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TELECOM PRIVATE INVESTMENT AND ECONOMIC GROWTH:

THE CASE OF AFRICAN AND CENTRAL & EAST EUROPEAN COUNTRIES

Paper within Economics, Bachelor Thesis

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Abstract

This paper examines the contribution of telecommunication private investment to economic growth in Africa and CEE countries using graphical and regression analysis. Data for fourteen African countries and thirteen CEE countries were used for the empirical analysis. The time series data is from 1999-2005. The contribution of telecommunication private investment to economic growth was estimated to be positive but insignificant in the pooled regression analysis. After controlling for country specific effects and causality, the effect of telecommunication private investment on GDP was found to be positive and significant. However, the positive impact on GDP was not substantial. When a cross-sectional test was carried out, the contribution of telecommunication private investment to economic growth was discovered to be positive except in 2005, and was also seen to be statistically significant up to 2002. The contribution of the mobile subscribers to economic growth was revealed to be positive and significant both in the pooled and cross-sectional regression analysis.

Abbreviations

CA = Current account

CEE = Central and East European

FDI = Foreign Direct Investment

GDP = Gross Domestic Product

GNP = Gross National Product

IMF = International Monetary Fund

ITU = International Telecommunication Union

MDGs = Millennium Development Goals

Mobilesub = Mobile Subscribers

PPI = Private Participation Index (Used as Telecom private investments)

SSA = Sub-Saharan Africa

TFP = Total Factor Productivity

UN = United Nations

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1 Introduction

Until recently in most countries, telecommunication service providers were state-owned, state-operated, and often operated in protected monopolistic markets (Noll, 1999). Nowadays, policy-makers, especially in the developing countries and the transition economies, have realized that private participation in the infrastructural facilities, especially in the telecommunication sector, is needed to boost the growth in their economies. There have been wide claims that private sector participation in telecommunication infrastructure is expected to expand and improve services, create incentive for efficiency, and reduce the burden on strained public resources.

Private provision of telecommunication services is also expected to lead to greater efficiency through technological spillover to other sectors, which has long lasting effects on the economy.

In most developing and transition countries, insufficient resources to finance long-term investment is a major problem. This lack of finance is a big set-back to economic growth and this is making it more difficult to achieve the millennium development goals (MDGs) by 2015 as set by the United Nations. Private participation in the telecommunication sector is seen as an avenue of getting the required funds for investments and to enhance productivity, so most countries have privatized their telecommunication sector to achieve these objectives. Due to perceived importance to economic growth, telecommunication private participation should be studied and extensive research should be done on it to understand it, so as to have vivid understanding of how it contributes to economic growth.

1.1 Problem

The policy-makers in these countries have recognized that the growth rate of output is increased when the level of technological process is high, leading to efficient use of factors of production. This has motivated infrastructure privatization in both transition and developing economies, with the aim to increase the level of private capital that will help to expand and improve services, create incentives for efficiency, and reduce the burden on strained public resources. In addition to domestic knowledge and capital, foreign knowledge and capital also become available in the country through foreign firms. Hence, to expand and improve services provides the rationale for privatizing the telecommunication sector in both developed and developing countries. It has become painfully obvious to policy-makers that an efficient communication sector is vital to a well-functioning modern economy, and that constructing such as system requires capital investment spending on a scale that few governments can either achieve or effectively manage (Roeller and Waverman, 2001), hence, the call for telecommunication privatization in these countries. The magnitude of the effect of telecommunication technology on economic growth depends on the level of telecommunication private investment in a country. When the level of private investment is high, the technological spillover on the entire economy

is greater and that leads to a greater effect on economic growth. The World Bank (2003) report of private participation of infrastructure in developing countries demonstrated the role of high telecommunication private investment by stating "in many cases the biggest gains from private provision come through increased investments to meet increasing demands and serve previously unattended consumers". The World Bank report says that the results have been particularly impressive in telecommunication, especially, where competitive regimes have been established. For example in Latin America, evidence suggests that expansion of networks has been far slower where competition has not been allowed, and even private monopolies have expanded more quickly than public ones (Wellenius, 1997; see also Ranamurti, 1996; and Ros, 1999). Telecommunication privatization has therefore been seen as a major channel through which these countries could tap the needed capital and technology with the view that the technology would spillover to domestic firms, thereby enhancing the overall level of productivity.

1.2 Purpose

The purpose of this thesis is to investigate the impact of telecommunication private investment on GDP in the CEE and African countries. Given that telecommunication is a source of technological process, it is interesting to investigate if the technological spillover effect that originates from telecommunication is conditioned on the level of private investment which enhances the penetration effect through increased mobile subscription in these economies.

There are two reasons why we think telecommunication private investment affects GDP. Firstly, as capital augmenting, since total investment in a country consists of both domestic and foreign investment. Therefore, telecommunication private investment has the potential to increase the total amount of investment in the sector which influences economic growth. Secondly, we expect that there is technological spillover effect that originates from telecommunication private investment which enhances the productivity in other sectors.

1.3 Outline

The outline of the thesis is as follows. Section two presents a background to reform in the telecommunications sector. In section three we will review some of the previous studies within the topic of telecommunications and growth. Section four presents an theoretical framework explaining the link between telecommunication and economic development. Section five gives a short introduction to our data and methodology used in the analysis. In section six, an empirical analysis is carried out, to test whether there is any evidence for a positive connection between PPI and GDP. Our conclusion and suggestions for further studies are presented in section seven.

2 Background to reform in the telecommunications sector

The central and East European countries (CEE), handicapped by their peculiarities of their unique history and the need to transform their economies, were confronted with three difficult challenges to their telecommunication sectors: they had to develop their network at an accelerated pace; they needed to implement the new technology; and they had to adapt to the new competitive commercial environment (Wellenius & Stern, 1995, p.339). Together, these make the overall circumstances and problems in CEE telecommunication sectors quite different from those found in other part of the globe. Nevertheless, a substantial beginning has been made, which is in line with the success of the telecommunication sectors in these countries, backed by willingness of the politicians.

Until 1980s, telecommunication was relatively neglected by the CEE governments, which resulted in the overall investment being low and the little new investment that was forthcoming was only used to connect new lines rather than maintain, replace, or strengthen the underlining infrastructure. As a result of this, the countries that belong to the CEE have inherited underdeveloped, worn out, and unbalanced networks (Wellenius & Stern, 1995).

CEE has about 100 million inhabitants and approximately 11 million were connected to the direct exchange lines in the 1980s, giving an average penetration of 11 lines per 100 inhabitants. According to World Bank statistics, the GNP per capital for the CEE countries averages about $2500. However, having recognized the important role telecommunication services play in modern economies like in the Western European countries, CEE governments are aiming to reach a penetration rate of around 40 per 100 by 2010 (Wellenius & Stern, 1995). Achieving such growth will be difficult and costly, but failing to achieve it perpetuates the environment of acute shortage and poor service which in turn poses a strong barrier to economic growth in these economies.

As said earlier, the need to introduce new technology in the telecommunication sector has been in the mind of the governments in the CEE countries, because all CEE networks before 1980s were overwhelmingly analog, since only 5% of the facilities were digital (Wellenius & Stern, 1995). The economics and technology of modern telecommunication virtually indicate that all new equipment must be digital and the existing equipment should be replaced as rapidly and economically as possible.

Before the beginning of 1990, telephones and the telephone services in these countries were big luxury and were meant for the commercial sector, the government, and the ruling cadre rather than for the entire population. The available waiting list from the private sector did not represent the true total demand from the private sector because getting one's name in the demand list entails that he/she must be connected to the ruling party or has bribed officials (Wellenius & Stern, 1995, p. 353). Having noticed that demand for telecommunication services is increasing, the government proposed to bring a lasting solution by:

- "Commercialization: distancing management of operations from government and the attendant bureaucracy to become more businesslike,
- Liberalization: increasing the role of market forces in the provision of public services by moving from monopoly towards open entry, and
- Privatization: increasing the scope for private sector participation in ownership and control of infrastructure" (Wellenius & Stern, 1994).

Similarly, the African countries demonstrated the same problems in their telecommunication sectors that resulted in the move to reform their telecommunication sectors. According to (Mustafa, Laidlaw & Brand, 1994), in sub-Saharan Africa (SSA), the telecommunication sector is predominantly state-owned and has yet to show the benefits from the transformation in patterns of ownership, market structure, and provision of service that is taking place throughout the world. The slow pace of the reform was acknowledged to be due mainly to the absence of a consensus on the benefits that can be secured. Apart from this, business interests do not press strongly for change, residential users fear loss of cross-subsidization, and management and staff in the telecommunication sector tend to fear loss of status and job. In sub-Saharan African countries and some other countries in Africa, government control of public services is linked with independence and nation-building. Privatization is usually viewed as an enemy because there is wide belief that it leads to loss of sovereignty. This way of reasoning is changing, but slowly.

African governments have looked at telephone access as a luxury good which is reserved for the wealthy in the society. At the same time De Melo (2000) provides an example from Chile that indicates that the poor in developing countries do not consider telecommunication to be a luxury good since they tend to spend a larger share of their income on telecommunication than the rich ones in their society. Governments in developing countries have mostly been interested in giving the wealthy minority good access to telecommunication and new technologies rather than expanding the network to the rural areas. Whereas private investors are more interested in expanding the current network to reap the benefits of the underlying demand in rural areas for communication services (Forrestier, Grace and Kenny, 2002).

Previously, the telecommunications sector in SSA and some countries in other parts of Africa has relied for finance primarily on a range of public sector sources- in particular, bilateral loans with involvement of international financial institutions like the International Monetary Fund (IMF). Recently, meeting the financial requirements to develop their telecommunication sectors has shifted to private sources of finance, leading to the privatization of this important sector. This reform strategy is estimated by International Telecommunications Union (ITU) to add over 26 million lines to meet demand for basic telecommunications services by the year 2008 in SSA. Overall, lack of investment capital, coupled with lack of proper management capacity, were the cause of the poor performance of the telecommunication sector in these countries.

3 Literature Review

In 1848 John Stuart Mill wrote, "it is hardly possible to overstate the value, in this present low state of human improvement, of placing human beings in contact with persons dissimilar to themselves and with modes of thought and action unlike those with which they are familiar " (Forestier, Grace, Kenny, p.624. 2002). These thoughts have become the corner stone in the research concerning the impact of communication on economic development and growth. Several studies have been aimed at providing empirical findings that support the notion of a link between telecommunication expansion and economic growth. Leff (1984) is one of the basic studies on this topic. Leff argues that telecommunication lowers the cost of acquiring and transmitting information, which will result in a quantitative and qualitative increase of information supply. According to Leff "this creates new markets and makes already active markets more efficient". In particular, the agricultural sector in developing countries is said to benefit from increased flow of information. However, Leff does not provide any empirical evidence to confirm his theory that telecommunication has a positive effect on economic growth.

Norton (1992) on his part, provides some empirical testing of the hypothesis that telecommunication lowers the transaction cost (here referred to as the difference between the price paid by consumer and price received by the producer). His findings indicate a positive relationship between telecom investments and growth. Furthermore, he also demonstrated that investments in telecom have a positive impact on the overall investment ratio. These findings have been confirmed by later studies (Waverman, Meschi and Fuss, 2005; Sridhar and Sridhar, 2004; Roeller and Waverman, 2001; Madden and Savage, 1997). There is some criticism concerning the magnitude of the impact presented by Norton, in that the estimated effect of telecommunication is considered to be unreasonably high (Roeller and Waverman, 2001). The majority of the literature dealing with this topic does warn about the problem of reverse causality and the risk of overstating the impact of telecommunication. Sridhar and Sridhar (2004) find the income and price elasticity of telecom services to be above one, which could indicate reverse causality. Roeller and Waverman (2001) attempt to get around this problem by presenting a model that endogenizes the telecommunication sector into the aggregate economy. Their result is similar to that in previous studies as far as the positive link between telecommunication and growth is concerned. However, the impact on growth is not as substantial as showed in earlier reports. Madden and Savage (1997) run a test for precedence between growth and telecommunication. They find that there exist mutual precedence between growth and telecommunication, although, the evidence of telecommunication preceding growth is stronger than evidence of the reversed case. Hence, caution is advised when running a regression with these two variables.

More recent studies have focused on investigating the link between telecommunication and decreasing income inequality within countries. The conclusions follow the same basic patterns: expanding telecommunication infrastructure should theoretically drive the development towards less inequality of income, but historically, this has not been the

case-instead the inequality tends to increase as telecommunication improves (Forestier, Grace and Kenny, 2002). Roeller and Waverman (2001) find evidence of scale effect; they demonstrated that countries with penetration rate above 40% will see a stronger impact of telecom infrastructure on growth.

When it comes to private participation in telecom investments and its effects on growth, the studies are more scarce. Studies that have examined the effects of private investment in infrastructure in general have found a positive impact on growth and productivity (Duggal, Salzman, and Klein, 2006; Papanek, 1972; and Ghura, 1997). Doh and Teegen (2003) and World Bank (2006) give an overview of the trends and policies concerning private participation in telecom infrastructural investments. Also see Banerjee, Oetzel and Ranganathan (2006) for the determinants of private investments. Fink, Mattoo, and Rathindran (2002); Li, Qiang and Xu (2001); and Li and Xu (2000) provide evidence for strong association between competition and telecommunication performance measured in terms of teledensity, connection capacity, and price of telephone services. Most of these studies find some evidence of positive effect of teledensity on growth.

4 Theoretical Framework

This section is divided into four subsections. In the first subsection, the idea of the growth accounting equation is applied. The second subsection presents a clear evidence of telecommunication private investment as productivity enhancer, third subsection shows telecommunication private investment as the link to global market. Fourthly, in this subsection, we presented telecommunication private investment as an investment enhancing tool.

4.1 Growth Accounting

The Solow (1957) approach of the growth accounting equation can be used to capture the factors that account for the growth in total output. According to Solow's growth accounting concept, the growth rate of total output depends on the growth rate of capital and labour weighted by their shares of income plus the level of technological progress.

The equation below (in Cobb-Douglas form) represents total output(Y) as a function of total-factor productivity (A), capital input (K), labor input (L), while α and α-1 represent income shares of capital and labour respectively.

$$Y = A \times K^{\alpha} \times L^{1-\alpha} \tag{4.1}$$

The growth accounting equation, as presented in equation 4.1 above, stated briefly the contribution of growth in inputs and improved productivity to the growth of output.

Capital and labour each contribute an amount equal to the share of their income multiplied by their growth rates. The residual in the growth accounting equation, total factor productivity (TFP), is the technological level. Increase in TFP comes from improvement in the method of production which increases the efficiency of factor inputs, hence, more output is produced. Solow found that the growth in output outpaced the weighted average of increase in capital and labour inputs. This difference has often been termed the Solow residual.

Thus, if we know the proportional growth rates of output, the labour force and the capital stock, then we can use the growth accounting equation to calculate the growth rate of technological progress. The level of technology in an economy can be decomposed into two main parts. First, it depends on the level of human capital and level of private investment. With a high level of private investment, the potential for new knowledge emerges thus creating fertile ground for new inventions and innovations. Hall and Taylor (1997) support this assertion by postulating that the long run growth of technology is dependent on the number of workers in the technology production and the number of people doing research. An increase in the number of workers will increase the growth rate of technical level (A). The growth rate of technical process can be enhanced by a permanent increase in the level of private investment which makes firms to engage in research and development leading to innovation that brings new products and production processes. Second, apart from the level of knowledge created within an economy, foreign knowledge becomes available to the economy through telecommunication private participation. FDI according to Mansfield and Romeo (1980)

has therefore been seen as the cheapest means of transferring technology, as the recipient firms do not need to finance the acquisition of new technology and the transfer of technology is faster than licensing and international trade. Since technological process as a result of private participation in telecom infrastructure has direct effect on the efficiency of firms, it has the possibility of creating spillover to other firms. From equation 4.1 above, an interesting question to ask is what determines the level of technical process (A)? The assumption in this thesis is that the rate of technical progress depends on the level of telecom private investment in a country. With high private investment, the potential for new knowledge emerges thus creating a fertile ground for new inventions and discoveries. There are substantial external benefits through knowledge spillover to other firms contributed through the creation of new knowledge since benefits that originate from new knowledge are partially captured by the creator. Mansfield and Romeo (1980) presented a similar argument. It should be noted that the extent to which knowledge spillover to the economy occurs depends on the level of private sector participation in the economy. A higher level of private investment leads to competition and innovation, which enhance the multiplier effect of technology spillover.

4.1.1 Telecommunication private investment as the link to Global Market

Large-scale consumers, and more particularly multinationals, for which networks had progressively become the nervous system on which decision-making, production management, and competitiveness are dependent, increased pressure on operators for international services to be coherent, homogenous, well adapted to the needs, and also to be economical as services provided by the best domestic operators. The telecommunication market was designed to burst its national frontier and become globalized. On the other hand, firms are increasingly going international to form joint ventures or other forms of cooperation. The trend towards globalization applies to an increasing number of commodities and services, especially in the telecommunication sector. Increased availability of telecommunication provides external economies that accrue to many other sectors. These externalities that originate from the telecommunication expansion are in fact extremely important, for they involve the efficiency with which markets and organizational structure functions. Telecommunication is of course a means of transmitting information. Specifically, modern telecommunication has sharply reduced the costs of transmitting information over space and time. In both instances, telecommunication expansion facilitates the flow of information that is current and useful for economic and organizational decisions (Leff, 1984). Indeed, the welfare consequences of telecommunication expansion include public-good effects, notably in enhancing a country's capacity for responding to new problems and opportunities. A fall in the costs of obtaining accurate and timely knowledge is particularly important in developing countries in order to withstand the current wave of international trade.

4.1.2 Telecommunication private investment as a productivity enhancer

Since telecommunication is an avenue for inceasing productivity, policy-makers in developing countries have been motivated to re-examine the existing structure in the telecommunication sector in 1970s. By the early 1980s, it was evident that the state-owned monopolies were inefficient in balancing supply with growing demand for telecom services. The imbalance between supply and demand was evident from the long waiting lists for mainline access in many developing countries. In addition, as indicated by Wellenius (1993), many developing countries reported "call traffic congestion, poor service quality and reliability, limited territorial coverage, and demonstrated willingness of users to pay for higher prices to obtain services". Therefore, private provision of telecommunication services is believed to bring a lot of benefits that improve productivity. The ability to communicate instantaneously can facility the reduction of downtime in business transactions. For example, timely ordering of spare parts and immediate contact with technicians can reduce time lost due to broken machinery such as pumps, tractors, generators, etc. Likewise, timely delivery of products to the market (for example, fish or fresh fruit) is improved through well established contact between producers and shippers to arrange scheduling for delivery of products to the market, which reduces spoilage. Improving the quality and speed of decisions by the managers will raise the productivity of its complementary inputs, namely capital and labour (Leff, 1984).

4.1.3 Telecom private investment as domestic investment enhancer

One of the objectives of liberalization of the telecommunication sector was to attract private capital to upgrade networks. This, in turn, led to the growth of mobile and other wireless services along with the development of international trade in telecommunication services, supported by an increasing number of global service providers.

One of the effects of telecommunication private investment is the provision of private capital, which comes in the form of both domestic and foreign private investment in an economy. These private investments in the telecommunication sector will also help by attracting foreign investments to other sectors by improving the efficiency of markets in the receiving countries. Reynolds, Kenny, Liu and Qiang (2003) provide evidence to the above statement by saying that there is strong relationship between privatization of the telecommunication sector and the amount of foreign direct investment a country receives. They find that privatization increases the amount of foreign direct investment into a country. Standard economic growth theory reveals that an increase in total investment would have a positive effect on growth. Therefore, an increase in the level telecommunication private investment would lead to an increase in the gross capital formation and at the end spur growth. A large part of the uncertainty surrounding business in developing countries disappears through increasing the flow of information in the economy. Norton (1992) argues that larger availability of information concerning the probability distribution of prices will transform uncertainty into risk. With a

lower level of uncertainty, investors and entrepreneurs tend to be more willing to invest in such an economy. By removing uncertainty, telecommunication private investment generates a multiplier effect that enhances the total investment in the economy.

In the case of foreign capital inflow, Johnson (2005) gave evidence that an inflow of capital is more evident in the case of greenfield investment rather than brownfield investment. The former provides more capital because it involves the funding of a new facility while the latter is more focused on change of ownership, hence, less capital is added.

4.2 Network externalities

Communication has always been seen as the main mechanism for two parties to conduct business. Even early economic thinkers such as Adam Smith and John Stuart Mill recognized the importance of communication. In the modern business world, the importance of telecommunication can not be underestimated. It will be interesting to look at some the peculiarities of the telecom sector before looking at the benefits of expanding telecom services. A feature of the telecom sector is network externalities. The benefit of a single user rises as the number of additional users connected to the network increases. In developing countries, the percentage of the total population that consists of subscribers is small; therefore the net utility of subscribers is smaller as compared to that in developed countries. Hence, the marginal social gain from expanding the network is greater in countries that have a low penetration rate. Roeller and Waverman (2001) findings contradict this theory, with their evidence of a "critical mass". They argue that countries with a penetration rate above 40% will see a larger effect on growth from an expansion of the telecommunication network while the effect in those countries with a lower penetration rate will be less significant.

4.3 Employment effect

A more observable externality is the increase in employment stemming from the expansion of this sector. Of course there is a direct effect on employment in this sector on its part. In addition to this, there is a more indirect effect on employment through the emergence of cell phone vendors, phone repair shops, call shops and card recharge establishments. Observations have indicated that the indirect effects of expanding the access to telecom services are significant. Forestier, Grace and Kenny (2002) describe a project in Colombia where "microwave-radio telephone system along with community access points was installed in the remote region of Tumaco (Colombia) in 1994"(p. 630). After a period of three years, the project produced some very positive results: such as, "better trade and market opportunities, new business opportunities, reduced unemployment, improved healthcare delivery and information access, im-

provements in public safety and security, and an overall improvement in the level and quality of available government services"(p.630). In addition to this, it is also believed that there is positive relationship between access to telecom services for farmers and the price they receive for their crops. This leads us to argue that improving the access to telecom services can be a means for reducing poverty in developing countries, by enhancing efficient allocation of resources. Hence, expanding the network, such that it covers the entire bounded area of a country is likely to lead to an equalisation of incomes. However, historically the case has been the opposite. Investments toward the telecom sector has mainly been directed to the urban areas due to the significant cost of providing network access to the rural areas. By excluding the poor from this service while allowing the wealthy part of the population to reap the benefits, income inequality has actually increased. It is also worth mentioning that surveys conducted by da Silva and Zainudeen (2007) indicate that a majority of telephone calls are of personal nature rather than economic. So, there are both social and economic gains from increasing the access of communication networks to the poor.

4.4 Allocation of resources

A classical illustration often used in the literature to illustrate the benefit of communications is the following: Consider a fisherman who takes his daily catch to sell it at the nearest harbour. If he had access to a mobile phone, it would be possible for him to acquire information about the prices at all the nearby harbours and take his fish to the one where he would receive the highest price. This illustrates a general problem in the most developing countries where the actors in the economy lack knowledge about the economy in which they are active. This leads to inefficient use of resources and non maximization of incomes. It is worth noting, already at this stage, that in order to reap the benefits of an increased flow of information the foundations for a stable economy need to be present. Hence, telecommunication privatization is a necessary but not sufficient condition for economic growth. This illustration can be applied on a larger scale, in that better information about prices, demand and behaviour by competitors generally increases the efficiency and competition in the markets. Therefore, expanding the telecommunication network will lead to a decrease of the transaction costs, hence, aligning the difference between the price paid by consumers and the price received by the producer (Norton, 1992). Private investments in the telecom sector can further be assumed to generate spillover to a larger extent than government investments. This is because governments will mainly concentrate in expanding the current network while private investments are more interested in introducing new technological solutions in the telecom sector.

5 Methodology and Data

The variables that we use for our empirical analysis, telecommunication private investment (PPI), GDP, Mobile subscribers (Mobilesub), and Current account (CA). The countries considered in our analysis are Botswana, Egypt, Kenya, Lesotho, Morocco, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Swaziland, Tanzania, Uganda and Zambia from the African continent, and Azerbaijan, Bulgaria, Czech Republic, Georgia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Turkey and Ukraine, from the European continent. The country selection is solely based on the availability of data for a consecutive line of years, from 1999 to 2005.

We collected our data on private investments in the telecommunication sector from the World Bank Private Participating Infrastructure (PPI) index. This index records infrastructure project funded (partly or totally) by private investments in low and middle income countries. The index records the following types of investments: management and lease contracts, concessions, greenfield (which accounts for the vast majority of telecom investments) and divestures. It is however appropriate to mention the drawback with using this index. Since the index explicitly relies on publicly available resources, the reported investment amount has a tendency to be underestimated. According to the World Bank, around 75-80% of the total amount is accounted for in the index.

As said earlier, the country selection is solely based on the availability of data for a consecutive line of years. We have not differentiated between different types of investments, since it is the total amount that is crucial in this report. In addition to the investment data, we have also collected statistics for the number cell phone subscribers (Mobilesub) over the same years (collected from international telecommunication union ITU webpage). Cell phone subscriber data is collected for the purpose of controlling for the effect of increased penetration of telecom services. GDP and current account are collected from IMF database and presented in US dollars. The current account data will be used to control for external shocks which have impact on economic performance of developing countries.

In order to test for the correlation between private telecom investment and GDP in the selected countries, a regression is carried out. The following model is regressed.

$$Log\ GDP_{i,t} = a + \beta_1 Log\ PPI_{i,t-1} + \beta_2\ dum\_africa_i + \beta_3 Log\ Mobilesub_{i,t-1} + \beta_4\ CA_{i,t} + \mu_{i,t,} \qquad (5.1)$$

where dum_africa is an Africa dummy variable (1 if the data is from an African country, 0 otherwise), μ is the error term, and the i and t subscripts are respectively country and year of the observation. Both PPI and Mobilesub variables are lagged one year in this model. This is done because there is expected to be a lag between the investments and the actual expansion of the network, thus the effect on GDP is not instantaneous. However, CA is neither logged, since it is impossible to take the log form of negative numbers, nor lagged, since the effect of a decrease in the net export will be felt more instantly than changes in the other variables in the model above. Also, we chose not to in-

clude more control variables in order to avoid a degrees of freedom problem. However, the hypothesis for the empirical work is that the contribution of PPI to economic growth in Africa and CEE countries is positive. This will be tested by looking at the relationship between log PPI and log GDP.

6 Empirical analysis and results

In this section, we present our empirical testing based on the data collected and for the purpose of investigating if there is a positive link between private telecom investments and GDP.

Plotting the data in two scatter plots provides the following figures. In figure 6.1, log GDP is plotted against log PPI (PPI is lagged one year) and in figure 6.2 log GDP is plotted against log (Mobilesub) which is lagged one year as well. Figure 6.1 does not indicate any clear relationship between the log of private investments and log GDP. Figure 6.2 shows a strong positive relationship between log GDP and log mobilesub. This confirms the conclusions from previous studies that increased access to telephone services is correlated with GDP.

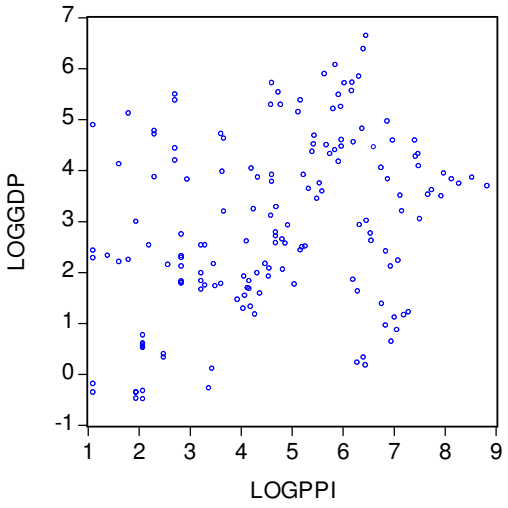

Fig 6.1

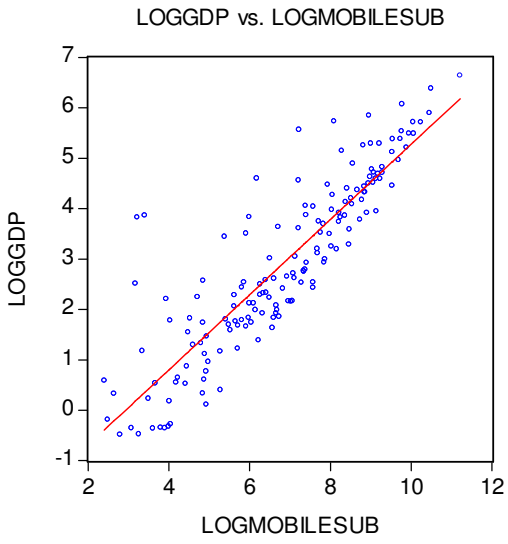

Fig 6.2

The statistics for the estimated version of equation 5.1 is presented in table 6.1 below. In addition to the coefficient estimates and associated t values, we also show the R-squared and Durbin-Watson statistics.

Table 6.1

Variables	*B*	*t value*	R^2	*DW*
CONSTANT	-2.331601	-6.947334	0.788688	0.965208
LogPPI$_{t-1}$	0.054319	1.498694		
LogMobilesub$_{t-1}$	0.725401	19.65784		
Dum_Africa	0.051090	0.335516		
CA$_t$	0.016265	2.700391		

Number of observations = 162, pooled data for 6 years and 27 countries. Log GDP$_t$ is the dependent variable.

A first glance at this result, there are indications that all variables have the expected positive signs. R-squared is high, showing that this model explains 78.8% of the change in GDP. However, previous studies have shown that variables measuring telecom investments and telecom density have tendency to take into account the effect of other economic variables not included in the model, thereby overestimating the impact on economic growth. The regression result also shows positive autocorrelation of the residual. Furthermore, it is obvious that the dummy variable for Africa can be excluded from the model, because it is statistically insignificant, meaning that there is no evidence of differences between African and East European countries. According to the regression results, the beta coefficient of PPI is positive showing that one percent increase in lagged log PPI is estimated to cause the GDP to increase by 0.054319%, on the other hand, it is statistically insignificant at the 5% significant level according to the t-test.. Therefore, we can not find support that private investments in the telecommunication sector do influence the GDP, which is surprising considering the findings of previous studies. But, there are several explanations for this result. First, despite an increasing share of private investments in the telecom sector, this important sector is still heavily regulated compared to other sectors making it harder for private actors to be profitable. This is because when liberalizing a market that has previously been under state monopoly, the presence of perfect competition will not be completely felt, particularly, in the telecom sector where the ownership of the network tends to be in the hands of only one firm even after the liberalization, thus, creating obstacles for private firms to enter. Second, the insignificant result can also be explained by the limitations of the data, since most private investments are based on long term contracts with single or limited number of investors, causing countries to see almost the same amount of investment every year, and when this is regressed with respect to GDP which has more variation over the years, then no correlation will be found.

When looking at the individual projects in each country in our sample, we found that colonial relationships tend to be an important factor in the allocation of private investments in African countries, because companies have the tendency to invest in countries that have historical ties to the home country of the company, thus investments may be motivated by historical and social factors rather than economic factors.

Khan and Kumar's (1997) paper on private and public investments in developing countries provides an interesting argument that is in line with our finding. They argue that private investments are less efficient (although still more effective than public) in developing countries due to the lack of infrastructure. Thus, it could be the case that due to relatively low level of telecommunication infrastructure in our selected countries, the cost for private investors to expand the network becomes more substantial than in countries with a larger stock of telecom infrastructure, thereby diminishing the effectiveness of private investments. This implies that government investment is complementary to private investments in the telecom sector.

It is interesting that the coefficient estimate for mobilesub is positive and at the same time highly significant, which provides support for the basic argument that increased access to communication services has a positive impact on GDP. GDP is estimated to increase by 0.725401%, if the lagged mobilesub increases by 1 percent. The magnitude of the impact originating from the mobilesub variable is likely overestimated. Overestimation of the impact on growth is a problem that most studies related to this topic have encountered. Variables measuring the telephone density (here mobilesub) within countries have a tendency to take into account the effect on other economic factors not included in the model. The coefficient estimate for CA has the expected positive sign and is significant, implying that if CA increases by 1 unit then GDP will increase by 1.6265%.

Another problem is the direction of causality. It can be shown that the amount of mobile subscribers can increase the GDP level in a country. On the other hand, as income increases the demand for telecommunication services are likely to increase, thus, the causality works both ways. Previous studies such as Roeller & Waverman (2001) and Madden & Savage (1997) have tried to overcome this obstacle. Roeller and Waverman presented a model that endogenizes the telecom sector into the aggregate economy. They find a positive relationship between telecom investments and growth, although, the magnitude of the impact is reduced, compared to their model where the telecom sector is not endogenized in the aggragate economy. In their article, Madden and Savage ran a test for precedence in order to see whether growth precedes expansion of the telecommunication access or if the case is reversed. Their findings provide evidence of mutual precedence.

To test for whether our explanatory variables cause GDP, we introduced a variable for GDP with a one year lag as an explanatory variable in equation 6.1:

$$logGDP_{i,\,t} = a + \beta_1 logppi_{i,\,t-1} + \beta_2\, logmobilesub_{i,\,t-1} + \beta_3\, CA_{i,\,t-1} + \beta_4 logGDP_{i,\,t-1} + \beta_5 dum\_azerbaijan_i \ldots\ldots B_{30} dum\_ukraine_i + \mu_{i,\,t-1}$$

In addition, we also included a one-year lag on the variable for current account balance (CA). Equation 6.1 is suggests that GDP is dependent on past values of itself as well as past values of the other explanatory variables Gujarati (2003). By lagging all the explanatory variables, this allows us to treat this test as equivalent to a Granger causality test.

Differences between the countries included in this study are likely to have a substantial effect on the perceived link between PPI and GDP. Such differences could be in the form of initial stock of telecommunication infrastructure, political differences and economic differences. Geographical differences are also crucial in the case of telecommunication. Geographical differences between these countries could affect the cost faced by the private firms interested in expanding the telecommunication network. To control for these country specific factors, we introduce dummy variables for each country in equation 6.1, where dum_ with the country name appended represents a dummy variable which is 1 when the data is from that country and is 0 otherwise . We do not present the coefficient estimates and test statistics for each dummy variable, since due to the low number of observations for each country they would not add anything crucial to the issue at hand. In fact, only the dummy variables for Nigeria and Russia turned out to be significant in their coefficient estimates. Russia is by far the country which has attracted the largest amount of private investment into the telecom sector. Also Nigeria has seen an increasing share of private investment in this sector, particularly, foreign private investments going to the telecom sector.

The coefficient estimates and test statistics for equation 6.1 are presented in table 6.2. The R-squared is quite high at 0.99, which is almost certainly explained by the inclusion of lagged GDP as an explanatory variable.

Table 6.2

Variables	B	t value	R^2
CONSTANT	-0.192249	-3.674017	0.996900
LogPPI$_{t-1}$	0.006706	6.150501	
LogMobilesub$_{t-1}$	0.056524	6.371411	
CA$_{t-1}$	0.001659	1.441806	
LogGDP$_{t-1}$	0.983786	57.78036	

Number of observations = 162, pooled data for 6 years and 27 countries. Log GDP$_t$ is the dependent variable.

The correlation between GDP and lagged GDP is strong and highly significant, which is what we expected. The coefficient estimate for lagged log PPI is, after controlling for country specific factors and causality, both positive and significant. [1] This is consistent with our hypothesis that a positive relationship exists between PPI and GDP. The coefficient estimate for lagged log PPI shows that a 1% increase in the amount of private telecom investments makes GDP to increase by about 0.006706%. This estimate is much smaller compared to the estimated effect found in previous studies. The sole focus on private investments is one reason for this result. Furthermore, although the countries in this study have liberalized their telecom markets, they still find their telecom markets dominated by one or a few number of firms and in most cases, government investments is the main source of funds. Hence, the impact of private investment in the telecom sector is not substantial. When the liberalization process of this sector progresses even further we expect the importance of private investment to increase. The variable for mobile-phone subscribers has a positive and significant coefficient estimate, indicating that a 1% increase of the amount of mobile subscribers yields a 0.056524% increase in GDP. Thus, mobile subscribers do Granger-cause GDP even after controlling for country specific effects. However, the magnitude of its impact on GDP has been sharply reduced as compared to the regression without lagged log GDP. This may be due to the tendency of variables measuring the density of telecom services

[1] We ran regression 6.1 without the country dummies, see appendix on page 31 for the coefficient estimates and test statistics, and found the coefficient estimate for lagged log PPI to be positive, but insignificant according to the t-statistics under those circumstances.[1]

to take into account the effect of omitted variables in this case lagged log GDP. The coefficient estimate for lagged CA is positive, which is expected since a positive net export in previous year should have a positive effect on current level of GDP. However, the lagged CA was insignificant in its coefficient estimate and intuitively, there is no reason behind putting CA in lagged form, since the effect from a change in the account balance is likely to be felt in the short run as well as in the long run. The only reason for lagging the variable was to achieve a regression equivalent to a Granger causality test.

Earlier, we argued that differences between countries have a large impact on the effectiveness of private telecom investments. However, the differences between the African countries and the European countries are supposedly significant enough to justify to separating the countries according to continent of origin. The initial stock of telecommunication infrastructure is larger in the European countries, because the average amount of private investments toward the telecom sector is above the average for the African countries, resulting from of the fact that liberalization process was initiated at an earlier stage in Europe compared to Africa. Due to these differences, it is appropriate to perform separate regression for the two continents. This is done in equations 6.2 for the European countries and equation 6.3 for the African countries.

$$LogGDP_{i,\,t-1} = a + \beta_1 LogPPI_{i,\,t-1} + \beta_2 LogMobilesub_{i,\,t-1} + \beta_3 CA_{i,\,t} + \beta_4 t + \beta_5 dum\_azerbaijan_i \ldots \beta_{16} dum\_ukriane_i + \mu_{i,\,t} \quad (6.2)$$

$$LogGDP_{i,\,t-1} = a + \beta_1 LogPPI_{i,\,t-1} + \beta_2 LogMobilesub_{i,\,t-1} + \beta_3 CA_{i,\,t} + \beta_4 t + \beta_5 dum\_botswana_i \ldots \beta_{16} dum\_uganda_i + \mu_{i,\,t} \quad (6.3)$$

Due to our choice of GDP rather than GDP growth as our dependent variable, the problem with time trends occurred. GDP is likely to increase over time following a general trend, thus it might be misleading to argue that an increase in GDP is caused by our explanatory variables if this is not taken into account. To control for the time trend factor, we include as an explanatory variable the variable t.

Also, in equations 6.2 and 6.3, country specific effects are controlled for and CA is not lagged. Coefficient estimates and test statistics for Europe and Africa are presented in Table 6.3 and 6.4 respectively.

Table 6.3 Europe

Variables	B	t value	R^2	DW
CONSTANT	-1.335521	-2.195985	0.961486	0.922918
LogPPI$_{t-1}$	0.190554	4.278869		
LogMobilesub$_{t-1}$	0.501366	4.857276		
CA$_t$	-0.008679	-1.320092		
t	-0.061034	-1.276096		

Number of observations = 78, pooled data for 6 years and 13 countries. Log GDP$_t$ is the dependent variable.

Table 6.4 Africa

Variables	B	t value	R^2	DW
CONSTANT	0.113480	0.404212	0.953553	0.943850
LogPPI$_{t-1}$	-0.188427	-5.078677		
LogMobilesub$_{t-1}$	0.544334	13.64703		
CA$_t$	-0.088810	-3.707594		
t	-0.191831	-5.505718		

Number of observations = 84, pooled data for 6 years and 14 countries. Log GDP$_t$ is the dependent variable.

The lag of logged PPI is significant in explaining log GDP in both Africa and Europe. However, while it has the expected positive sign for the European countries, it turns out to be negative for the African countries. There are two main explanations for these results. The first concerns the nature of investments: By looking at the individual investments projects for all the countries, it tends to be case that investments in the African countries are based on long

term commitments, while the focus in the European countries is on large and short term commitments. Thus, several African countries will receive the same amount of investments every year, and when this amount of private investment is regressed against GDP which varies over time, the result will not show any positive sign of correlation. The second explanation concerns the process of liberalization of the telecom sector. The liberalization process began earlier in Europe and has thus progressed further than in Africa. This means that the share of private investment in the telecom sector is larger in Europe than in Africa, both in relative and absolute terms. The slow process of liberalization in the African countries creates obstacles for private firms, and make them less profitable. Further explanations as to why the coefficient estimate for lagged log PPI turns out to be negative in the case of Africa can be found in the allocation of investments. Due to economic uncertainty in many African countries, private investments tend to come from old colonial rulers. Hence, allocation of private investments towards Africa is based on historical factors rather than economic factors, making them less efficient compared to private investments in the European countries. On the other hand, the variable for mobile subcribers has a positive and significant effect on output in both cases. However, the coefficient estimate is slightly higher and more significant in Africa compared to Europe. This is in line with the argument put forward by Norton (1992), that the marginal returns from expanding the telecommunication network is greater in countries with a lower penetration rate. The direct effect on GDP from increasing the access to mobile communication is likely to be more substantial in less indutrialized countries, when looking at the countries individually. Both Norton (1992), and Sridhar and Sridhar (2004) argue that a farmer in a developing countries experiences more benefits from access to telecommunications than an industrial worker in an industrialized country.

The time trend variable and CA were found to have negative effects on output in both Africa and Europe, but were seen to be insignificant for the European countries. A negative coefficient estimate for the time trend shows that GDP actually decreases over time. A closer look at the data reveals that the countries in this study, particularly the African countries, experienced decreasing level of GDP during 2001 and 2002 which explains the negative sign on the time trend variable. The negative sign for the current account balance is not what we expected since a positive current account balance, intuitively, should have a positive impact an GDP. Since the selected countries are either low or middle income countries, the internal economic environment is most likely functioning in an inefficient manner. Thus, when the current account is increasing, the associated resources are likely not to be allocated efficiently, resulting in a negative correlation between CA and GDP.

In addition to the pooled regressions presented above, a cross-sectional regression is performed to avoid the problem of having a short time span. Equation 6.4 is estimated for each year, 2000-2005:

$$Log\ GDP_{i,t} = a + \beta_1 Log\ PPI_{i,t-1} + \beta_2\ dum\_africa_i + \beta_3 Log\ Mobilesub_{i,t-1} + \beta_4\ CA_{i,t} + \mu_i \qquad (6.4)$$

The coefficient estimates are presented in table 6.5 with the t values shown within the parentheses.

Table 6.5 Cross-sectional regression result

	Regression 2000	**Regression 2001**	**Regression 2002**	**Regression 2003**	**Regression 2004**	**Regression 2005**
Constant	-2.068571	-1.906534	-3.438258	-3.907634	-4.063988	-4.582620
$LogPPI_{t-1}$	0.466051 (3.259798)	0.366383 (2.672817)	0.338215 (4.196759)	0.156883 (1.941743)	0.122037 (1.396745)	-0.115539 (-1.237684)
$LogMobilesub_{t-1}$	0.421620 (2.537646)	0.421063 (2.492844)	0.644716 (7.052353)	0.828174 (9.344533)	0.862432 (9.614972)	1.066981 (10.52529)
Dum_Africa	0.584436 (1.546260)	0.340055 (0.926805)	0.313323 (1.598766)	0.248368 (1.466578)	0.149484 (0.890437)	0.044469 (0.289309)
CA_t	0.036271 (2.502024)	0.043926 (1.965186)	0.031836 (2.354476)	0.014571 (1.493572)	0.003632 (0.595205)	0.002066 (0.512189)
R^2	0.849589	0.828471	0.950800	0.962469	0.962391	0.968913

Number of observations = 27, 1 observation for 27 countries in each year, Log GDP_t is the dependent variable. T-values are given in parenthesis.

At first glance on the information in table 6.5, we noticed that the R-squared increases over time which indicates that the model explains a larger portion of the change in GDP in 2005 compared to 2000. The PPI variable was seen have a significant and positive effect during the first three years. As displayed in the table, there is evidence of a diminishing effect of PPI, also the associated t-values decrease over time. We surmise that the cause of this is diminishing returns to scale associated with telecom private investments over this period. Gramlich (1994), argues that there are increasing returns originating from building a network but not necessarily from expanding the same network, which is in line with our findings of a diminishing effect of telecoms private investments in this our research. By studying each investment project separately, two aspects clearly appears. A vast majority of the investments are greenfield, which involves building and operating own network facilities, and the investments tend to be larger in the beginning of the sample period. This implies that private investors face substantial start up costs. However, it is during this initial pe-

riod that the effect on GDP is most significant. Intuitively, there are two additional reasons, apart from Gramlich notion concerning decreasing returns to scale, which explain why this is the observed pattern. First, there is an employment effect that originates from this private investment in the telecom sector. The employment effect that comes from both the telecom sector and other sectors is most significant during the initial phase of private telecommunication projects. If this employment effect is strong enough, it could provide an economic boost for the country, thus resulting to positive impact on GDP. However, in the long run the direct effect on employment becomes less significant, although the indirect effect is substantial (discussed in section 4.3). Nevertheless the indirect effect will not be strong enough to provide the necessary boost for the economy to make up for the diminishing direct effect. The second intuitive explanation is the focus of the investments. The initial private investments are aimed at building network facilities to be run by the investing firms. This creates the mentioned effect on employment and further, it introduces new technical solutions in the receiving countries, and these technical solutions generate benefits not only within telecom sector but for the economy as a whole (Sridhar and Sridhar, 2004). After the initial phase, investment is focused on maintaining and operating the network facilities instead of constructing network facilities or the introduction of new technology, so the effect on GDP is less significant.

The variable for mobile subscribers on the other hand shows positive and significant correlation with GDP in every year. In fact, the Mobilesub tends to become increasingly important over time. Both the coefficient estimate and the t-value increases during the studied time span. This is in line with the theory of network externalities which says an increase in the number of subscribers benefits not only the new subscribers but also the current subscribers. It does however contradict Norton's (1992) argument that the effect of the penetration is greater in countries with a low penetration rates. This result could be due to bi-directional causality, i.e. GDP and mobilesub cause each other. While an increasing number of mobile subscribers has a positive effect on GDP, it is also likely that the demand for mobile subscription increases as the GDP level increases.

Another possible explanation to why the estimated effect, of lag logged mobilesubscribers on log GDP, is increasing from 2000 to 2005 is that the expansion of telecom networks to rural areas have allowed the proportion of the population that are poor to reap the benefits from increased flow of information. This has resulted in a more efficient allocation of resources, less uncertainty in the market and improved competition.

Finally, the variable measuring the current account is positive in every year but only significant in years 2000 and 2002.

7 Conclusion and suggestions

The purpose of this thesis was to investigate the impact of telecommunication private investment on GDP in the CEE and African countries.

The initial result from estimating equation 5.1 indicates that the coefficient estimate of the PPI variable is positive, but it was found to be statistically insignificant at the 5% significant level according to the t-test from the pooled data regression. However, the coefficient estimate for the mobile subscribers variable was found to be positive and statistically significant. In order to strengthen the findings we examined causality and controlled for country-specific effects. In that regression, the effect of the PPI variable on GDP became positive and significant, but the magnitude of the impact on GDP was not substantial. The effect of the mobile subscribers variable was still positive and significant after these controls, but after including lagged GDP as an explanatory variable the coefficient estimate decreased sharply.

Performing separate regressions for the African countries in one group and European countries in another group yielded positive and significant coefficient estimates for the mobile subscribers variable in both regressions. However, the amount of mobile subscribers has a slightly higher effect on GDP in the African countries than in European countries. This is in line with the argument which says that countries with a lower penetration rate will see higher returns from expansion of the network. The PPI variable turned out to be negative in Africa while positive in Europe. The reasoning behind this finding is that the process of liberalization of the telecom sector has progressed further in the European countries as compared to the African countries. This makes the telecommunication markets in Europe function more efficiently.

On the other hand, when a cross-sectional regression was carried out, the estimated coefficients for both the PPI and mobile subscribers variables indicated positive relationships with GDP, except in 2005, where the estimated coefficient for the PPI variable shows a negative relationship with GDP. The result also revealed that the coefficient estimate for the PPI variable was statistically insignificant according to the t test, starting from 2003. This could be an indication of diminishing returns to private investments (see Gramlich, 1994). The number of mobile subscribers on the other hand tends to become more important in affecting GDP variable over the years.

Can we conclude now that telecommunication private investment is not important for economic growth by looking at those regression results that have no positive sign for the coefficient estimate on the PPI variable? The answer is no for the following reasons:

First, the positive and significant coefficient estimates for lagged log PPI in the early years in the cross sectional and in the pooled analysis after controlling for causality and country specific effects, suggests the existence of spillover effects which is not visible from the regression results. Private investments will introduce new innovations and technical

solutions in developing countries. But the benefits from these innovations that originate from telecom private participation are not contained only in the telecom sector, rather they generate positive returns for the economy as a whole, by increasing the efficiency and productivity in the economy.

Secondly, the short time span of the data used in this research posed serious drawbacks in drawing clear cut conclusion from the results since it limits the number of lags that can be used. Another limitation of the data is that since most private investments are based on long-term contracts with single or limited number of investors, countries will see the same amount of investments being invested every year, and when such investments are included in regression to explain GDP which has more variation over the years, then no correlation will be found.

Finally, the Khan and Kumar (1997) paper on private and public investments in developing countries provides an interesting argument that is in line with our finding. They argued that private investment is less efficient (although still more effective than public) in developing countries due to the lack of infrastructure. Thus, it could be the case that due to a relatively low level of telecommunication infrastructure in our selected countries, the cost for private investors to expand network becomes more substantial than in countries with larger stock of telecom infrastructure, thereby diminishing the effectiveness of private investments. This may explain the negative correlation between lagged log PPI and log GDP for the African countries seen in table 6.4 and the relatively small corresponding coefficient estimate found in table 6.2.

In our own view, we suggest that care should be taken when reforming the telecommunication sector. This is because proper reform policy should be complemented with the availability of necessary infrastructures that are important for the success of these private network operators. Global experiences with reforms of telecommunication sector have already established the major parameters of the policy changes required to secure greater private sector participation. Mustafa, Laidlaw & Brand (1997) paper on telecommunications policies for Sub-saharan Africa provides policy suggestions that could be beneficial for governments when reforming their telecommunication sectors, they are:

- Governments should establish a clear strategy for the reform of the sector, based on structuring profitable investments opportunities.
- Liberalization should be treated as vital tool that helps to maximise investment opportunities and generate incentives to meet demand and improve efficiency.
- Regulations should be refocused on providing an enabling environment that serves to contain risk (p. vii in the executive summary).

Although we have noted that FDI is an important part of the private investments in the telecommunication sector, the United Nations (2003) noted that attracting foreign investment is not enough; the national policies that will make the investment beneficial to the economy are crucial. Even though telecommunication private investment is important for economic growth, the direct impact it exacts on economic growth is not clear. Nevertheless, its indirect impact from mobile subscription can provide enough evidence for its importance in economic growth.

For further studies, it will be interesting to investigate how telecommunication private investment has helped in the industrialization of the African rural areas. Also, comparing the impact of telecommunication FDI with oil sector FDI on African economic growth could be another line of study that would be interesting to engage in.

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Internet Sources:

http://ppi.worldbank.org . PPI index

www.worldbank.org

www.IMF.org International Monetary Fund

www.itu.int International Telecommunication Union

Appendix

Regression 5.1

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 10/15/07 Time: 14:13

Sample: 1 162

Included observations: 162

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.331601	0.335611	-6.947334	0.0000
LOG(PPI)	0.054319	0.036244	1.498694	0.1360
LOG(MOBILESUB)	0.725401	0.036901	19.65784	0.0000
DUM_AFRICA	0.051090	0.152273	0.335516	0.7377
CA	0.016265	0.006023	2.700391	0.0077

R-squared	0.788688	Mean dependent var	2.911625
Adjusted R-squared	0.783304	S.D. dependent var	1.716347
S.E. of regression	0.798969	Akaike info criterion	2.419389
Sum squared resid	100.2212	Schwarz criterion	2.514685
Log likelihood	-190.9705	F-statistic	146.4945
Durbin-Watson stat	0.965208	Prob(F-statistic)	0.000000

Regression 6.1 without the country dummies

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 01/29/08 Time: 14:06

Sample: 1 162

Included observations: 162

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.147765	0.038467	-3.841318	0.0002
LOG(PPI)	0.006284	0.004602	1.365557	0.1740
LOG(MOBILESUB)	0.051887	0.008301	6.250349	0.0000
LOG(LAGGEDGDP)	0.954435	0.010089	94.59930	0.0000
LAGGEDCA	0.002572	0.001030	2.498071	0.0135

R-squared	0.996349	Mean dependent var	2.911625
Adjusted R-squared	0.996256	S.D. dependent var	1.716347
S.E. of regression	0.105019	Akaike info criterion	-1.638980
Sum squared resid	1.731539	Schwarz criterion	-1.543684
Log likelihood	137.7574	F-statistic	10711.62
Durbin-Watson stat	1.571098	Prob(F-statistic)	0.000000

Cross-sectional regression result 2000

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 10/15/07 Time: 14:08

Sample: 1 27

Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.068571	0.671147	-3.082142	0.0054
LOG(PPI)	0.466051	0.142969	3.259798	0.0036
LOG(MOBILESUB)	0.421620	0.166146	2.537646	0.0188
DUM_AFRICA	0.584436	0.377968	1.546260	0.1363
CA	0.036271	0.014497	2.502024	0.0203

R-squared	0.849589	Mean dependent var	2.661802
Adjusted R-squared	0.822241	S.D. dependent var	1.687244
S.E. of regression	0.711367	Akaike info criterion	2.322319
Sum squared resid	11.13294	Schwarz criterion	2.562288
Log likelihood	-26.35130	F-statistic	31.06638
Durbin-Watson stat	1.925975	Prob(F-statistic)	0.000000

Cross-sectional regression result 2001

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 10/15/07 Time: 14:09

Sample: 1 27

Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.906534	0.762062	-2.501810	0.0203
LOG(PPI)	0.366383	0.137078	2.672817	0.0139
LOG(MOBILESUB)	0.421063	0.168909	2.492844	0.0207
DUM_AFRICA	0.340055	0.366911	0.926805	0.3641
CA	0.043926	0.022352	1.965186	0.0621

R-squared	0.828471	Mean dependent var	2.682617
Adjusted R-squared	0.797284	S.D. dependent var	1.701603
S.E. of regression	0.766129	Akaike info criterion	2.470645
Sum squared resid	12.91299	Schwarz criterion	2.710614
Log likelihood	-28.35370	F-statistic	26.56458
Durbin-Watson stat	2.336100	Prob(F-statistic)	0.000000

Cross-sectional regression result 2002

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 10/15/07 Time: 13:22

Sample: 1 27

Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.438258	0.462199	-7.438919	0.0000
LOG(PPI)	0.338215	0.080590	4.196759	0.0004
LOG(MOBILESUB)	0.644716	0.091419	7.052353	0.0000
DUM_AFRICA	0.313323	0.195978	1.598766	0.1241
CA	0.031836	0.013521	2.354476	0.0279

R-squared	0.950800	Mean dependent var	2.756399
Adjusted R-squared	0.941854	S.D. dependent var	1.717969
S.E. of regression	0.414261	Akaike info criterion	1.240935
Sum squared resid	3.775469	Schwarz criterion	1.480905
Log likelihood	-11.75263	F-statistic	106.2882
Durbin-Watson stat	1.833321	Prob(F-statistic)	0.000000

Cross-sectional regression result 2003

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 10/15/07 Time: 13:39

Sample: 1 27

Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.907634	0.440151	-8.877946	0.0000
LOG(PPI)	0.156883	0.080795	1.941743	0.0651
LOG(MOBILSUB)	0.828174	0.088627	9.344533	0.0000
DUM_AFRICA	0.248368	0.169352	1.466578	0.1566
CA	0.014571	0.009756	1.493572	0.1495

R-squared	0.962469	Mean dependent var	2.952916
Adjusted R-squared	0.955645	S.D. dependent var	1.725005
S.E. of regression	0.363296	Akaike info criterion	0.978380
Sum squared resid	2.903651	Schwarz criterion	1.218349
Log likelihood	-8.208125	F-statistic	141.0455
Durbin-Watson stat	1.705059	Prob(F-statistic)	0.000000

Cross-sectional regression result 2004

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 10/15/07 Time: 13:52

Sample: 1 27

Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.063988	0.448406	-9.063186	0.0000
LOG(PPI)	0.122037	0.087373	1.396745	0.1764
LOG(MOBILSUB)	0.862432	0.089697	9.614972	0.0000
DUM_AFRICA	0.149484	0.167878	0.890437	0.3829
CA	0.003632	0.006102	0.595205	0.5578

R-squared	0.962391	Mean dependent var	3.128024
Adjusted R-squared	0.955553	S.D. dependent var	1.753481
S.E. of regression	0.369678	Akaike info criterion	1.013207
Sum squared resid	3.006558	Schwarz criterion	1.253176
Log likelihood	-8.678288	F-statistic	140.7408
Durbin-Watson stat	2.301955	Prob(F-statistic)	0.000000

Cross-sectional regression result 2005

Dependent Variable: LOG(GDP)

Method: Least Squares

Date: 10/15/07 Time: 14:06

Sample: 1 27

Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.582620	0.472716	-9.694226	0.0000
LOG(PPI)	-0.115539	0.093351	-1.237684	0.2289
LOG(MOBILESUB)	1.066981	0.101373	10.52529	0.0000
DUM_AFRICA	0.044469	0.153708	0.289309	0.7751
CA	0.002066	0.004034	0.512189	0.6136

R-squared	0.968913	Mean dependent var	3.287994
Adjusted R-squared	0.963261	S.D. dependent var	1.776455
S.E. of regression	0.340500	Akaike info criterion	0.848770
Sum squared resid	2.550679	Schwarz criterion	1.088740
Log likelihood	-6.458395	F-statistic	171.4248
Durbin-Watson stat	2.145013	Prob(F-statistic)	0.000000