRA)	Regulator
Mauritius	Information and Communication Technologies Authority	Regulator
	Ministry of Information Technology and Telecommunication	Ministry
Mozambique	Instituto Nacional das Communicacoes de Mozambique	Regulator
	Ministry of Transport and Communication	Ministry
Namibia	Communications Regulatory Authority of Namibia (CRAN)	Regulator
	Ministry of Information and Communications Technology	Ministry
Seychelles	Ministry of Information Technology and Communication (MITC)	Both ministry and regulator
South Africa	Independent Communications Authority of South Africa (ICASA)	Regulator
	Department of Communications	Ministry
Swaziland	SPTC	Regulator
	Ministry of Tourism, Environment and Communications	Ministry
Tanzania	Tanzania Communications Regulatory Authority - TCRA	Regulator
	Ministry of Communications and Transport	Ministry
Zambia	Zambia Information and Communications Technology Authority	Regulator
Zimbabwe	Postal & Telecommunications Regulatory Authority (POTRAZ)	Regulator

Source: http://www.itu.int/ITU-D/icteye/DisplayCountry.aspx?code=ANG

2 Literature review

Institutional framework

The scholarly literature which provides the basis of this study's analysis falls into the category of institutions and commitment. This section therefore summarizes the major highlights of this body of literature, emphasizing its relationship with the expected pattern of basic mobile telephone infrastructure deployment.

Regulations and commitment

Henisz and Zelner (2001) argue that the extent to which the regulatory environment in place supports political actors' commitments not to expropriate the property or rent-streams of investing firms enhances the incentives which encourages telecommunications firms to continue investing. To this end, two impacts of the regulatory environment on the growth rate of mobile telecommunications infrastructure are hypothesized.

Expropriation or hold-up

The unavailability of a credible commitment[8] by the elite and powerful political actors within the government and/or the State not to expropriate capital assets or the returns generated, increases the risk associated with investment in assets that are largely sunk—that is, that cannot be redeployed without significant loss of value and therefore have large quasi-rents (Goldberg, 1976; Spiller, 1993). Given the relatively large sunk costs incurred before profits start to accrue, mobile telecommunications infrastructure provides a classic example of non-redeployable assets. Furthermore, as Levy and Spiller (1994) note, economies of scale in and massive consumption of mobile telephone services create an inherent political interest in the pricing of such services and may therefore provide strong incentives for government seeking to win favour with the electorate to expropriate the mobile telephone firm's returns once the firm has deployed infrastructure on the ground. The convergence of profitable opportunity and political motivation consequently creates an inherent contracting problem in the provision of mobile telephone services. The fact that the life span of mobile telephone investments is measured in decades, and thus extending over several elections (and leadership changes), also complicates the problem.

Faced with such a contracting problem, investors will only take the government seriously and believe its pledges regarding future pricing and regulatory policy to the extent that such pledges and guarantees are credible. Credibility, in turn, depends on the degree to which regulatory safeguards that escalate the expenses of reneging on previous policy commitments are in place. In the absence of such safeguards, the expense to the government of reneging on previous decisions declines, and the probability that the short-term gains to seek re-election into office or popular support emanating from policy reversal will yield positive net present value to political actors' increases.

Rent seeking

The second distinct impact of the regulatory environment on economic activities relating to mobile telephone infrastructure investments involves rent seeking. In countries where political regimes can be easily manipulated, the ability of firms to get substantial economic returns from their investment activities depends more on political activities. For example, where political manipulation is rife, it means that the assignment of licences for monopolies over new technology, quotas for imports of certain products, and lucrative contracts from the public sector typically involve both political and economic logic. In these cases it means that as the role of politics in these assignments increases, sizeable financial and managerial resources are diverted from economic activity to political rent seeking (Krueger, 1974; and Shleifer and Vishny, 1994). Henisz and Zelner (2001) argue that this shift in resource allocation results in wasteful resource use and in turn implies sub-optimal investment in tangible economic infrastructure and greater investment in grey- and black-market activity.

Hypothesis

The literature on regulations and commitment suggests that the investment in mobile telephone infrastructure—which is largely non-redeployable—is more likely to occur in the presence of an institutional (regulatory) environment that provides credible safeguards against arbitrary or unpredictable changes in the policy or regulatory environment. At the same time, regulatory environments that are unable to provide such commitments are a breeding ground for increased rent-seeking behaviour, which creates an additional channel through which political institutions can affect the growth of infrastructure.

Theoretical review

This sub-section outlines the theoretical review which provides a link between regulation and investment activities in the mobile telephone sector. As already alluded to, there are two regulatory categories, namely incentive regulation and access regulation.

The impact of incentive regulation on investment

Incentive regulation can take a variety of forms including rate of return (RoR), price cap and profit sharing or revenue sharing mechanisms. Cambini and Jiang (2009) contend that rate-of-return (RoR) regulation has been widely used to regulate the telecommunications sector for more than a century. However, with increased technology and evolving new dynamics in the sector, regulatory incentives dealing with RoR have not been used due to their limited ability to reduce operating costs. Regulation has been rendered inefficient in stimulating an appropriate effort in cost reduction, and as such it has been abandoned. In most countries, abandoning RoR has resulted in a shift towards other regulatory alternatives such as price cap, profit sharing or revenue sharing mechanisms.

The relationship between regulatory incentives and mobile telephone infrastructure investment is not straight forward as different incentives are likely to affect investment differently. For example, Cambini and Jiang (2009) argue that RoR regulation is likely to provide strong incentives for developing new infrastructure since the RoR on the asset base is guaranteed and the risk faced by the firm is considerably reduced. When considering price cap, the situation changes. A price cap mechanism is likely to dampen or diminish the incentive to invest in infrastructure, especially when the regulatory lags are shorter than the life of the assets, due to regulatory opportunism. The possible impacts of these incentives are complicated once we introduce uncertainty.[9]

Dobbs (2004) indicates that when investment is largely irreversible, the intertemporal price cap regime can be used to encourage the competitive solution under certainty, but the same price cap regime is likely to encourage the regulated firm to delay its capacity investment under uncertainty. Given that pure price cap schemes separate regulated prices from realized costs, these schemes have the potential of accruing extremely high profits to the firm, which could not be favoured by regulators. To deal with this potential problem of very high profits, some hybrid plans have been considered as possible remedies and these include profit or revenue sharing plans. However, profit or revenue sharing plans also have a tendency of negatively affecting investment decisions. The study by Panteghini and Scarpa (2003) indicates that profit sharing is ineffective as a device to promote investment by reducing a firm's certainty on future regulatory policies. A separate study by Moretto et al (2008) reported that the introduction of a profit-sharing element leads to underinvestment compared with pure price cap unless the profit-sharing intervention threshold is very high.

The impact of access regulation on investment

Friederiszick et al (2008) argue that the potential efficiency gains from competition in the context of telecommunications industries can be severely hampered by parts of the infrastructure that have natural monopoly properties. The local loops, which connect individual households to the local switch, are the most often cited example of such infrastructure. Duplication of the copper wires constituting the local loops is prohibitively expensive, at least for providing an alternative supply of traditional telecommunication service. This has forced regulatory authorities in most countries to introduce mandatory access to the incumbent telephone network by means of unbundling and sharing the local loop. The mandated access facilitates the so-called service-based competition, in which the entrant is able to compete with the incumbent in the retail market by leasing the local loop at some regulated price. This is very different from facilities-based competition, in which both the incumbent and the entrant own the essential infrastructure and no leasing arrangements are required. According to studies such as Cave and Vogelsang (2003), and Cave (2004), advocates of the access regulation stress that although low access fees may not promote infrastructure investments, they do allow the entrants to climb the first rung of an investment ladder.

In fact, in the area of access regulation, a great deal of involvement is about mandatory unbundling and its effect on firms' investment incentives. According to Cambini and Jiang (2009), access regulation is commonly regarded as a pro-competitive measure and an instrument to spur the so-called "stepping stone" or "ladder of investment" theory. This theory posits that allowing new entrants to lease those network elements that are particularly difficult or extremely expensive to replicate at the initial stage of competition provides impetus for them to invest in their own facilities at a later date. That is, in the first step, the new entrant would be able to attract its installed base of subscribers and gain a better understanding of the demand and the costs by leasing the parts of the incumbent's infrastructure that are costly to duplicate. After accomplishing this first step, an increase in access charges together with technological progress and falling costs should encourage the entrant to roll out its own network and start the facilities-based competition. Thus, before long rival networks are built and facilities-based competition is created, so that regulation of wholesale terms could be highly limited. In short, mandatory network sharing is a means to an end, not the end in itself.

Information from ITU Online Database indicates the status of most countries with regards to whether local loop unbundling is mandatory or not. Table 5 provides the local loop unbundling requirements for SADC countries. Tabulated information shows that the requirement is mandatory in six of the 15 countries as of 2010.

Table 5: Local loop unbundling requirements in SADC countries, as of 2010

Country	Is unbundled access to the local loop required?	Year decision was made
Angola	Not mandatory	2007
Botswana	Not mandatory	2010
DRC	Mandatory	2010
Lesotho	Mandatory	2004
Madagascar	Not mandatory	2008
Malawi	Mandatory	2010
Mauritius	Mandatory	2000
Mozambique	Mandatory	2005
Namibia	Not mandatory	2008
Seychelles	Not mandatory	2010
South Africa	Mandatory	2004
Swaziland	Not mandatory	2002
Tanzania	Not mandatory	2004
Zambia	Not mandatory	2009
Zimbabwe	Not mandatory	2010

Source: http://www.itu.int/ITU-D/icteye/DisplayCountry.aspx?code=ANG

Empirical review

Friederiszick et al (2008) focused on the relationship between entry regulation and infrastructure investment in the telecommunications sector. The empirical analysis was done using a comprehensive data set which involved 180 fixed-line and mobile telephone operators in 25 European Union (EU) countries over 10 years. The empirical analysis employed an indicator measuring regulatory intensity in European countries. To deal with the potential endogeneity problem in its econometric estimations, this paper used instrumental variables[9] (IVs) and found that although entry regulation (e.g., unbundling) discourages infrastructure investment by entrants, the regulation had no effect on incumbents in fixed-line telecommunications. In the case of activities in the mobile telephone sector, the study found no significant impact of entry regulation on investment in mobile telephony.

The positive role of price cap regulation on promoting investment incentive when compared to the traditional RoR mechanism is supported by both theory and empirical literature. Greenstein et al (1995) investigated the influences of price cap and profit sharing on investment in modern infrastructure equipment by local telephone exchange companies. This paper used local exchange carriers (LEC) specific data in US and the results revealed a positive effect of price cap on the deployment of modern equipment. The research further concluded that price regulation would have increased infrastructure deployment by at least 75% in those states that had not adopted such schemes by 1991. The findings by Ai and Sappington (2002)

support the importance of price cap when compared to RoR regulation mechanism. Specifically, Ai and Sappington (2002) found that network modernization, in particular the deployment of fibre-optic cable, was greater under various incentive regulation regimes than under RoR.

When comparing different regulatory incentives, theoretical analysis indicates that profit sharing is not an effective device to foster investment because it probably causes the regulated firm to underinvest in further expansion. Empirical results from Greenstein et al (1995) supports this statement and the research found that price cap regulation is more powerful than the standard profit-sharing scheme, and it is more effective in triggering infrastructure deployment when price regulation is implemented by itself than when two different schemes are mixed.

With regards to the impact of access regulation on investment, a large part of the empirical literature is centred on local loop unbundling. Results from empirical analysis are somewhat two-fold. On the supporting side, Willig (2006) found that a 1% reduction in unbundled network element (UNE) rates corresponds to approximately a 2.1% to 2.9% increase in incumbent local exchange carriers (ILEC) investment. According to Willig (2006), policies which promote access to unbundled network elements are believed to encourage both competition and investment.

Wallsten (2006) tests the impacts of access regulation and demographics on broadband development in a panel data set across the Organisation for Economic Co-operation and Development (OECD) countries with respect to different forms of unbundling—full unbundling, bitstream and sub-loop unbundling. In summary, the research found that extensive unbundling mandates and some types of price regulation can reduce broadband investment incentives, though regulations ensuring easier interconnection with the incumbent can increase investment. The results further show that in the case that extensive obligations on the incumbent reduce broadband penetration, regulation per se could also become an important tool in promoting broadband adoption and milder regulations ensuring easier interconnection with the incumbent can increase penetration and investment.

Contrary to supporting studies, Cambini and Jiang (2009) and others are opposed to mandatory unbundling. The root of the opposition emanates from the fact that the mandated prices under unbundling are calculated based on a forward-looking cost methodology. Cambini and Jiang (2009), for example, claim that this calculation methodology is widely disputed because it neglects the important role of sunk and irreversible investments in telecommunications so that the price is set too low to compensate the incumbent without allowing any markup over cost for the risk associated. The failure to recognize the sunk cost character of network investment leads local loop unbundling (LLU) to negative economic incentives for innovation and for new investment.

Analyses looking directly into the relationship of investment and access regulation prove the disincentive effect of mandatory unbundling in reality. Crandall and Singer (2003) investigated United States (US) Regional Bell Operating Company' (RBOC) data and found that for every line lost to a competitive local exchange carriers (CLEC) via

unbundled network element-platform (UNE-P) at the regulated rates, RBOC loses roughly US$18.50 in revenue, US$15.50 in earnings, and US$10 in operating cash flows each month, which in turn reduces the ILEC capital spending. In another study, Ingraham and Sidak (2003) analysed three of the largest US ILECs (Bellsouth, SBC Communications and Verizon). The study confirms the hypothesis that mandatory unbundling would increase the volatility of the ILEC stock returns during times of recession and therefore increase their equity costs, which eventually decreases their investment incentives in the network. Zarakas et al (2005) suggests that mandatory sharing of the incumbent's facilities blunts incentives to make durable investments and diminishes aggregate investment in local exchange infrastructure in general, and broadband facilities in particular.

3. Methodology

It is notoriously difficult to measure policies affecting the services trade because of their variety and complexity (Deardorff and Stern, 2008) due to the fact that, services by nature are intangible. Furthermore, it is important to recognize that the service sector encompasses a largely heterogeneous selection of activities (Walsh, 2006). For example, operation of the financial or communications sectors is different to that of the health services or transport sectors. To this end, to achieve the stated objective, the research used a quantitative (econometrics) approach.

Econometric approach

Determinants of infrastructure investments in mobile telephone sector

In analysing the relationship between regulation and investment in the telecommunication sector, Friederiszick et al (2008) identified four groups of variables that are likely to affect the infrastructure investment of a firm: (i) demand shifters; (ii) cost shifters, ; (iii) competitive pressure; and (iv) regulation.

Demand shifters are considered as variables that affect consumer demand for telecommunications infrastructure. These variables include consumer wealth and are typically measured by gross domestic product (GDP) per capita.

The second group covers investment cost shifters. Because the density of households determines, to a large extent, the costs of building local loops, a natural cost measure is the population density and the level of urbanization. The third group of variables comprises measures of competitive pressure. In particular, investment incentives of telecommunications companies can be influenced by facilities-based competition from alternative platforms. One such measure used in the literature is cable TV penetration, as cable broadband offerings directly compete with digital subscriber line (DSL) broadband access over fixed-lines. By the same token, the number of main lines in a country constitutes a measure of competitive pressure in mobile telecommunications.[10]

Regulatory policies constitute the fourth group of relevant variables. Among them is entry regulation, including unbundling and sharing of the local loop are some of the regulations. Since 2000, several SADC countries have adopted mandatory unbundling

polices. To capture this policy, the study used a dummy which takes a value of one for the year in which a given country adopted mandatory unbundling, and zero otherwise. Following Henisz and Zelner (2001), the study will also have a second regulatory variable in the form of political constraints index (POLCON). The hypothesis which underpins the use of POLCON in this study is that stronger political constraints should be associated with higher levels of investment. Thus, a positive relationship will be expected between political constraints and investment in mobile telephone. To check for robustness of the results, the study also rotated/interchanged both the dummy and POLCON variable with other regulatory variables which have been used in literature. The study also used political rights, civil liberties and ease of doing business indicators in place of the regulator mandatory access dummy and POLCON to check for robustness.

Derivation of the econometric model

This paper used an econometric model along the lines suggested by Greenstein et al (1995) as presented in Friederiszick et al (2008). It is a partial adjustment model, in which the current infrastructure stock is a weighted average of the long-run desired stock and of the lagged stock value, where the weights reflect the speed of adjustment to long-run equilibrium.

Specifically, it is assumed that $Infr^*_{kt}$ reflects the long-run desired stock of mobile telephone infrastructure in country k in time period t. Let $Infr^*_{kt}$ be given by:

$$Infr^*_{kt} = X_{kt}\beta + \varepsilon_{kt} \quad (1)$$

From Equation 1, X_{kt} comprises all the four groups of explanatory variables which have been discussed and the constant term α_0. Current infrastructure investment stock levels are given by the adjustment process:

$$Infr^*_{kt} = Infr_{kt-1} + \alpha_1\left(Infr^*_{kt} - Infr_{kt-1}\right) + \mu_{kt} \quad (2)$$

Substituting Equation 1 into Equation 2, we obtain:

$$Infr_{kt} = \alpha_1 Infr_{kt-1} + X_{kt}\beta + \nu_{kt} \quad (3)$$

Where

$$\alpha_1^{'} = 1 - \alpha_1, \beta^{'} = \beta \Big/ \alpha_1^{'} \; and \; \nu_{kt} = \alpha_1^{'}\varepsilon_{kt} + \mu_{kt}$$

Equation 3 yields the empirical model that is going to be estimated in this study. Estimation of this equation provides information on two aspects of the investment process. First, the estimate of α_1' reflects the speed of adjustment. Second, the estimates of β' provide information on the effect of regulatory and economic variables on the long-run desired stock of infrastructure.

Empirical model

In line with Greenstein et al (1995) as presented in Friederiszick et al (2008) and as previously presented, the following is the empirical model that the study will estimate:

$$\ln(Invcap_{kt}) = \alpha + \beta_1 \ln(Inv_{kt-1}) + \beta_2 GDPCap_{kt} + \beta_3 PD_{kt} + \beta_4 FL_{kt} + \beta_5 \mathrm{Re}\, g_{kt} + \beta_6 POLCON_{kt-1} + \beta_7 POLCON_{kt-1} x \ln(Inv_{kt-1}) + \beta_8 D_{Year} + \varepsilon \quad (4)$$

In the above empirical model (i.e., Equation 4), the dependent variable is per capita investment ($Invcap_{kt}$) in mobile telephony for each of the SADC countries and for the time period between 2000 and 2012. The left-hand-side variable is specified first, as annual total investment in mobile telecommunication in US dollars.

The existing level of infrastructure investment, measured as the natural logarithm of annual per capita investment in mobile telephony at the end of the previous period (ln(Invit-1)), appears on the right-hand side both alone and as part of a multiplicative interaction term. The coefficient in the former case measures the extent to which the existing level of infrastructure investment affects investment in mobile telephone conditional on all of the other right-hand side variables (with the exception of $POLCON_{kt-1}$).

The empirical model also includes right-hand side variables to measure (potential) demand. Consistent with the investment framework, the first of these is the natural logarithm of the level of real GDP per capita (lnGDPCap). In this instance, when the level of demand in a country increases, so too does the long-run steady-state level of infrastructure investment for that country. Consequently, the growth rate of infrastructure investment increases during a lengthy transition interval until the new steady-state level is attained. The level of infrastructure investment should therefore be positively related to the level of real GDP per capita.

Our two main variables of interest are Reg_{kt} and the political constraints index ($POLCON_{kt-1}$). Reg_{kt} represents regulation on unbundling. For countries with mandatory unbundling, the variable will assume a value of one (1) from the year in which the regulation was decided upon. A value of zero (0) implies that the country does not have mandatory unbundling. Table 5 provides the unbundling regulatory status of each of the SADC countries. Given that previous studies showed that implementation of mandatory unbundling may both negatively, and positive impact investment in telecommunications infrastructure, the a priori sign of the coefficient of Reg_{kt} is therefore indeterminant.

The measure of political constraints (POLCON) was constructed by Henisz (2000) and shows the extent to which the structure of a nation's political institutions and the preferences of the actors that inhabit or constrain any one political actor from effecting a change in government policy. Compared to other used measures of the political system, POLCON addresses one important issue pertinent to investors: the credibility of the policy regime. The derivation of this measure employs spatial modelling techniques of positive political theory to quantify the extent of the limitations imposed by the structure of a nation's political institutions and the preferences of the actors that inhabit them on the feasibility of policy change. The main outcomes of the derivation of POLCON, according to Henisz (2000), are that: (1) each additional veto point (branch of government that is both constitutionally effective and controlled by a party different from other branches) provides a positive but diminishing effect on the total level of constraints on policy change; and (2) homogeneity (heterogeneity) of party preferences within an opposed (aligned) branch of government is positively correlated with constraints on policy change. POLCON is computed annually and covers more than 157 countries and the variable has been computed since 1960. All the 15 SADC countries are also covered. In terms of interpretation, stronger political constraints should be associated with higher levels of investment. Thus, a positive relationship is expected between political constraints and investment in mobile telephony. The hypothesis also suggests that the presence of strong political constraints may improve the ability of countries with low levels of investment to catch up. An interaction term in which the existing level of infrastructure investment ($\ln(Inv_{it-1})$) is multiplied by the level of political constraints ($POLCON_{kt-1}$) is also used as a determinant of mobile telephone sector infrastructure investment. The interaction term allows for the possibility that in the presence of strong political constraints (high $POLCON_{kt-1}$), a country with low levels of investment in mobile telephony (a small value of $\ln(Inv_{kt-1})$) has a larger effect on encouraging investment than it does when political constraints are weak (low $POLCON_{kt-1}$). Accordingly, we expect the estimated coefficient on the interaction term to be negative in sign. Lastly, we include a vector of year dummies to capture sample wide temporal effects such as technological innovation and increased globalization.

Variable PD_{kt} captures population density in the areas serviced by various mobile operators. Because the density of households determines to a large extent the costs of building local loops, economies of scale in terms of cost are achieved in areas where there is higher density when compared to areas with low density. Freedom and civil liberties (FL_{kt}) is another variable which has been used to augment political constraints (POLCON). All things being constant, a country with freedom and civil liberties, that is, where freedom of speech, association and civil liberties are enjoyed, is expected to be a haven for investment in mobile telephone infrastructure. Thus, a positive relationship is expected between freedom and civil liberties (FL) and per capita investment ($Invcap_{kt}$) in mobile telephony.

Data sources

The various data sources that were used are presented in Table 6. Table A3 in the annexes shows an example of the actual data used for each of the country in the panel using an example of South Africa.

Table 6: Data sources

	Name of variable	Source(s)
1.	Telecoms investment (US$)	World Bank Development Indicators
2.	POLCON	POLCON database
	Unbundling regulation (Reg)	International Telecommunications Union
3.	GDP per capita	World Bank
4.	Population density (PD)	World Bank
5.	Dummy on mandatory unbundling	Respective countries' policies
6.	Political rights and civil liberties	Freedom House

Source: Author compilation

4. Results

Econometrics results

Table 7 presents the regression results using the empirical model, Equation 4, for the period covering 2000 to 2012.[11] Four different model results are tabulated, though this section will largely interpret the random effects model results from Model III, and the pooled model results from Model I as they are contained in Table 7. Overall, and across most models, the coefficient of GDP per capita is positive and statistically significant. As indicated before, increases in this variable imply increase in demand and this in turn motivates infrastructure investment in mobile telephony. In other words, increases in national demand as captured by increase in GDP per capita increases the long-run steady-state level of infrastructure investment for that country.

Table 7: Regression results (dependent variable: Ln(Invcapkt))

Variable	Pooled Models		Random Effects Models	
	Model I	Model II	Model III	Model IV
Ln (Invkt-1)	-0.02 (-0.19)	0.27 (1.8)*	0.37 (2.37)**	0.38 (2.18)**
LnGDPcap	0.21 (3.54)***	0.10 (1.08)	0.53 (4.06)***	0.41 (1.57)
Regkt	0.69 (2.02)***	0.64 (1.67)*	0.54 (1.35)	0.53 (1.12)
Polconkt-1	-4.10 (-4.26)***	-2.52 (-2.37)**	-1.70 (-1.38)	-1.70 (-1.31)
Polcon*(ln(Invkt-1))	0.98 (3.46)***	0.42 (1.30)	0.19 (0.56)	0.16 (0.43)
PD	---------	-0.16 (-1.65)	---------	-0.03 (-0.18)
FL	---------	0.30 (2.88)***	---------	0.10 (0.47)
Year Dummy	---------	0.03 (0.86)	---------	0.02 (0.46)
Constant	---------	---------	-3.57 (-3.44)***	-2.78 (-1.38)
Adjusted R2	0.24	0.28	0.24	0.21
Obs	195		195	195

Key: [***]; [**]; [*] – significant at 1%; 5% and 10% respectively.
Source: Author

Of central interest to this study are the coefficients on the previous level of mobile telephone infrastructure investment variable by itself (Ln(Invkt-1); unbundling regulation (Regkt) variable; the political-constraints variable by itself (POLCONkt-1); and the interaction term (Polcon*(ln(Invkt-1))). The positive coefficient estimates on

the first of these terms implies that there is a systematic positive association between previous level of mobile telephone infrastructure investment and current level.

The results from Model I (of Table 7) show that the coefficient of Reg variable is positive sign and statistically significant. This positive sign is expected and according to Cambini and Jiang (2009), mandatory unbundling access regulation allowing new entrants to lease some network elements that are particularly difficult or extremely expensive to replicate at the initial stage of competition provides an impetus for them to invest in their own facilities some time later. That is, in the first step, the new entrant would be able to attract its installed base of subscribers and gain a better understanding of the demand and the costs by leasing the parts of the incumbent's infrastructure that are very costly to duplicate. After accomplishing this first step, an increase in access charges together with technological progress and falling costs should encourage the entrant to roll out its own network.

POLCON has a negative and statistically significant impact on determining the level of mobile telephone infrastructure investment in SADC countries. This implies that stronger political constraints are retarding mobile telephone investments. This result is against expectations. One possible explanation may be the presence of a high level of rent seeking behaviour, whereby strong interested economic groups manipulate policy makers or institutions which are supposed to enforce the various political constraints for their selfish benefits. In most SADC countries, rent seeking is rife. This is a situation where political regimes are easily manipulated and the ability of firms to get substantial economic returns from their investments activities sometimes depends more greatly on political activities. In this case the assignment of licenses for monopolies over new technology, quotas for imports of certain products, and lucrative contracts from the public sector typically involve both political and economic logic. In these cases, it means that as the role of politics increases in economic activities in these countries, investment in mobile infrastructure will be negatively affected.

The negative coefficient estimates on the interaction term (Model I) implies that in the presence of strong political constraints (high POLCONkt-1), a country with low levels of investment in mobile telephony (a small value of ln(Invkt-1)) has a larger effect on encouraging investment than it does when political constraints are weak (low POLCONkt-1).

5. Conclusion and policy recommendations

The use of mobile telephones as a mechanism for reducing information asymmetry especially in developing countries, it is argued, is a determinant of economic growth and market development. Hence any activities in this area attract attention from various angles, chief among them being the regulatory and investment nexus. This research investigated the impact of policy regulations on investments in mobile telecommunications network infrastructure in all the 15 member countries of the SADC region.

The research used panel data econometrics to achieve its stated objective. Estimated results show that the coefficient of GDP per capita is positive and statistically significant, implying that an increase in this variable results in increase in demand and this in turn motivates infrastructure investment in mobile telephony. The coefficient on the previous level of mobile telephone infrastructure investment variable (Invkt-1) was found to be positive and statistically significant. This means that there is a systematic positive association between the previous and current levels of mobile telephone infrastructure investment. The coefficient of the main variable of interest representing mandatory unbundling (Regkt) was found to be positive sign and statistically significant. This implies that, overall, mandatory unbundling access regulation boost infrastructure investment in mobile telecommunications. Regression estimates show that the coefficient of one of the variable of interest, political constraint (POLCON) has a negative and statistically significant impact on determining the level of mobile telephone infrastructure investment in SADC countries. Whilst this result is against expectations, one possible explanation may be presence of high level of rent seeking behaviour.

Regression results show that the coefficient of GDP per capita is positive and statistically significant, implying that an increase in this variable results in increase in demand and this in turn motivates infrastructure investment in mobile telephony. The coefficient on the previous level of mobile telephone infrastructure investment variable (Invkt-1) was found to be positive and statistically significant. This means that there is a systematic positive association between previous level of mobile telephone infrastructure investment and current level.

The variable representing mandatory unbundling (Regkt) was found to be positive sign and statistically significant. This implies that mandatory unbundling access regulation allows new entrants to lease some network elements that are particularly

difficult or extremely expensive to replicate at the initial stage of competition provides an impetus for them to invest in their own facilities some time later.

The political constraint variable, POLCON, had a negative and statistically significant impact on determining the level of mobile telephone infrastructure investment in SADC countries. Whilst this result is against expectations, one possible explanation may be presence of high level of rent seeking behaviour. In most SADC countries, rent seeking is rife. In rent-seeking, political regimes are easily manipulated and the ability of firms to get substantial economic returns from their investments activities sometimes depends more greatly on political activities. In these cases it means that as the role of politics in these assignments increases, sizeable investment in mobile infrastructure may also increases. Going forward and in terms of policy recommendations, what is emerging is that for SADC countries, unbundling is the way to go. This is more so given the limited financial muscle that potential new mobile telephone entrants (or investors) in the region have for expending on sunk costs. Thus, SADC governments should consider making bundling mandatory to encourage new entrants in the mobile sector.

Notes

1. Welcome remarks by His Excellency Paul Kagame, President of the Republic of Rwanda, at Connect Africa Summit. Available at: http://www.gov.rw/government/president/speeches/2007/29_10_07_itu.html.

2. The United Nations (UN) agency responsible for information and communication technologies.

3. The current 15 SADC member States are: Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

4. Penetration rates are calculated as number of subscribers divided by total population, and expressed in percentage.

5. It is common in mobile telephone studies to have penetration rates of more than 100 as some subscribers have more than one mobile sim cards.

6. http://ppi.worldbank.org

7. Ownership structure is defined into broad two categories: (1) Privately owned means the entity is purely private, and (2) public operated means the entity maybe owned by either public or other private, but the operations are ceded to a particular private entity (who may not be the owner).

8. The study considers "credible" as incentive-compatible in an inter-temporal sense, or "time-consistent".

9. The instrumental variables (IVs) were categorized into two, namely political variables and neighbouring markets. Political variables included political ideology of the government, attitude of the government toward European integration, attitude of the government toward regulation, and the level of checks and balances constraining the discretion of politicians' and bureaucrats' decisions. Neighbouring markets included the level of regulation in other European countries as possible instruments.

10. The optimal choice of explanatory variables should not aim to explain as much variation in the investment variable as possible, but rather minimize omitted variable problems

thereby contributing to the accuracy of estimates on the regulatory variables. Inclusion of variables that might be correlated with investment levels as well as regulatory policies (like the installed cable TV infrastructure) is then crucial.

11. Part B of the Annex provides regression results which includes price as one of the explanatory variables. Given that the prices were only available from 2008, the regression results are therefore for the period covering 2008 to 2012.

12. Which is defined as "Mobile-phone prepaid – price of a one-minute local call (off-peak, off-net)" in the ITU database.

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Annexes

A POLCON values

Table A1: Annual values of Polcon for SADC countries

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
1	Angola	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.16	0.16	0.16	0.16	0.31
2	Botswana	0.71	0.20	0.20	0.20	0.20	0.72	0.72	0.25	0.25	0.25	0.25	0.25	0.25	0.34
3	DRC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.66	0.66	0.66	0.66	0.34	0.28
4	Lesotho	0.02	0.02	0.67	0.74	0.74	0.74	0.74	0.74	0.76	0.76	0.76	0.76	0.76	0.63
5	Madagascar	0.53	0.53	0.53	0.37	0.37	0.37	0.37	0.37	0.20	0.20	0.20	0.20	0.20	0.34
6	Malawi	0.75	0.75	0.42	0.42	0.42	0.11	0.11	0.11	0.11	0.11	0.42	0.42	0.42	0.35
7	Mauritius	0.69	0.70	0.71	0.71	0.71	0.71	0.74	0.74	0.74	0.74	0.74	0.73	0.73	0.72
8	Mozambique	0.33	0.33	0.33	0.33	0.33	0.33	0.31	0.31	0.31	0.31	0.25	0.25	0.25	0.31
9	Namibia	0.72	0.72	0.72	0.72	0.72	0.70	0.70	0.70	0.70	0.70	0.71	0.71	0.71	0.71
10	Seychelles	0.15	0.15	0.15	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.24
11	South Africa	0.46	0.46	0.46	0.46	0.46	0.42	0.42	0.42	0.42	0.42	0.41	0.41	0.41	0.43
12	Swaziland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	Tanzania	0.25	0.11	0.11	0.11	0.11	0.11	0.16	0.16	0.16	0.16	0.16	0.27	0.72	0.20
14	Zambia	0.70	0.70	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
15	Zimbabwe	0.02	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.39	0.39	0.39	0.15

B Regression results for period 2008 to 2012

Table A2 presents the regression results in which price[12] is the additional variable when compared to the results presented in the main text (Table 7). For most variables, the results are the same as those in Table 7. The coefficient on the price variable in both the pooled and random effects models is not statistically significant. This implies that mobile telephone prices in SADC member countries do not significant impact on infrastructure investment in the same sector.

Table A2: Regression results (dependent variable: Ln(Invcapkt))

Variable	Pooled models	Random effects models
Ln (Invkt-1)	0.43 (3.79)***	0.43 (4.52)***
LnGDPcap	0.13 (3.0)***	0.10 (1.09)
Reg	0.42 (1.23)	0.41 (1.43)
Polconkt-1	-2.15 (-2.22)**	-2.12 (-2.58)**
Polcon*(ln(Invkt-1))	0.54 (2.68)***	0.52 (2.95)***
Price	-0.003 (-0.60)	-0.003 (-0.72)
Constant	------	0.23 (0.33)
Adjusted R2	0.37	0.37
Obs	75	75

Table A3: Sample data used in regressions (example of South Africa)

Year	Invcap ($)	Invcap(t-1) ($)	Inv ($)	GDPcap ($)	PD_SA	FL_SA	Reg	POLCON	Time dummy
2000	41.3	52.1	2291	2,986	36.3	11.06389	0	0.44	0
2001	41.4	41.3	1840	2,633	37.0	10.81984	0	0.46	1
2002	42.9	41.4	1863.7	2,445	37.8	10.48762	0	0.46	2
2003	41.1	42.9	1955.5	3,656	38.3	10.28611	0	0.46	3
2004	38.5	41.1	1889.8	4,723	38.8	10.19914	1	0.46	4
2005	25.2	38.5	1787	5,267	39.3	9.804025	1	0.46	5
2006	28.6	25.2	1183.5	5,511	39.8	9.489086	1	0.42	6
2007	42.2	28.6	1357	5,910	40.3	9.136585	1	0.42	7
2008	39.4	42.2	2043	5,606	40.9	8.802907	1	0.42	8
2009	48.3	39.4	1927	5,746	41.4	8.488581	1	0.42	9
2010	42.0	48.3	2387	7,271	42.0	8.211481	1	0.42	10
2011	34.1	42.0	2101	8,066	42.5	7.944324	1	0.41	11
2012	30.9	34.1	1727.2	8,202	43.1	7.694816	1	0.41	12

Key: Invcap = per capita investment in telecommunication infrastructure; PD = population density; FL = telephone lines per 1,000; Reg = represents regulation on unbundling (dummy variable taking 1 for mandatory unbundling or 0 otherwise); POLCON = political constraints index.

Mission

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