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Abstract

Infrastructure investments expansion typically adds to the productive capacity in an economy, and thus to its economic growth. Network industries account for between one–tenth and one-quarter of economy wide investments (OECD 2009 B). Telecom industry is one of the network industries, and broadband is a new technology that is widely used all over the world. It is the popular mode of access to the internet, as it refers to high speed internet access. This study aims at examining the impact of broadband infrastructure on economic growth in emerging countries and Arab countries. In addition, the impact of competition in telecom sector has been included in the growth equation estimated to control for the effect of competition in telecom sector, and thus broadband, on the economic growth in these countries. The empirical study reaches a conclusion in line with previous studies that there is a positive impact of broadband uptake on economic growth. In addition, the contribution of this paper is also in the construction of the competition index which was statistically insignificant, but became significant once we controlled for FDI as a percent of GDP. Thus, governments should create an enabling environment and open their markets for more competition in order to induce the establishments of more broadband and telecom networks in their respective countries.

ملخص

تضيف البنية التحتية للاستثمارات لتوسيع الطاقة الإنتاجية في الاقتصاد، وبالتالي للنمو الاقتصادي. تساهم شبكة الصناعات بمدة تتراوح بين عشر وربع استثمارات الاقتصاد (OECD 2009).صناعة الاتصالات هي واحدة من شبكة الصناعات ، وتكنولوجيا النطاق العريض (broadband) هي تكنولوجيا جديدة تستخدم على نطاق واسع في جميع أنحاء العالم. هذا هو النمط المتعارف عليه للوصول إلى شبكة الإنترنت، كما يقصد به السرعة المستخدمة للوصول إلى الإنترنت. تهدف هذه الورقة إلى دراسة التأثير واسع النطاق للبنية التحتية على النمو الاقتصادي في البلدان الناشئة والبلدان العربية. وبالإضافة إلى ذلك، فقد أدرجت المنافسة في قطاع الاتصالات ، وبالتالي النطاق العريض ، في معادلة النمو المقدر لقياس تأثير المنافسة على النمو الاقتصادي في هذه البلدان. تصل الدراسة الميدانية إلى استنتاج يتماشى مع دراسات سابقة وهو أن هناك تأثير إيجابي لامتصاص النطاق العريض على النمو الاقتصادي. وبالإضافة إلى ذلك، تساهم هذه الورقة في بناء مؤشر المنافسة والذي كان احصائيا عديم الاهمية ، والذي اصبح ذو أهمية بعدما تمت السيطرة على عامل الاستثمار الأجنبي المباشر كنسبة مئوية من الناتج المحلي الإجمالي. وبالتالي، يتعين على الحكومات خلق بيئة مواتية وفتح أسواقها أمام المزيد من المنافسة من أجل حث المؤسسات أكثر من النطاق العريض وشبكات الاتصالات في بلدانها.

1. Introduction

Network industries account for between one –tenth and one quarter of economy wide investments (OECD 2009B). Infrastructure investments expansion typically adds to the productive capacity in an economy and thus to its economic growth. Telecom industry is one of the network industries, and broadband (or high speed internet access) is a new technology that is widely used all over the world to access the internet.

Telecommunications networks play a vital role in today's economies, as broadband infrastructure is a key impetus for the 21st-century global economy. Broadband is considered a general purpose technology, which is a prerequisite for many vital services, and is a necessary condition for innovation and growth worldwide. Broadband Access to the Internet is considered by many economists and policy makers as the way to achieve knowledge based economy. (Badran et al., 2007). For this reason, the increase in broadband penetration rates is one of the goals that these countries aim to achieve. Broadband creates an enabling environment for businesses and governments, improves overall productivity and creates jobs. Besides, telecom is considered in many emerging countries the source for revenues for the national treasury, as it attracts a lot of FDI for these countries. Benefits of broadband include enhanced productivity growth and hence economic growth. For firms and workers broadband improves employment conditions and positively reduce congestion and pollution. Broadband makes it easier to "telework" by connecting to the company network, while swapping large files is much easier. Other applications are video-on demand, online gaming, videoconferencing, and many other interactive features. Broadband can be delivered by several technologies or platforms. The most commonly used technologies include: DSL (Digital Subscriber Line), coaxial cable, power-line, fiber optic, satellite, UMTS and WLAN.

Before recent technological changes, dial up using a modem was the most popular mode of access to the Internet. However, the advent of broadband Internet access or high-speed Internet access changed the way people access the Internet. When comparing broadband (i.e. high speed internet access) to dial up access, it is worth mentioning the idiosyncratic attributes to broadband. These include an increase in capacity, an "always on" connectivity, since the user does not need to dial into a network, but is always online. This constant connection greatly facilitates the use of the Internet, and leads to more intensive use of broadband, which extends the utilization of the Internet for new purposes. It greatly facilitates the exchange of large files such as movies, images and sound. This creates opportunities for business and leisure applications such as games of multi-user games (MUGs) and Role-Playing Games (RPGs).

Many of the most effective applications, which help foster development, are only available through the high speed internet connection. These applications include telemedicine, e-commerce, e-banking, and e-government. Broadband applications have a far greater impact on people, society, and businesses compared to their narrowband equivalents. (ITU 2010) Moreover, Broadband has an important impact on infrastructure and industry. In the electricity industry, broadband networks can show consumers and suppliers how much power is being used in real time, and where. This means that demand and supply can be stabilized as power is delivered or stored on "smart grids" (ITU 2010). In smart buildings energy is saved through constant monitoring of heating and lighting. The manufacture and distribution of goods can be tracked using broadband networks, which are also the foundation for cloud computing that offers rapid scalability of resources for businesses as well as flexible access for individuals.

According to a report by the OECD in December 2009, "Network developments in support of innovation and user needs," suggests that broadband networks can pay for themselves within ten years because of the savings made in delivering services.

Emerging countries are a heterogeneous group of countries which are not confined to a certain geographic region. They represent countries that have the potential for high growth rates and very active stock markets. These countries proved to be resilient to the recent financial crisis and remarkably managed to retain positive economic growth rates. The impact of broadband uptake on economic growth was emphasized in a recent study by the World Bank, which reaches the conclusion that 10% increase in broadband uptake would lead to 1.3% increase in economic growth in emerging countries (Qiang2009).

The present paper investigates empirically the impact of broadband uptake on economic growth in emerging countries, using empirical methods, and how competition in telecom sector can play a role in enhancing growth in these countries as well.

The paper is divided into the following sections: Section 2 highlights the trends of broadband growth in Egypt and some emerging countries; Section 3 the impact of growth and enhancement of broadband infrastructure on economic growth in emerging countries in light of recent financial crisis. Section 4, tackles the issue of telecom investments in emerging countries. Then, in the following section, I review the literature on the impact of broadband on economic growth. Section 6, develops the empirical model, and finally follows a discussion about results and policy recommendations.

2. Trends of Broadband Growth in Egypt and some Emerging Countries

There are certain characteristics that differentiate emerging countries from developed countries, when it comes to establishing a knowledge base economy.

Among these characteristics, the rural teledensity is very low, and the low purchasing power of rural population (Kala Seetharam Sidhar, V. Sridhar (2009), and the importance of public point of access in these countries. In addition, the huge share of the informal sector, whose income is not actually reported or taken into statistics. (Badran 2007)

Increasing broadband penetration and thus broadband infrastructure is related to the economic growth in the countries under study. Many emerging countries are experiencing the leapfrogging phenomena with respect to ICT and broadband uptake. These countries managed to overcome growth hurdles and use technology, such as broadband, to increase their growth rate, and to integrate into to the global economy.

Thus establishing broadband infrastructure will facilitate the transition to knowledge based economy and at the same time, benefit from all spillover effects that come with such a network.

These effects include the increase in economic growth, which is certainly worth investigating and analyzing. Recently, the World Bank estimated that 10% increase in broadband penetration, would lead to 1.3 % increase in economic growth in developing countries, where the impact of broadband penetration on economic growth is higher in the latter than that in developed countries (Qiang 2009).

Figure 1 depicts the positive relationship between economic growth (income per capita) and broadband penetration. There are outliers like Bahrain, UAE and Qatar; however most of the countries seem to be found around the fitted regression line.

3. The Impact of Growth and Enhancement of Broadband Infrastructure on Economic Growth in Emerging Countries in Light of Recent Financial Crisis

Since the period under investigation in this study includes the year of the financial crisis, it is imperative to shed some light on the impact of enhancing broadband infrastructure on economic growth in emerging countries, during the time of crisis. The global economy was hit hard with a financial crisis that quickly moved to the real economy causing a major recession all over the globe, especially in developed countries. Investment in infrastructure with high capabilities, such as broadband infrastructure, was regarded as a way of boosting the economy and generating new jobs. The deployment of broadband infrastructure would lead to generating thousands of jobs in many fields such as construction, engineering, manufacturing and high-tech sectors — as well as the communication services, entertainment and retail businesses. These are described as direct effects (demand) and indirect effects (supply).

Developing countries have also to follow the developed countries footsteps in devoting a part of their stimulus packages to broadband infrastructure, since this has an immediate short term effect on job creation, and causes an increase in aggregate demand (Qiang 2009). Expansion in the ICT sector, which is lead by the demand side, would actually stimulate growth. Investing in strengthening the existing broadband infrastructure, or even developing more broadband infrastructure as a core part of the current stimulus packages in developed countries, reveals the imperative role played by the broadband infrastructure in terms of creating more jobs both during the buildup of these networks, and after its completion. This takes the form of allowing more tele-working and SOHOs (Small Office Home Office) to be created, leading to spillover effects of these investments in other segments of the economy of emerging countries. Broadband networks have inherent characteristics of positive network externalities associated with broadband and telecom infrastructure. This means that adding new customers or broadband subscribers to the network would benefit the entire network and increases its value to the existing customers. In addition broadband deployment would greatly encourage and benefit SMEs which constitute the bigger share of the private sector in most emerging countries

The impact of broadband penetration is expected to be even more robust, once the penetration reaches a critical mass. As most developing countries are at an early stage of broadband development, they are likely to gain the most from investing in these networks to reach the critical mass for higher impact, and before the diminishing returns take effect.

Several factors highlight the potential of broadband infrastructure as an important area of public investment during economic downturn, including first, delivering immediate employment and aggregate demand effects and network effects, secondly: bringing forward longer-term aggregate supply-side (spillover) effects which can improve the productivity of the entire economy. Thirdly, Crowding in private investment is realized, when access to private financing is decreasing and more expensive due to the economic crisis (Qiang 2009).

4. Investment in Telecom Networks in Emerging Countries

Investment in telecom infrastructure has risen, due to rapid technological change that promoted a switch from traditional mainlines to broadband and mobile telephony. Infrastructure growth can have effects on growth over and above those arising from adding to the capital stock. These effects can occur through a number of different channels, such as facilitating trade and division of labor, competition in markets, a more efficient allocation of economic activities across regions and countries, the diffusion of technology and the adoption of more organizational practices or through providing access to new resources.

Extending telecommunications networks to un-served or underserved areas could have stronger marginal effects on supply and productivity than simply upgrading previously established networks, such as electricity, gas, water and transportation. This is referred to as the universal service goal set by telecom regulators worldwide to promote telecom services (OECD 2009A).

Public telecommunications investments can be divided into two categories, namely backhaul and last mile connectivity. There are two types of connectivity improvements in this regard, extending connections to un-served or underserved areas or improving the existing connections to higher capacity, such as installing fiber optic cables instead of copper cables.

Upgrading the last mile or kilometer in rural areas is much more expensive than establishing a similar improvement in urban areas in all countries. In developed countries for example, rolling out next generation network (NGN) to 16% of the population in of rural areas is equal in cost to connecting 58% of the population who live in urban area(OECD 2009A). So, telecommunications investments in rural areas cost much more than performing the same investments in urban areas due to civil engineering work, which is labor intensive and constitutes about 80% of the total cost of building a fixed network.

Concerning the countries that cover the sample of this study, we find that in the period (1998-2008) telecom investments as percent of GDP fluctuated significantly during this period. Nevertheless, the average for the whole period reveals that there are countries that have invested on average in this sector an amount equal to or exceeds their GDP. These countries include Colombia, Egypt, Jordan, Malaysia, Morocco, Oman, Saudi Arabia, Syria and Tunisia. Jordan reportedly spent 188% of GDP on telecommunication followed by Colombia, Malaysia and Oman. In Colombia, for example, the telecom investments as a percent of GDP always exceeded the GDP for the whole period of investigation. However, due to the fact that their GDP is not high, the absolute value of the telecom investments is comparatively still low.

The rapid technological change that the telecom sector is experiencing plays a major role in the economic growth, where emerging countries are concerned. These countries could therefore leapfrog in their growth and reach potential high growth rates if they invest in these new technologies. A conservative approach to investment in broadband networks might choose economical ADSL, FTTN or WiMAX to meet minimal performance requirements, delivering transmission speeds not lower than 2 Mb/s. Fiber optics connections, in comparison with ADSL, require greater upfront investments, but offers both short-term and long-term benefits for the economy. In this case, 70 percent to 96 percent of the investment goes to labor — providing immediate job stimulus for construction workers, technicians and equipment manufacturers. For ADSL, only 9 percent to 10 percent of deployment costs go to labor. Once networks are in place, fiber's exceptional data speeds deliver a longer term return on this investment by enabling a wide array of new business and entertainment services — and by ensuring that the infrastructure continues to support leading broadband services well into the future. Another milestone in network development is the next generation telecommunication network (NGN) investment, which has been a key driver as many operators are upgrading their network to benefit from the technological changes that this sector is experiencing. NGN is considered a major technological change in the telecom sector and it traverses whole sectors of the economy worldwide.

5. Literature Review: Previous Studies on Telecom Infrastructure and Growth in Developed and Emerging Countries

Since broadband, i.e. high speed internet access, is relatively new technology, studies that investigate its impact on economic growth are rather limited. To widen the pool of the related studies, we start by studies investigating the impact of telecom infrastructure and growth in developed countries. The aim is to show that it has been empirically proven that there is a positive and significant relationship between telecom investment in infrastructure and economic development, whether in developed or developing countries. Some studies estimate the effect of telecom infrastructure on economic growth (Hardy 1980), and find that dividing the countries into developed and less developed shows the results that there is larger effect on the less developed countries compared to the developed countries. For example, telecommunications lower transaction costs can otherwise impede economic growth. Thus, there are positive and social returns to expanding the stock of telecommunications for many less developed countries (Norton 1992). Roller and Waverman 2001 find that modern fixed line telecoms infrastructure in the OECD countries was responsible for one third of output growth between 1970 and 1990. They apply the Annual Production Function (APF) approach. In their paper, a model which endogenizes telecom investment is implemented. A micro model for telecom investment is jointly estimated with a macro production function. The authors solved the problem of endogeneity using both simultaneous equation model and country fixed effects. They reach the conclusion of significant positive causal relationship between telecom infrastructure and economic development. This is especially the case when a critical mass appears to be at the level of telecoms infrastructure that reaches the universal service threshold. In an another study of Leornard Waverman and Meschi and Fuss (2008) they explore the impact of telecoms on economic growth in developing countries and reach the conclusion, that mobile telephony has twice as large impact on growth in developing countries compared to developed countries. This is attributed to the less investments needed to create a mobile network. Mobile networks provide by and large the main communication networks in many developing countries, that suffer from poor public fixed line network, hence they effectively supplement the information –gathering role of fixed –line systems.

In a recent study, Czernich et al 2009 investigate the effects of broadband infrastructure on economic growth using annual data for a panel of 25 OECD countries in 1996-2007. They apply instrumental variable approach, where they conclude that broadband uptake increases growth in GDP per capita in the range of 2.7-3.9 % on average controlling for country and year fixed effects. A more recent and relevant paper by Pantelis Koutroumpis, investigates the economic impact of broadband on growth in 22 OECD countries based on data collected for the period 2002-2007. He also uses a macroeconomic production function with a micro economic model for broadband investment. He follows the same methodology as Waverman and Roller, but applies it on broadband infrastructure instead of fixed telecom. The paper concludes that there are increasing returns to investment in broadband internet access. The author attributes this to the presence of network effects. The paper also refers to the critical mass at the 30% of broadband investments level would mean that half of the population has access the broadband internet access.

Sridhar et al (2009) in their paper "Telecommunications infrastructure and economic growth: evidence from developing countries", estimate the supply and demand of telecom infrastructure and endogenize telecom investment and the change in telephone penetration. They use data from 1990-2001 for 63 developing countries. In addition, they estimate the system of 4 equations using 3 sls without fixed effects and 3 sls with country fixed effects, separately for fixed telephony, mobile telephony and both fixed and mobile telephony. They find significant effects of mainland lines and cell phone penetration on economic growth as they control for the effects of capital and labour. Traditional economic variables explain demand for main fixed telephone service as well as mobile telephone service.

It is noteworthy to mention that to the importance of spillover effects, as it is sometimes argued that in addition to their direct impact on output growth, broadband generate spillovers and free benefits, that exceed the direct returns to ICT capital. If such effects are large they should translate into acceleration of multifactor productivity growth (Schreyer 2009).

Adding the impact of competition on the growth of broadband infrastructure to estimate its impact on economic growth in emerging markets, would allow us to include a new dimension to the available previous literature investigated earlier. The effect of competition in telecom sector on the economic growth is evident. The increased competition in telecom sector improves efficiency and reduces prices, increases productivity of labor in telecommunications as measured by revenues per employee, by as much as 60 percent and lower telecom costs by as much as 50 (Intel 2009). In a another paper by Carlo Rossotto et al (2005), after controlling for other important structural determinants, the share of telecommunications revenues in GDP appears to fall short even of the average share in countries with least competitive markets in MENA region. Allowing for greater competition, could increase the average size of telecommunications revenues reaching a considerable share of the GDP, and thus affects economic growth, by as much as 0.8%. Competition in the telecom sector would also boost internet uptake as it lowers access cost to the Internet and increases expansion of backbone infrastructure. In the MENA countries, full market openness would increase Internet penetration dramatically by up to 18 hosts per 10,000 people on average, from only 2 hosts currently in service. Eventually, in the long run this could bring Internet penetration close to the international levels of high-income countries in the future. (Rossotto et al 2005). Furthermore, in another paper empirical research emphasizes that competition between the different platforms induces the uptake of broadband, inter-platform competition, compared to competition among the providers of the same platform, intra platform competition. (Distaso et al 2006).

Another approach to investigating the impact of broadband infrastructure on economic growth is estimating a growth equation for each country by following the cross sectional growth framework of Barro (1991), then we use the Solow and Swan (1956) and then the endogenous growth models, where a Solow-type equation is estimated. A similar approach was implemented by Michael Enowbi Battuo, Ancona Marche (2008) “The Role of telecommunication infrastructure in the regional economic growth of Africa”. In this paper they used a dynamic fixed effect method. They concluded that there is a conditional convergence hypothesis which means that countries with higher level of GDP per capita tend to grow at slower pace. Telecommunications is positively impacting economic growth in terms of real GDP per capita growth in Africa. Another finding of the study includes telecommunications investment is experiencing diminishing returns to scale suggesting that countries at earlier stage of development would benefit from telecom investments.

In the current study we investigate research the following research questions: Does broadband infrastructure impact economic growth? Does competition in telecom sector as well as the level of FDI in the emerging and Arab countries play a significant role in economic growth in these countries?

6. Empirical Estimation of The Impact of Broadband Infrastructure on Economic Growth in Egypt, Some Arab and Emerging Countries

Due to the both heterogeneity and endogeneity problems, we conduct the study of the impact of broadband on economic growth using the growth equation from Barro (1991).

In this paper we follow Barro (1991) in measuring growth and the drivers of growth in a cross-country setting. This method assumes that the production function of each country is fixed for all countries. Thus individual country characteristics will not be feasible which is a major drawback of this methodology. Therefore, Islam (1995) is followed and a panel data method is used to analyze cross-country growth. Islam (1995) built on Mankiw et al. (1992) who initiated new empirical research on the role of human capital in the growth process. Their estimation strategy is based on a log-linear approximation around the steady state of an augmented Solow model. (K. Sekkat 2004)

The Methodology

We estimate a fixed effect model and random effect model following Islam (1992) to examine whether broadband penetration has a positive impact on growth in the 22 emerging countries that constitute our sample.

We also test the conditional convergence hypothesis (Solow and Swan 1950) and the endogenous growth theory, where the finding of convergence has thought to support the Solow-Cass-Koopenmans model, and the absence of convergence would be in support of the endogenous growth models. (Islam 1995)

An important assumption that is being relaxed using the fixed effect model is the assumption of identical aggregate production functions for all countries. The panel data frame work allows the differences in the production functions using unobservable individual country effects. This will overcome the problem of omitted variable bias. Then we compare the POOLED OLS which indicates common intercept with the fixed effect model which allows a different intercept to each country, Hausman specification test was also performed to choose between the 2 models with the null hypothesis of the random effect model in comparison to the alternative hypothesis of fixed effect, and Hausman specification test follows a chi-square distribution.

The Empirical Model

The empirical model relies on a log–linear approximation around the steady state of an augmented Solow model, where we control for additional variables to determine further factors that impact growth in the 22 countries included in the sample for the time period 1998-2008, including the broadband penetration rate and competition level in telecom sector and FDI as percent of GDP. Countries investigated will be 22 emerging countries, which are: Algeria, Argentina, Bahrain, Brazil, Colombia, Jordan Kuwait, Lebanon, Malaysia, Mexico, Morocco, Oman, Qatar, Russia, Saudi Arabia, Syria, Tunisia, Turkey, Egypt, UAE, Venezuela, and Uruguay.

The equation to be estimated is

$$\Delta \log y_{it} = \alpha_0 - \alpha_1 \log y\text{-}1_{it} + \alpha_2 \log educ_{it} + \alpha_3 \log (TI/y)_{it} + \alpha_4 \log (\Delta I/ y)_{it} + \alpha_5 \log(G)_{it} + \alpha_6 \log(BB)_{it} + \alpha_7 \text{Competition index} + \alpha_8 \log (FDI/GDP) + \alpha_9 Z_i + \varepsilon_{it}$$

Where i index is for the countries, t index stands for time; y_{it} is per capita income; sec educ is secondary education; prim educ is primary education; TI/y is telecom investments as percent of GDP; $\Delta I/ y$ is the difference between gross capital formation and investment in telecom as per cent of GDP; Competition index is calculated using the Principle component analysis , G, is population growth rate, BB is broadband penetration per hundred inhabitants , yt_1 is the level of per capital income in previous year; FDI/ GDP is foreign direct investment as percent of GDP; z it refer to the unobserved variable that varies from country to another but does not change over time.

Estimation method is panel data techniques of fixed and random effects and then to choose between the 2 models we use the Hausman test. The Hausmann test is performed, with Ho: random effect model and H1: no random effect model. The P value of the X2 test is 0.000 which means that we cannot accept the null hypothesis and that the model is not a random effect model. Taking the LM and the F test into consideration, we can conclude that the fixed effect model is the appropriate model to implement.

Along the fixed effects models, F-test was performed to test the null hypothesis of common intercept. According to the results, we cannot accept the null hypothesis and the fixed effect model is again the right model, which is consistent with the literature. Since the calculated F-test is less that the F- tabulated, the conclusion is to reject the null hypothesis of common intercept and to use the fixed effect model as the intercepts are different over cross section units

The competition index was constructed using the Principle Component Analysis (PCA) technique. Data on competition (i.e. Paging, Local Services … etc.) about nineteen variables were used in constructing the competition index. These variables were obtained from the ITU website, where there is a matrix that indicates the level competition in the following domains: Local services, Domestic fixed long dist, Inter-national fixed long dist, Wireless local loop, Data, DSL, Cable modem, VSAT, Leased lines, Fixed Wireless Broadband, Mobile, Paging, Cable TV, Fixed sat, Mobile sat, GMPCS, IMT 2000, Internet services and Inter-national gateways. Then, the competition index is classified according to the level of competition into full competition, partial competition and monopoly, where 1= monopoly; 2= partial competition and 3= full competition.

From Table 3, we can see that the estimation was enhanced (percentage of explained variance by the first PC increased from 50 percent to 54 percent) when omitting the paging variable as its weight is very limited .003.

The Table 4 shows the distribution of the countries consisting our sample according to levels of competition.

Data sources

Data on these explanatory variables and the dependent variable are obtained from the **International Telecommunication Union (ITU) database**, specifically the World Telecommunication/ICT Indicators, and the **WDI database for the period (1998-2008).**

A priori expectations of the impact of the independent variables on the difference in the change in per capita income which is the dependent variables in our model are as follows:

The level of Education, whether primary or secondary education, is expected to have a positive impact on economic growth, as these variables represent investment in human capital.

The investment rate of telecom over GDP is expected to have a positive sign, as the increase in investments in telecom sector, whether voice or data, should be positively impacting the growth rate of the sampled countries, with a caveat that this investment level should first have reached the critical mass before having this positive impact of change in GDP, or the growth rate.

The explanatory variable indicating the difference between gross capital formation and telecom investments as a percent of GDP is expected to positively affect the growth rate of the respective countries. This variable represents the non telecom investments as a percent of GDP.

The competition index is another explanatory variable we control for in the model. The competition index was constructed using the Principle Component Analysis (PCA) technique. The competition index is classified according to the level of competition into full competition, partial competition and monopoly, where 1= monopoly; 2= partial competition and 3= full competition. A priori, we expect that the impact of competition according to the economic theory that increases the efficiency of the markets, and overcomes the problem of x-inefficiency as well. So a priori we expect for it to have a positive sign.

The population variable is found in the original model of the growth empirics, and in the case of emerging countries it is expected to have a negative impact on economic growth, as measured by the change in per capita income between 2 years. This is according to the optimal growth theory of population.

The lagged value of per capita income in our model is included to test for the convergence theory. The expected sign is negative, as this means that eventually emerging countries would catch up in terms of increase in per capita income with advanced countries.

Finally we add the foreign direct investment as a percent of GDP as an explanatory variable, as emerging countries are characterized by providing opportunities to foreign investors in general, and this includes the telecom sector as well. We expect the impact of FDI as a percent of GDP to have a positive impact on economic growth.

6. Analysis of the Results

All models are statistically significant as the P-value of the F-statistic was zero. We notice that estimating the regressions equation using the fixed effect model increase the significance of the whole model, compared with the pooled OLS estimation technique. This is manifested in the values for R-squared that are higher in FE model 1 compared to pooled OLS model 1 from 0.17 to 0.34 and in model 2 from 0.17 to 0.19.

Telecommunication investment as a percentage of GDP is used as a proxy for investment budget allocation on telecommunications in the respective countries. The estimated coefficient in all the models is found to be a negative sign and economically insignificant, indicating that the increase in the investment in teleocm has insignificant impact on growth rate. This is despite the fact that the correlation coefficient between economic growth and telecom investment is positive (0.025). This can be explained as follows: For the emerging countries, even though they are spending all portions of their GDP on telecom investments, this amount is still not enough to realize economic benefits that derive the communication investment. In other words, these investments have not yet reached the critical mass needed in order to reap the benefits if these investments as the case in the developed countries. According to Waverman and Roller, 2001, unless a critical mass in telecommunication investment is achieved, the expected economical development may not be achieved, (Negash and Patala 2006). Moreover, these investments are short term and unsustainable thus their impact is not appearing in the model we are estimating. In emerging countries, unlike in developed countries, the telecom operators wait for the trend to happen and then follow it, thus they don't invest as much in the emerging countries until they discover unmet demand for a certain service in the respective country. For the social network for example the development for these services which requires broadband internet access is bottom up not top down approach. This new development in the ICT market in emerging countries contradicts with the top down approach that the governments is taking in these countries to promote e-applications like e-government and e-education for example. In addition, we find that investments in telecom as they are scarce and have not yet reached the critical mass, many of the operators resort to infrastructure sharing as a way to reduce their operating costs, and thus the amount they invest in these countries. Infrastructure sharing in broadband encourages the roll out of broadband, especially in underserved areas.

Broadband infrastructure as controlled for by the BB penetration rate per hundred inhabitants and is highly significant in all our models. The coefficient of BB is significant at 1% significance level, and indicates that one percent increase in broadband penetration would lead to 0.005 % increase in the growth rate of the emerging countries under study. This answers one of the questions that were raised before.

This indicates the vital role that broadband is playing in emerging countries, as it helps them traverse to the knowledge based economy. The positive impact that broadband is having on economic growth in emerging and Arab-countries is due to the benefits that emerging countries gain from broadband diffusion. These benefits include generating more jobs, creating an enabling environment that induces investments.

The negative coefficient on the *lagged income variable* in the fixed effects models proves the conditional convergence hypothesis, which states that developing countries would catch up with developed countries since the lower the level of income, the higher the growth rate of the economies under study.

Education or human capital: In the regressions in model 1 FE, when we controlled for secondary school enrollment, it is not found significant with the right expected positive sign. However, in other models when we control for primary education instead of secondary education we notice that estimated results are not significant with the wrong sign as well. This is not new, since there is previous literature in which the human capital when added to the growth regressions, have occurred negative and insignificant. According to Islam 1995, there are 2 kind of explanations: The first refers to the great discrepancy between the measured human capital and the actual one, and the second is that the measure used does not include any indication to the quality of schooling.

When we controlled for the *FDI as a percent of GDP*, the *competition index* becomes significant and positive, indicating the important impact the competition in telecom sector has on the economic growth of the emerging countries.

Competition is vital to not only the telecom's sector growth, but it is vital to the development of the whole economy per se. Competition in telecom industry induces innovation, gives incentive to the firms to reduce their costs and compete in customer satisfaction and improving quality of service. It also helps regulate in achieving universal service objective of broadband service. Thus competition raises economic efficiency by cutting the excessive monopoly profits that would otherwise occur in the industry.

Transparent national policies that promote competitive environment would result in attracting more investments and FDI, lower prices and thus reaching the critical mass would be more feasible in emerging countries.

Once we controlled for FDI, the competition index becomes significant. This confirms the positive and critical role that competition plays in the telecom industry especially as the number of market players increase. Opening up the telecom market for new foreign entrants and the increase in the level of FDI, actually enhances the positive impact of competition in the telecom market and promotes economic growth.

Population growth rate is mostly not significant except for one model and it is almost always will have the negative sign. So, in model 1 fixed effects, the coefficient is significant and negative indicating the negative impact of population growth on economic growth in the respective countries. This is consistent with the expected negative sign, according to the optimal growth theory of population.

7. Conclusion and Policy Recommendations

In this study we tackle the issue of the impact of new technology such as high speed internet access or broadband on the economic growth in 22 emerging and Arab countries during the period (1998-2008). The findings of the empirical model are consistent with the expectations of highly positive impact of broadband per hundred inhabitants on the economic growth in these countries even during the financial crisis. Results show that one percent increase in broadband penetration would lead to 0.005 % increase in the growth rate of the emerging and Arab countries covered by this study. This is consistent with similar findings by the World Bank. (This impact is not as high as the study from the World Bank indicated. This is probably due to not including other emerging countries like India and South Africa in our sample.) Thus governments should put more effort in encouraging the establishment of more telecom and broadband networks. This can be achieved through first allowing more private firms to enter the telecom market and build new networks. Ensuring open access in terms of offering capacity or access to the network providers to all market participants on equal and non-discriminatory terms and conditions, in case that the government intervened as a provider or subsidizing the networks (Qiang 2009). Governments should find a way to crowd in private capital and not to crowd it out in the telecom sector. Thus it should provide the right incentives for private capital to encourage it to enter this sector. This can take the form of PPP with the private sector. Motivating the demand side of the market as well is another way that governments in emerging countries can increase the broadband uptake in their countries. By focusing on e-applications that are beneficial to the public like e-government, e-health and e-education, this would increase the uptake of broadband and increase awareness of its importance of broadband to the public and integrate the marginal communities in these countries as well.

Competition in the telecom sector has a positive impact on economic growth in the countries under study. A competitive environment is generally supportive of the efficient use of resources and removing barriers to entry in network related but inherently competitive market segments can foster higher rates of investment in the network industries. Entry barriers can be reduced by, for example, requiring firms that own the network infrastructure to divest their activities in related competitive markets (so called vertical unbundling or structural separation) or by establishing regulated regimes to set access conditions and prices to networks for all firms. (OECD 2009 B).

In addition, recently advanced countries, such as Finland, enacted a law that stipulates the right of each citizen to broadband access. This is a critical step toward enabling the population to participate the creating a knowledge based economy. Promoting the same citizens' rights to have access to broadband would empower the population in emerging and Arab countries and would eventually lead to faster shift to the knowledge based economy in these countries through a bottom up approach.

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Figure 1: The positive relationship between changes in GDP per capita and broadband penetration in 2008

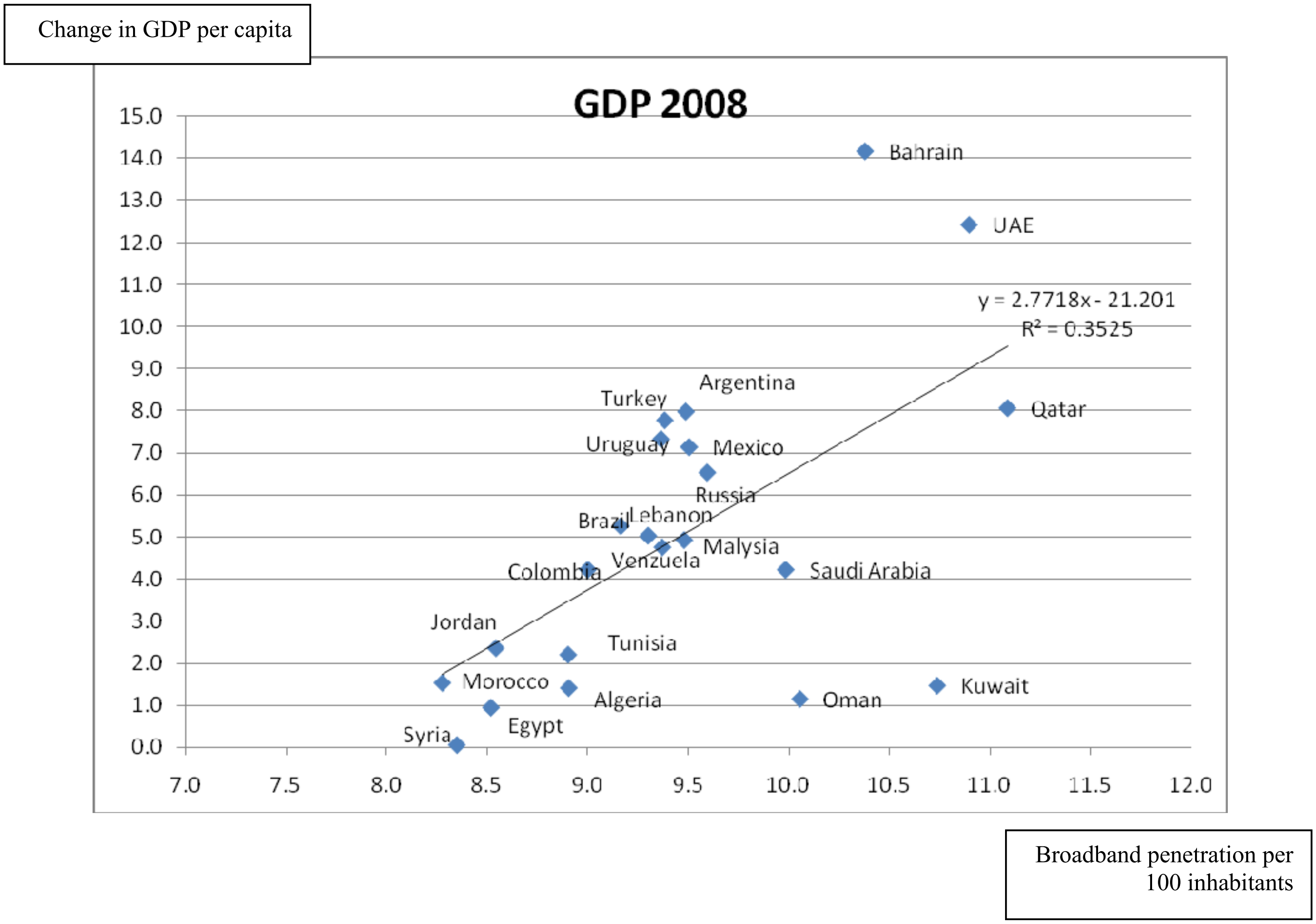

Table 1: 11 year trend for telecom investments as a percent of GDP for 22 emerging and Arab countries:

country_name	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average
Algeria	0.32	0.24	0.21	0.17	0.19	0.17	0.19	1.78	1.04	1.04	1.00	0.58
Argentina	0.49	0.61	0.67	0.32	0.40	0.38	0.34	0.34	0.30	0.27	0.30	0.40
Bahrain	1.18	1.17	1.05	1.38	0.79	0.69	0.62	0.70	0.60	0.52	0.46	0.83
Brazil	1.70	1.07	1.37	1.00	0.78	0.43	0.66	0.86	0.74	0.95	1.00	0.96
Colombia	1.16	1.77	1.55	1.61	1.91	1.96	1.99	1.98	1.95	1.90	1.88	1.79
Egypt, Arab Rep.	0.60	0.76	0.51	0.72	0.68	0.40	0.59	0.83	1.26	1.76	2.91	1.00
Jordan	1.84	1.50	2.56	2.98	2.07	1.59	1.57	2.04	1.92	1.35	1.27	1.88
Kuwait	0.74	0.14	0.33	0.47	0.47	0.89	1.06	1.36	1.44	1.44	1.49	0.89
Lebanon	0.71	0.56	0.28	0.30	0.21	0.33	0.29	0.28	0.26	0.24	0.22	0.33
Malaysia	1.70	1.34	1.19	1.33	1.30	1.15	1.22	1.72	2.53	3.09	3.54	1.83
Mexico	0.61	0.73	0.87	0.99	0.53	0.44	0.59	0.54	0.55	0.46	0.53	0.62
Morocco	0.36	0.64	1.60	1.86	0.93	0.63	0.66	0.99	1.15	1.25	1.67	1.07
Oman	0.44	0.40	0.36	0.57	0.62	0.74	1.10	4.07	3.95	3.59	3.79	1.78
Qatar	0.61	0.37	0.21	0.30	0.37	0.44	0.45	0.49	0.44	0.47	0.42	0.41
Russian Federation	0.54	0.35	0.23	0.28	0.37	0.37	0.61	0.79	0.29	0.45	0.45	0.43
Saudi Arabia	1.55	1.39	0.81	0.77	0.81	0.59	0.47	0.88	3.55	3.60	4.25	1.70
Syrian Arab Republic	0.55	0.78	1.15	0.88	0.70	0.47	0.29	0.20	0.35	0.33	0.35	0.55
Tunisia	0.90	0.56	0.82	1.04	1.47	1.85	1.78	1.13	1.19	0.86	1.08	1.15
Turkey	0.23	0.23	0.24	0.14	0.07	0.08	0.33	0.41	0.49	0.51	0.79	0.32
United Arab Emirates	1.15	1.11	0.77	0.61	0.37	0.30	0.38	0.33	0.34	0.33	0.33	0.55
Uruguay	0.44	0.59	0.51	0.92	0.17	0.14	0.11	0.54	0.27	0.58	0.37	0.42
Venezuela, RB	1.14	1.02	0.869	0.94	0.695	0.23	0.383	0.861	0.000624	0.00084	0.527	0.61

Table 2: Description of the variables

Variable	Description	Source
y_{it}	Per capita income	WDI, WB
sec educ	secondary school enrollment ratio	WDI, WB
prim educ	Primary school enrollment ratio	WDI, WB
TI/y	investment rate of telecom over GDP	Telecom indicators data base , ITU
I/ y	the difference between TI and the investment rate of the countries which is the gross capital formation over GDP	Calculated by the author
Competition index	Takes 3 levels: level one takes value one which means no competition at all (full monopoly). Level 2 represents the partial competition, level 3 countries that have full competition.	Developed by the author
G	population growth (0.05+ population growth rate)	WDI, WB
bb	penetration rate of broadband	Telecom indicators data base , ITU
yt_1	per capita income (lagged one year)	WDI, WB
FDI/ GDP	Foreign direct investment as percentage of GDP	WDI, WB

Table 3: Weights of the variables used in constructing the competition index

Variable	Weights
Paging	-
Local Services	0.2585
Domestic fixed long dist	0.2772
International fixed long distance	0.2539
wireless local loop	0.2305
Data	0.2871
DSL	0.2578
Cable modem	0.2064
Vast	0.2332
Leased Lines	0.2892
Fixed wireless broadband	0.2048
Mobile	0.1556
Cable TV	0.1774
Fixed Sat	0.2769
Mobile Sat	0.2401
GMP CS	0.2105
IMT 2000	0.1744
Internet service	0.2372
International gateways	0.2154
Explained variance	54%

*See Appendix 1 for definitions of terms

Table 4: levels of competition in telecom sector in the emerging and Arab countries

Country Name	Levels of competition
Algeria	2
Argentina	3
Bahrain	2
Brazil	3
Colombia	2
Egypt	2
Jordan	3
Kuwait	1
Lebanon	1
Malaysia	3
Mexico	3
Morocco	3
Oman	1
Qatar	1
Russia	2
Saudi Arabia	3
Syria	1
Tunisia	1
Turkey	2
UAE	1
Uruguay	1
Venezuela	2

Table 5: Descriptive statistics

Variable	Mean	St.dev.	Min	Max	n
Secondary education	81.23	14.51	36.66	109. 50	242
Primary education	105.80	12.77	74.72	154.62	242
Telecom investments as percent of GDP	0.91	0.79	0.001	4.25	242
(Gross capital formation – Telecom investment) as percent of GDP	21.12	5.45	-0.422	35.7	242
Competition index	1.22	1.20	0	3	242
Population Growth rate	2.03	1.76	-0.47	12.88	242
Broadband penetration rate per 100 inhabitants	1.286	2.26	0	14.18	242
Per capita income lagged one year	15227.79	14982.48	2755.041	66597.7	242
Foreign direct investment as per cent of GDP	3.41	3.55	-1.79	23.88287	242

Table 6: POOLED OLS, FIXED EFFECTS and RANDOM EFFECTS

Dependent variable: (log_yt - log_yt_1)

	Model (1)			Model (2)			Model (3)		Model (4)	
Variable	OLS	FE	RE	OLS	FE	RE	FE	RE	FE	RE
Log prim education	-.0286	.0537	-.0286	-.037	-.055	-.0386				
	(.0241)	(.0587)	(.020)	(.024)	(.044)	(.023)				
Log sec education							.036	0.013	.0268	0.014
							(.031)	(0.022)	(.037)	(0.022)
Log $(TI/y)_{it}$	-.000	-0.001*	-.000	.000	-.002	-.000	-.002	1.445	-.000	1.008
	(.003)	(0.003)	(.002)	(.003)	(.004)	(.003)	(.004)	(1.424)	(.003)	(1.813)
log $(\Delta I/ y)_{it}$	.025 **	.114*	.025	.024*	.041	.0259*	.053*	-1.449	.048	-1.013
	(.012)	(.045)	(.016)	(.010)	(.026)	(.013)	(.027)	(1.424)	(.027)	(1.813)
Competition index	-.002	-.001	-.002	.003	.008*	.003	.007**	-0.013	.006**	-0.013
	(.003)	(.004)	(.002)	(.002)	(.003)	(.003)	(.003)	(0.008)	(.003)	(0.009)
$\log(G)_{it}$	-.008	-.042***	-.008	-.003	.001 (	-.003	-.005	-1.447	-.002	-1.007
	(.006)	(.013)	(.005)	(.004)	.024)	(.008)	(.027)	(1.424)	(.026)	(1.831)
log_bb	.006***	.010***	.006***				.005***	0.007***		
	(.002)	(.002)	(.001)				(.001)	(0.002)		
bb				.004 *	.005*	.004**			.005***	0.002
				(.001)	(.002)	(.001)			(.002)	(0.002)
log_yt_1	-.008**	-.245***	-.008	-.006	-.125 *	-.006	-.1346**	0.984***	-0.134*	0.987***
	(.005)	(.546)	(.003)	(.004)	(.052)	(.004)	(.056)	(0.005)	(0.064)	(0.007)
log_fdi/GDP				.002	.005*	.002			.003	0.007*
				(.002)	(.002)	(.002)			(.002)	(0.004)
_cons	.176	1.751 ***	.176	.168	1.284*	.1667	.939	6.850	.9781	4.703
	(.138)	(.546)	(.134)	(.133)	(.481)	(.133)	(.384)	(6.538)	(.432)	(8.352)
R-square (within)	0.17	0.34	0.18	0.13	0.19	0.14	0.19	0.85	0.19	0.87
Number of observations	160	160	160	218	218	218	229	130	218	136
Hausman test: Chi 2			26.39			20.94		46.08		23.04
Prob>chi2			0.0002			0.0039		0.0000		0.0017

*** significant at 1%, ** significant at 5%, * significant at 10%. Robust standard errors between brackets

Appendix 1: Some particular definitions of technical terms used in the competition index

Local services: Services offered to local subscribers, connected to local exchange.

Domestic fixed long distance service: Services offered on the long distance lines between 2 cities.

Inter-national fixed long distance services: Services offered on the lines between 2 countries.

Wireless local loop: Radio link connecting subscriber to local exchange as substitute to local subscriber wireline**.**

Digital Subscriber Line (DSL): This is a regular subscriber copper wire line, where the low frequencies up to 3400 KHZ are used for regular telephony, while higher frequencies are used for high speed access to the Internet.

Cable modem: A modem designed to operate over cable TV lines. Because the coaxial cable used by cable TV provides much greater bandwidth than telephone lines, a cable modem can be used to achieve extremely high speed access to the Internet.

VSAT: A Very Small Aperture Terminal (VSAT), is a two-way satellite ground station with a dish antenna that is smaller than 3 meters

Leased lines: This is a transmission line leased from Public Telephone Service, for private use.

Fixed Wireless Broadband: This is a microwave radio link between subscriber and local exchange to provide broadband internet access.

Fixed satellite: Fixed Service Satellite (or FSS), is the official classification (used chiefly in North America) for geostationary communications satellites used for broadcast feeds for television and radio stations and networks, as well as for telephony and data communications.

Mobile satellite: Mobile satellite services (MSS) refers to networks of communications satellites intended for use with mobile and portable wireless telephones

Global Mobile Personale Communications Services (GMPCS): Global Mobile Personal Communications via Satellite. A group of proposals for advanced satellite based systems to extend the coverage afforded by terrestrial cellular systems, and aiming to provide world-wide coverage of mobile services.

IMT 2000: ***International Mobile Telecommunications-2000 (IMT-2000), better known as 3G or 3rd Generation. An evolving standard for third-generation mobile communications, enabling personal mobility and converging mobile and fixed networks***

Inter-national gateways: This is an international exchange in a given country to connect lines with other countries.

Table 7: The maximum and minimum values of the components comprising the competition index

Variable	Obs.	Min.	Max.
Paging	22	0	2
Local Services	22	0	3
Domestic fixed long distance	22	0	3
International fixed long distance	22	0	3
wireless local loop	22	0	2
Data	22	0	2
DSL	22	0	2
Cable modem	22	0	2
Vast	22	0	2
Leased Lines	22	0	2
Fixed wireless broadband	22	0	2
Mobile	22	0	2
Cable TV	22	0	2
Fixed Sat	22	0	3
Mobile Sat	22	0	3
GMP CS	22	0	2
IMT 2000	22	0	2
Internet service	22	0	2
International gateways	22	0	2

Appendix 2: The methodology of the competition index

Principal components analysis (PCA) was used in producing the competition index. PCA technique is a statistical method used to identify a relatively smaller number of principal factors that can be used to represent relationships among sets of many interrelated variables. This procedure creates a number of new uncorrelated orthogonal components. It is often desirable to estimate principal components scores for each case. The principal components scores are easy to understand and can be used in subsequent analysis to represent the values of the principal components instead of a large number of correlated variables. A principal component can be estimated as a linear combination of the original variables. That is, for case k, the score for the j_{th} principal component is estimated as follows:

$$\hat{P}_{jk} = \sum_{i=1}^{p} W_{ji} X_{ik}$$

Where X_{ik} is the standardized value of the i_{th} variable for case k,

W_{ji} is the principal component score coefficient for the j_{th} principal component and the i_{th} variable and p is the number of variables. The minimum requirements to achieve the principal components analysis procedure are two or more numeric variables (Norusis, 1996).

The principal component score coefficient matrix[1] is $P = R^{-1}A$ where R^{-1} is the inverse of the matrix of correlation among variables and A is called principal components loads (weights) matrix[2]. The factor loading matrix is found by straightforward matrix multiplication as follow (Fidell and Tabachinck, 1989):

$$\mathbf{A = V \sqrt{L}}$$

where V: is a matrix whose columns are the eigenvectors of R

L: is a diagonal matrix whose main diagonal elements are the eigenvalues of R

Since one of the goals of principal components analysis is to obtain components that help explaining the correlations among all variables, the variables must be related to each other for the factor model to be appropriate. If the correlations between variables are small, it is unlikely that they share common principal factors. If the hypothesis that the population correlation matrix is an identity matrix cannot be rejected, the researcher should reconsider the use of the principal components model.

There are many ways to extract the principal components, where extraction process has many criteria. First, it is possible to compute as many principal components as there are variables. If all principal components are used, nothing has been gained, since there are as many principal components as variables. The question that needs to be answered is how many principal factors we need to represent the data? There are two most commonly used stopping criteria for the number of factors to extract. The first criterion is called latent root criterion. This rule is very simple to apply, the principal factors that having latent roots (eigenvalues) greater than 1 are considered significant, all principal factors with latent roots less than 1 are considered insignificant and disregarded. The second criterion is referred to as the percentage of variance, here, and no absolute cutting line has been adopted for all situations. However, in

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[1] Also, called matrix of regression weights used to generate factor scores from variables, i.e., the elements of this matrix, B, are the weights, W_{ji} , that shown by the above equation.

[2] Factor loading: The correlation between the original variables and the factors, and is the key to understanding the nature of a particular factor. Squared factor loadings indicate what percentage of the variance of the original variables is explained by a factor.

the hard sciences the factoring procedure usually should not be stopped until the extracted factors account for at least 95 percent of the variance. In contrast, in the social sciences, where information is often less precise, it is not uncommon for the analyst to consider a solution that accounts for 60 percent or less of the total variance as a satisfactory solution (AUS, Trewin, D. 2004).

The most commonly used method for principal components extraction is the first principal component that conducted from the principal component analysis method. In principal component analysis, linear combinations of the observed variables are formed. The first principal component is the combination that accounts for the largest amount of variance in the sample. The second principal component accounts for the next largest amount of variance and is uncorrelated with the first. Successive components explain progressively smaller proportions of the total sample variance, and all are orthogonal uncorrelated with each other (Afifi, 1996).

These procedures produce an eigenvalue for each component. This value indicates how much of the variance of the original indicators was explained by that component.

The principal component analysis was used in producing the Competition Index. Filmer and Pritchet (2001) used the first principle component since it captures the largest amount of information available in the enrolled variables. They used the following equation to construct the a composite index:

$A_{1j}=f_{11} * a_{1j} + f_{12} * a_{2j} + \dots + f_{in} * a_{nj}$

A_{1j}=first principal component

$f_{11} \dots f_{1n}$ the factors

$a_{1j} \dots a_{nj}$ representing the ownership of n assets by household j.

Table (3) shows the list of variables used to construct the index. .