What determines broadband uptake in emerging countries? An empirical study.

Badran, M.F.

Cairo University, NTI

2007

INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION DEVELOPMENT BUREAU

Document INF/001-Erev1
26 November 2007
Original: English

6TH WORLD TELECOMMUNICATION/ICT INDICATORS MEETING, GENEVA, 13-15 DECEMBER 2007

FOR INFORMATION

SOURCE: National Telecommunications Institute and Cairo University, Egypt

TITLE: What determines broadband uptake in emerging countries? An empirical study

_____

What determines broadband uptake in emerging countries? An empirical study

Mona Farid Badran* Prof. Dr. Ahmed EL Sherbini ** Prof. Dr. Adla Ragab***

Abstract

Before recent technological developments in telecom the use of available fixed line was limited to voice telecommunication only. At present the high frequencies on the subscriber line were used for high speed internet access. This Internet access technology is generally referred to as broadband. A popular example is the ADSL, the Asymmetric Digital Subscriber line for broadband Internet access.

Econometric studies performed to evaluate the uptake of broadband have focused on developed economies like USA and OECD countries. However, emerging economies are playing an increasing role in the global economy. These countries are neither developed or least developed countries. They are a heterogeneous group of countries that have certain characteristics in common. Out of 22 emerging economies used in the sample for this study, 15 economies are among the top 75 countries for broadband penetration per 100 inhabitants.[1] Recognizing the importance to transform their economies, these countries have adopted policies to transform their economies from traditional to knowledge based economies. Broadband uptake was recognized by economists and policy makers as the main vehicle to achieve knowledge based economy. The purpose of this paper is to determine the factors or indicators that impact broadband penetration in emerging countries, and to provide policy recommendations to increase broadband uptake in these economies.

This is the first academic econometric research study on broadband diffusion in Egypt, other Arab countries and some emerging countries.

Keywords: Emerging economies, broadband penetration, panel data, fixed effects, random effects.

JEL classification: L96, L86

*Researcher at National Telecom Institute. Assistant Lecturer, PH.D. Researcher at Faculty of Economics and Political Sciences, Cairo University, Egypt.

** Professor at Faculty of Engineering, Cairo University, Research Supervisor.

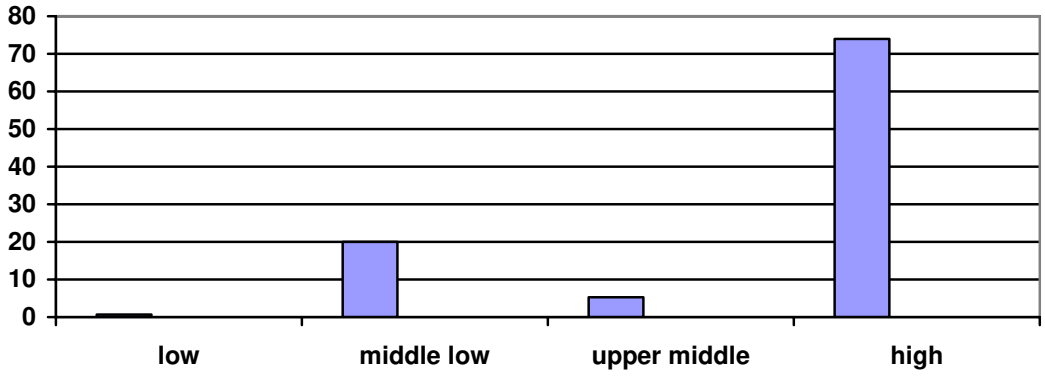
*** Professor at Faculty of Economics and Political Science, Cairo University, Research Supervisor.

[1] ITU, Internet Report, Digital life, 2006

1. Introduction:

Emerging economies are playing an increasing role in the global economy. The potential for growth make them an attractive target to all the multinational hi-tech companies that consider them as new markets they have to explore in the near future. Building knowledge based economy or e-economy is a goal set by the policy makers in these countries. For example, e-strategies are formulated and increasing internet access and internet penetration is becoming a main goal that policy makers in these countries are trying to reach. In the latest Internet Report 2006 by ITU, 15 countries out the 75 countries specified as leaders in broadband penetration, are considered emerging countries according to our sample. Their penetration rate ranges from 3.6 to 0.8 of broadband per 100 inhabitants. In the abovementioned report by the ITU, broadband uptake in lower middle income countries (which some of them fall under the concept emerging economies) is much higher than the upper middle income countries.

Figure one: Percentage of fixed broadband subscribers by income 2005



Source, ITU Internet Report 2006, Digital Life

1.1 DEFINITION OF EMERGING ECONOMIES:

Emerging markets really signifies a business phenomenon that is not fully described by or constrained to geography or economic strength. These economies are characterized by high growth potential and newly developed financial markets. Examples of emerging markets include Malaysia, countries in Eastern Europe, and parts of Africa and the Middle East and MENA Region. **Thus emerging Markets are** categorized as a category between developed and least developed countries, with relatively low per capita income, often with above-average economic growth potential.[2] This potential for rapid growth makes these markets attractive for investors prepared to accept a higher level of risk. Emerging or developing markets also include Turkey and Brazil.[3]

1.2 THE IMPORTANCE OF INCREASING BROADBAND UPTAKE IN EMERGING COUNTRIES:

The adoption of broadband, whether wire-line or wireless, has been identified by policy makers and economists, world -wide, as the way to achieve knowledge based economy[4]. Thus broadband uptake was carefully analyzed by economists to examine both the actual impact that broadband is playing thus far as well as the factors that affect its uptake. Broadband technologies would help these countries to accelerate their growth by integrating[5] marginal communities beyond the geographical limitations of their specific areas. This refers specifically to wireless broadband. Wi -Max technology was used in Spain, for example, among other countries, to connect villages to high speed internet access in a very short time without relying on fixed line network or the traditional infrastructure.

The popularity of DSL among the various broadband technologies has the share of by about 65% [6]of the total broadband technologies that include Fiber To The Home FTTH and T.V.Cable.

---

[2] TD Waterhouse
[3] www.swipartnership.com/media_centre/media_glossary_e.htm
[4] Maria Michalis (2001), Local competition and the role of regulation: The EU debate and Britain's experience, Telecommunications Policy 25 (2001) 759–776
[5] ITU, "Trends in Telecommunication Reform" 2006
[6] Point topic, Quarterly reports June 2007.

Advantages of broadband also include improving and enhancing business productivity in emerging countries, since broadband would help to reduce overall transaction costs and improve the revenue generating potential of businesses. It would also boost the employment rate as well as the GDP growth rate. The IT sector would be a leading sector to the growth in these countries as for example the, Republic of Korea, the growth in IT sector accounted for 50% of the GDP growth rate in 2002[7].

The digital divide, especially in terms of rural to urban, is one of the major worries that emerging countries have to deal with. Given the promising progress that these economies are undertaking in terms of high growth rates and active and flourishing stock markets, closing the digital divide and attaining knowledge based economy is an ultimate goal of these countries. As to the impact of broadband diffusion on the economy [8]in the USA, the economic impact of broadband adoption was measured on economic indicators like employment, wages and industry mix. These American communities experienced more rapid growth in employment, in the number of businesses overall, and in businesses in IT-intensive sectors. In addition, broadband availability resulted in higher market rates for rental housing in 2000. The significance of this study stems from the fact that this study was among the first to quantitively measure the economic impact of broadband penetration in the USA.

There is however one caveat that we have to keep in mind when evaluating the impact of broadband. Broadband does not act on the economy by itself, but in conjunction with other IT industries (primarily consisting of computers and software during the period studied here[9]) and associated organizational changes[10] . We have to bear in mind that the

[7]ITU, " Ubiquitous network societies, the case of the Republic of Korea" April 2005
[8] William H. Lehr, Carlos A. Osorio, Sharon E. Gillett, Marvin A. Sirbu " Measuring broadband's economic impact" Massachusetts Institute of Technology Engineering Systems Division, Working Paper Series ESD-WP-2006-02
[9] Brynjolfsson, E., Hitt, L. M. and Yang, S. (2002) "Intangible Assets: Computers and Organizational Capital," Brookings Papers on Economic Activity: Macroeconomics (1): 137-199
[10] Lichtenberg, F. and Lehr, W. (1998), "Computer Use and Productivity Growth in Federal Government Agencies, 1987-92," *Journal of Industrial Economics*, 46(2), pp. 257-279.

effects of broadband may be strongest in non-farm, non-manufacturing industries, where productivity improvements are typically less well captured by economic data[11].

1.3 BROADBAND UPTAKE AND E-STRATEGIES IN THE EMERGING COUNTRIES:

The importance of broadband lies in the e-strategies adopted by the emerging countries in order to induce demand for the high speed internet access. These strategies may include the killer application that would attract people to connect to the internet using broadband technologies. These strategies include e-government, e-health, e-learning etc. E-Strategies are vital as they empower local communities to shaping a future that is based on ICT and e-strategies to achieve sustainable development toward knowledge based economy or e-economy.

E-strategies are consisted of the following elements:[12]

ICT applications or e-application*s* can deliver basic services in a wide range of sectors including health, agriculture, education, public administration or government and commerce.

E-legislation: The information society requires an appropriate legislative framework to address data privacy, prevention of cybercrime, cybersecurity, electronic signatures, certification authorities and electronic contracts, create the necessary confidence and trust, and protect the rights of all parties in the use of ICTs in all sectors of life.

Internet protocol: internet protocol includes the issues of IP as designing IP-based networks, IP telephony / Voice over internet protocol (VoIP), "Triple Play" (integration of data, voice and video), interactive and video on demand (VoD), network security in critical IP infrastructures and quality of service in ICT networks. ***MCTs***: Multipurpose community telecenters MCT projects have been deployed in a number of countries, providing access to communication facilities and enabling the delivery of services for health, education and agriculture, enhancing business activities, as well as facilitating access to government services. Like e-education, e-employment etc. ***Cybersecurity***:

[11] Gillett, S., and Lehr, W. (1999) "Availability of Broadband Internet Access: Empirical Evidence," paper presented at 27th Telecommunications Policy Research Conference, Alexandria, VA.

[12] ITU, "E-strategies, empowering development", 2006

securing the information society identity theft, data privacy and the protection of critical information systems. The high reliance on ICTs as a vehicle for enhancing social and economic development and the speed with which critical information systems and data can be accessed, manipulated and destroyed have put cybersecurity at the top of the agenda as one of the main challenges facing the emerging information society and the knowledge-based economy. By addressing
these security and trust issues, the real potential of ICTs for delivering affordable value-added services is realized.

ICT awareness: Using ICTs as a cost-effective distribution channel for a wide range of services, the program targets concrete goals such as more efficient trading networks, more accessible communications, support for small business initiatives, good governance and better access to health and education.

Empirical studies, done by economists, show that broadband subscribers do increase their online research of health information[13].

Examples of e-strategies adopted by countries covered in the study include:

Egypt[14]: In 2003 a batch of e-strategies was launched in Egypt in the framework of the Egyptian Information Society Initiative (EISI), these include e-readiness, e-learning, e-government, e-business, e-health, e-culture. In addition Private Public Partnerships were formed in order to promote the role of ICT in development with the help of the private sector. **Lebanon[15]**: creating e-government infrastructure and services facilitating intra-governmental operations and citizen focused services **Oman**: assisting development of technology strategies for deployment of IP-based infrastructures and applications **Turkey**: enabling the transformation of the health sector through ICTs. **United Arab Emirates**: assisting in formulating technology policies and strategies for IP and e-government. **Latin America**: harmonizing the legal framework for e-commerce for the Andean Community Member States (**Bolivia, Columbia, Ecuador, Peru and Venezuela**)

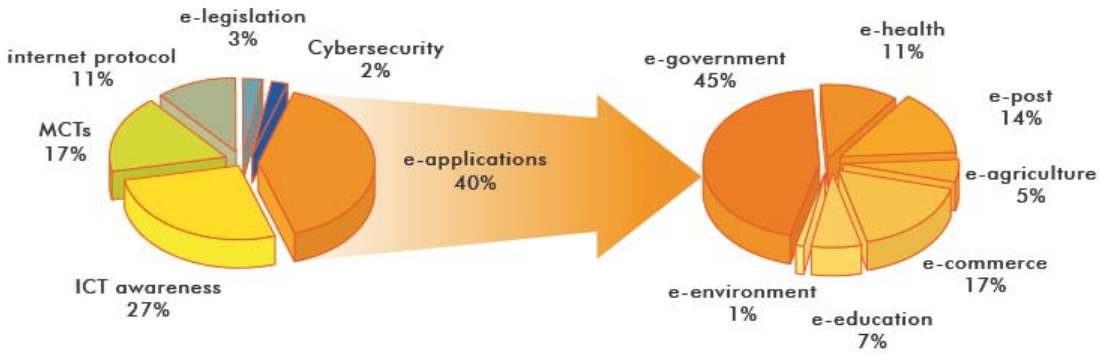
[13] Jed Kolko "Why Should Governments Support Broadband Adoption? Working Paper No. 2007.01, January 2007 , Public Policy Institute of California
[14]UNDP" Human Development Report", 2005
[15] ITU, "E-strategies, empowering development", 2006

Venezuela: supporting e-health technology facilitating tele-diagnosis over distance for populations in remote villages.

Figure two: E-Strategies

Allocated budget per key e-strategies, 2003–2005 in the 5 ITU regions including multiregional and global activities

Percentage of budget for various domains in 2003-2005 *in the 5 ITU regions including multiregional and global activities*



(*Source:* ITU)

Source: ITU, "E-Strategies empowering development", 2006

2. LITERATURE REVIEW ON EMPIRICAL STUDIES ABOUT BROADBAND PENETRATION:

In this section we shed the light on the relevant previous studies that explain the determinants to broadband penetration as well as the policies set to increase it in various economies, not necessarily emerging economies. These empirical studies can be divided into two major groups namely those that tackle the issue determining the factors i.e. indicators that affect broadband uptake and those that mainly focus on the various policies implemented thus far by regulators or governments in order to promote broadband uptake.

The first paper that developed the methodology utilized in this paper to empirically study broadband penetration, was developed by Bauer & al in investigating broadband diffusion in the OECD countries[16]. The sample consisted of 30 OECD countries for the year 2001 and the method of estimation was OLS. The authors concluded that population density and preparedness (where the latter means the attitudes of the population toward is information technology) are statistically significant. The price of broadband, the price of dial up Internet access, competition and relative income position are either less or not significant at all.

Ferreruela and Alabau-Munoz [17] took this methodology a step further as they studies all three relationships, supply, demand and adoption of broadband. There was a break down of the factors forming the supply, demand and penetration of broadband. Groups of variables were formed as they were classified as supply side and demand side and broadband penetration. It uses a comprehensive panel dataset from 30 OECD countries. The period of observation for this study is from 2000-2002. Pooled regression technique was implemented. The paper concluded that the percentage of dial up Internet subscribers is the most influential factor for DSL adoption followed by the one year lagged availability of DSL infrastructure. The interpretation of the results that considering all the OECD countries as whole broadband adoption could be explained By the usage previously available technologies and by availability of infrastructure to guarantee the shift to broadband.

Distaso & al.[18] addressed another factor of broadband adoption namely the effects of *inter platform* competition, i.e. competition between alternative platforms such as cable access, fiber optics, high speed Internet access, and *intra platform* competition, which is competition between different providers of the Digital Subscriber Line(DSL) segment of the market. Data from 14 European Countries over four years were obtained. These are

[16] Bauer, J.M., Gai, P., Kim, J., Muth, T.A., Wildman, S.S., 2003. Broadband uptake in OECD countries. Paper presented at the 31st Research Conference on Communication, Information and Internet Policy, Arlington, VA, USA

[17] Inmaculada Cava Ferreruela, Antonio Alaban-Munoz (2004), Key constraints and drivers for broadband development: a cross national analysis. Telecommunication Policy(2004)

[18] Walter Distaso, Paolo Lupi , Fabio M. Manenti(2006) Platform Competition and broadband uptake: Theory and Empirical evidence from the European Union., Information Economics and Policy 18 (2006) 87–106.

all EU countries except Greece. Three models were estimated using well known panel data techniques.

The findings of the estimated models show that competition between alternative technological platforms providers was significant and positive. This means that as competition between broadband providers with different platforms increases broadband penetration rate. However, competition among the providers of the same platform like DSL does not play a significant role in increasing broadband penetration.

In addition there are another set of papers[19] dedicated to measure the effect of various policies that aim at increasing broadband uptake and reducing the digital divide especially in USA. Implementing policies such as securing access to public rights of way in order to simplify and standardize regulations. Other findings of these papers include: First, population density is positively correlated with broadband penetration and connection speed. Second, regulations that promote mandatory unbundling slow down the penetration growth of broadband. Third, mandatory on site collocation is correlated with faster penetration growth of broadband.

In another paper by Scott Wallsten [20], he attempted to control for the different types of unbundling regulations implemented in the OECD countries when studying broadband uptake. The paper concludes that very extensive unbundling mandates and some types of price regulation can reduce broadband investment incentives. According to the findings of this paper there is no government policy that has a strong and clear positive impact on broadband penetration. Fixed effects panel data technique was implemented in this study. However, these findings contradicts with those of Ford and Spiwak [21]. They studied the effect of certain policies like unbundling of local loop on broadband uptake was empirically investigated by them. Many policy makers argue that the requirements that incumbents lease local loops to competitors (unbundling policy) at rates determined by the state commission retard the development of new broadband services. The paper

[19] For example Scott Wallsten, June 2005 "Broadband penetration, an empirical analysis of state & federal policies," Working Paper 05-12, June 2005, AEI Brooking Joint Center for Regulatory Studies

[20] **Scott Wallsten "Broadband and Unbundling Regulations in OECD Countries" , Working Paper 06-16, June 2006,** AEI Brooking Joint Center for Regulatory Studies, Washington, D.C.

[21] George S. Ford, Lawrence J. Spiwak(September 2004), The positive effects of unbundling on broadband deployment, Phoenix Center for Public Studies

proves empirically that states that have established relatively lower rates for unbundled loop access have enjoyed *more* consumer choice and have seen *more* deployment of broadband technology within their borders.

Another kind of government intervention policy is the subsidy policy. The importance of subsidies whether on the supply side or on the demand side for broadband adoption was discussed in a paper by A. Goolsbee [22]. Among the findings of his paper are that markets in which broadband service is available, subsidizing the demand will increase consumer well being by less than equivalent policies that subsidize supply. This would be in the form of subsidizing investments in underserved markets, in which new adopters would have high valuations. This paper used the consumer welfare approach and consumer surplus approach and concludes that any policy aimed at increasing broadband use should take into consideration the different policy implications between subsidizing the demand and subsidizing the supply of broadband.

3. THE EMPIRICAL STUDY:

The purpose of this paper is to determine the factors that affect broadband penetration in emerging countries, using econometric techniques.

A panel data will be used in estimating the model collaborated below. The panel data set consists 22 cross sectional units these are Egypt and other emerging Arab countries, like all of the Gulf countries that experience that high Internet penetration rate like UAE, Bahrain, Kuwait, Qatar, Saudi Arabia. From North Africa: Tunisia, Morocco Algeria and Arab countries Jordan, Lebanon, Oman and Syria.[23] From Latin America: Argentina, Brazil, Colombia, Mexico, Uruguay and Venezuela. From Europe: Russia, Turkey, and from Asia Malaysia. The analysis will cover the period from 2002-2005. These countries

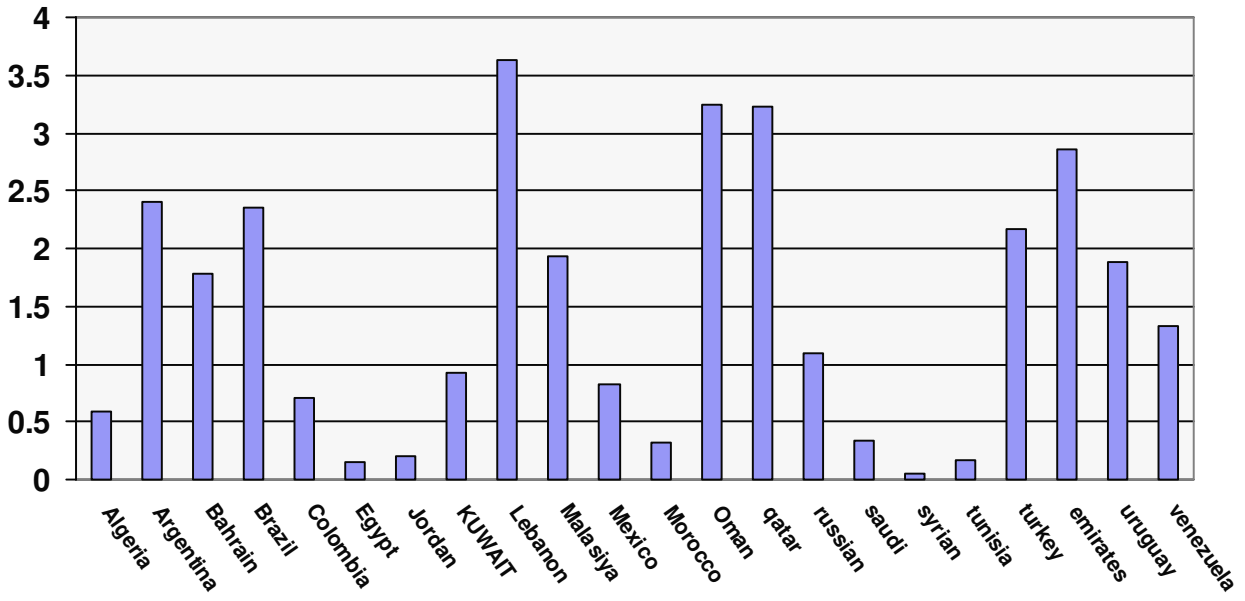
[22] Austan Goolsbee, 2002"**Subsidies, the value of broadband and the importance of fixed costs", 2002,** Broadband Should We Regulate High-Speed Internet Access? Edited by Robert W. Crandall James H. Alleman, AEI Brooking Joint Center for Regulatory Studies,Washington, D.C.

[23] World Economic Forum, Agusto Lopez –Claros and Klaus Schwab (2005) The Arab World Competitiveness Report 2005

were labeled emerging countries by economists and policy makers [24]due to the characteristics of new dynamic stock markets and their potential to achieve high GDP growth rates.

Data was obtained from **The *World Telecommunication/ICT Indicators*** database released by the ITU. In addition, the Arab World Competitiveness Report was also used as source for data. Other indicators were obtained from the **World Development Indicators, the IMF and Econstat** databases. The official websites for both the designated Arab Ministries of Telecom as well as the web sites for the Arab Telecom Regulators are a viable source for data utilized in this empirical study.

Figure (2) . Broadband penetration per hundred inhabitants by country in our sample



ITU, World telecom indicators data base, 2006

The theoretical modeling underling the econometrics analysis of this paper builds on the model developed by Bauer & al (2003) in investigating broadband diffusion in OECD

[24] Fernando A. Broner Guido Lorenzoni Sergio L. Schmukler, 2007, "Why do emerging economies borrow short term?", World Bank paper WPS 3389

[25] Bauer, J.M., Gai, P., Kim, J., Muth, T.A., Wildman, S.S., 2003. Broadband uptake in OECD countries. Paper presented at the 31st Research Conference on Communication, Information and Internet Policy, Arlington, VA, USA

countries[26], a supply and demand framework will be applied on the local level. Then an aggregation to the local level will yield the national level structured model. The combination of the supply factors and demand factors for broadband would then provide us with the penetration of broadband in Egypt and other emerging countries.

3.2. THE EMPIRICAL MODEL FOR BROADBAND PENETRATION:

$$BP_{i,t} = CONS + \beta_1 INC_{i,t} + \beta_2 SCHOOL\ ENROL_{i,t} + \beta_3 PCS/100_{i,t} + \beta_4 INTERNET\ USERS_{i,t} + \beta_5 POPD_{i,t} + \beta_6 FIXED\ LINES/100_{i,t} + \beta_7 HOSTS_{i,t} + \beta_8 P(t-1)_{it} + \beta_9 z_{it+} + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} \sim (N, \sigma)$ iid (identically independent, distributed errors)

Where : BP is the dependent variable and refers to Total broadband per 100 inhabitants which is a measure for broadband penetration , CONS is the intercept (constant), INC is income as GDP per capita measured in US$, SCHOOL ENROL refers to the percent the population that have obtained tertiary education. Demographic indicators : POPD is population density Population *Density* is based on land area data from the UN. ***Economic indicator***s include data for ***Gross Domestic Product per capita*** (**GDP per capita**) in current prices ($), GPD per capita using the PPP method and the GNI per capita. These were obtained from the Eurostat website.

Infrastructure indicators: Main fixed lines per 100 inhabitants (Teledensity). Fixed lines are telephone mainlines connecting a customer's equipment to the public switched telephone network. ***Internet penetration indicators: Internet hosts***[27] refer to the number of computers directly connected to the worldwide Internet network. Note that Internet host computers are identified by a two-digit country code or a three-digit code generally reflecting the nature of the organization using the Internet computer. The number of

[26] Bauer, J.M., Gai, P., Kim, J., Muth, T.A., Wildman, S.S., 2003. Broadband uptake in OECD countries. Paper presented at the 31st Research Conference on Communication, Information and Internet Policy, Arlington, VA, USA

[27] ITU, World Telecommunications / ICT indicators, 2006

hosts is assigned to economies based on the country code although this does not necessarily indicate that the host is actually physically located in the economy. In addition, all other hosts for which there are no country code identification are assigned to the United States. Therefore the number of Internet hosts shown for each country can only be considered an approximation. Data on Internet host computers are from Internet Software Consortium and RIPE (Réseaux IP Européens).

Internet *User per 100 inhabitations* is based on nationally reported data. In some cases, surveys have been carried out that give a more precise figure for the number of Internet users. However surveys differ across countries in the age and frequency of use they cover. The reported figure for Internet users—which may refer to only users above a certain age—is divided by the total population to obtain ***users per 100 inhabitants*.**

PCs shows the estimated number of Personal Computers (PCs), both in absolute numbers and in terms of **PCs per 100 inhabitants**. The figures for PCs come from the annual questionnaire supplemented by other sources.

International Internet bandwidth measured in Mbps, refers to the capacity which backbone operators provide to carry Internet traffic measured in bits per second. This indicator is intended to represent the *quality* of the experience of Internet users within a country. If the experience of an Internet user in a country is poor, because of slow speed, then either people will not use ICTs, or they will not be able to use them effectively and creatively. In many developing countries, most Internet access is to sites abroad and therefore

the amount of international bandwidth has a major impact on performance.[28]

In addition the **price of local call P(t-1)**was added in estimating the model lagged by one time period, as a proxy for the price of substitute(dial up). Z_{it} refer to the unobserved variable that varies from country to another but does not change over time e.g.: cultural differences toward broadband penetration.

In this paper we will estimate the pooled regression with no fixed effects, and calculating the F-test , then estimating the fixed effects model (within model) and the individual

[28] ITU, "*Core ICT Indicators,* Partnership on Measuring ICT for Development", 2005

country effects, the LSDV model. Finally, we estimate the random Effects Model and Hausman test.

Table 3 represents the Pooled Ordinary Least Square regression (OLS) which was performed for 4 models that we estimated. The difference between the 4 models are in the independent variables that we controlled for in each one in addition to whether we controlled for GNI per Capita or GDP per Capita in the model. Beta coefficients were also calculated in order to be able to compare and determine which of the independent variables affect broadband penetration the most. The four models were all statistically significant as the P-value of the F-statistic was zero. GNI per Capita and GDP per capita were divided by hundred in order to facilitate the interpretation of the regression models. The latter was not statistically significant in all four models. On the other hand, school enrollment, Internet users were statistically significant in all four models, which is consistent with Ferreruela and Alabau (2004). Price of dial up lagged one time period was statistically significant when controlled for. In addition the International band width was significant. These all are consistent with the literature.

The calculation of beta coefficient is regarded as an important addition to the analysis as it indicated that Internet users is the most factor that affects the uptake of broadband followed by school enrollment and finally fixed main lines and international bandwidth have also an important impact on broadband penetration.

Table 5 represents the least square dummy variable model was estimated with applying individual county effects.

Adding country fixed effects by generating dummy variable to each country and including all of them except one to avoid multicollinearity would lead to substantially decrease the degrees of freedom and thus jeopardize the quality of the estimators obtained. However, year fixed effect could be added to show that broadband penetration is a phenomenon that increases over time. However, in this model, since the time effect is relatively small, i.e. 4 years only, we will not add time effects to the estimated model. In the following tables we will control for unobservable effects of each country.

The base group was Egypt. We conclude the following : Compared to Egypt countries like Argentina, Bahrain, Jordan, Kuwait, Malaysia, Russia, Turkey, UAE, Uruguay, all have significant negative unobservable effects compared to Egypt in broadband

penetration. So their impact is negative compared to Egypt. However, only Algeria had a positive unobservable effects compared to Egypt. This is due to that the intercept of these countries is statistically significant.

In this regression the beta coefficient indicate that school enrollment, main fixed lines and population density have the most impact on broadband penetration in the countries covered in this study.

Then fixed effects model, table 4 and Random effects model table 5 were estimated. Then 2 tests were employed to decide whether fixed effects (FE) or random effects (RE) should be applied. First the LM test is performed to assess whether the estimates of OLS model without country effects, based on pooling the data, are consistent or there are specific country effects that should be incorporated into the estimation by using suitable procedure such as FE or RE. Second Hausman and Taylor test in used to compare the FE and the RE models. Both tests are significant at 0.05 level and thus the FE model cannot be rejected in favor of OLS and RE models. In table 3 the OLS results were reported and in table 4 FE estimates were reported.

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.

4. ANALYSIS OF THE RESULTS:

In general the obtained results from table 4 are consistent with the literature discussed earlier. Compared with previous studies that discuss factors i.e. indicators affecting broadband penetration we find that common factors or indictors used in previous and the present study include population density, internet subscribers, price of dial up, school enrollment, sites are found to be statistically significant. New indicators were added namely, PC/100 and fixed main lines /100 inhabitants.

(See table 7)

Table 7: Factors (Indicators) affecting broadband, comparison and summary

Independent variable (indicators)	Previous study Bauer	Previous Study Ferreruela	Arab & Emerging Countries	Comment
1.Income GNI /capita	Significant/not significant		Significant	In 5 models Depending on the model
2. School Enrollment		Significant	Significant	
3. Population density	Significant	Not significant	Significant	
4. Fixed lines /100			Significant	
5. Internet hosts		Not Significant	Significant/ not significant	In 3 models Depending on the model
6. Price of local call(dial up)	Significant		Significant	
7. PC/100			Is not a reliable indictor	
8. Internet users		Significant	Significant	

Legend

For Arab and Emerging countries, ITU statistics is the main source.

Panel data for 22 countries from the years 2002-2005. Fixed effect model.

Bauer &al: 30 OECD countries for year 2001.

Ferreruela &al: 30 OECD countries for the years 2000-2002.

Notes:

1.Bauer & al used other indicators that include: price of broadband, preparedness, competition and dummy variable for policy regimes.

2.Ferreruela &al used other indicators that include available bandwidth per $, lagged variable of DSL enabled Local loop, Unbundled local loop/100 access lines, monthly price of internet access and % of homes served by cable TV network.

3. For Arab and emerging countries, Indicators used in the table are mainly according to ITU available data.

In Table 4 of fixed effects models, *GNI per capita* is the right measure for income and is statistically significant in model 3, meaning that the higher GNI per capita in the emerging countries the more the penetration of broadband take place. The GDP per capita measure for the income variable is not statistically significant and economically not significant as well. An explanation to this result is found in the study of democracy and interconnectivity based on simultaneous equations analysis growth in Internet nodes, by Kedzie (1997)[29] . In his study "statistical test results do not support…economic development as a confounding third variable… neither democracy nor GDP proves to influence interconnectivity strongly". Another explanation of the statistical and economic insignificance of GDP per capita is that in the countries included in the sample the officially reported income is very small compared to the actual earned income to individuals especially government employees . In addition the informal sector in this economies is relatively large.

The *population density* is statistically significant which is also coinciding with a priori expectations and it means that in densely populated areas it is much easier to connect people to the internet and broadband. Furthermore, the more people are exposed to the internet the more the uptake of broadband will increase as the *internet users* variable in all the three models are statistically significant. These users are more likely to be appreciative of the benefits and advantages of high speed internet access. This is consistent with the previous literature that emphasizes the importance of internet exposure in increasing internet penetration rate.

School enrollment especially the tertiary level of education is a significant determinant of the broadband uptake in these countries. Although some reports indicate that basic literacy indicators should serve as an appropriate measure for the population ex ante capability for Internet access which includes broadband penetration. However, we argue that the level of education indicates the exposure to the language as well as sophistication

[29] Kedzie, C. (1997), "Communication and Democracy: Coincident Revolutions and the Emergent Dictator's Dilemma", RGSD-127, RAND Corporation, Santa Monica CA.

in thinking which is a prerequisite to able to navigate on line and benefit from on line activities. According toGlobalReach[30], 43 per cent of online users and 68.4 per cent web content use English, down from the 80 per cent of English language web pages in the late 1990s. Thus in depth human development indicators like the level of tertiary education is necessary variable to control for when studying the broadband penetration in emerging countries especially in Arab and emerging countries.

Number of Fixed Main lines per 100 inhabitants or Teledensity are considered the infrastructure requirement for broadband penetration in any country especially the wire line broadband is that statistically significant, as it plays a major role as a determinant of broadband penetration in the countries under study and this is consistent with a priori expectations and the literature as well.

The present PC's per hundred inhabitants indicator is statistically insignificant and with the wrong expected sign which needs a different methodology for its calculation. As a matter of fact access to a PC depends mainly in emerging countries on the popularity of Internet cafes and other public point of access that daily attracts hundred users at a very low cost. This requires a special study to assess its true value.
The variable controlling for the number of *internet hosts* is becoming statistically significant in the last model at a 1% level of significance. This is consistent with the fact that an increasing number of Internet hosts implies increased ability to handle, service and store large amounts of data. The hypothesis tested by the Garcia whether the local internet hosts are determinants of broadband penetration, and the empirical study indicated that it is not statistically significant means that it is not the local number of internet hosts rather the international number because according to the UNCTAD report[31] the internet hosts are commonly registered in generic top-level domains like *com*, *org*, *net* or *edu* rather than country domains like *cl* or *us*, and the statistics are based on these top level domain names. Furthermore, people in low-income countries who wish to reach

[30] UNCTAD Report, "THE DIGITAL DIVIDE REPORT: ICT DIFFUSION INDEX 2005" United Nations New York and Geneva, 2006
[31] UNCTAD Report, "THE DIGITAL DIVIDE REPORT: ICT DIFFUSION INDEX 2005" United Nations New York and Geneva, 2006

a global audience have an incentive to place content on servers in high-income countries with fast, reliable connectivity and relatively low prices. Doing so may even improve domestic access.

The *price of 3 minute local call* is used as a proxy for the internet access charges for dial up not broadband. This is due to the lack of data on time series data for rates on internet access specifically broadband.
We included this proxy in the model as the price of the substitute which is the dial up internet access. As the price of this mode of access to the internet becomes less expensive, the demand on dial up access will become more popular versus the broadband access and broadband penetration rates could be adversely affected.
To overcome the problem of endogeneity which is inherent characteristic in any model that controls for prices, we utilize the lagged variable of the price of local call, lagged one year in our model.
There are however certain limitations on this proxy[32]. For Example: Charges may be fixed or flat rate regardless of call duration. There could be price discrimination or off peak and peak pricing or the rate could differ whether the call is for Internet access; and finally, operators may provide discounted calls to user-specified numbers. The estimated coefficient is statistically significant, with the right sign consistent with a priori expectations. When the price of dial up increases, broadband service becomes more attractive and people switch to broadband, ceteris paribus. This can be referred to as the "switching effect"[33].

The R-squared as a measure for the goodness of fit of how much of the variations in is explained by the variations in the independent variables. In our fixed effect model number 3, the R-squared relevant in these models is the within R-squared and it has all

[32], UNCTAD Report, "THE DIGITAL DIVIDE REPORT: ICT DIFFUSION INDEX 2005" United Nations New York and Geneva, 2006

[33] Kenneth Flamm , Anindya Chaudhuri, 2005, "AN ANALYSIS OF THE DETERMINANTS OF BROADBAND ACCESS", presented at the Telecommunications Policy Research Conference Washington, DC, September 24, 2005.

the properties of the overall R-squared. The within estimator maximizes the R-squared within. In the three models chosen the within R-squared is relatively high indicating that the explanatory variables explain much of the variation in the dependent variable. We notice that when we controlled for income using the GNI per capita in model 2, the R – squared within improved, indicating that the these set of explanatory variables do explain better the changes in broadband penetration in these set of countries.

5. Conclusions and Policy Recommendations:

From the economic perspective it seams obvious that broadband penetration is determined by the controlled variables also called indicators that are referred to in the literature and theory. However, the independent variable PCs per 100 inhabitants can not considered as a true value and hence does not give the true effect on broadband penetration. A different method to assess the actual value of this indicator in emerging countries is needed that would take into account the public usage of internet access, such as internet cafes.

It seems that the deployment of more fixed main lines would increase broadband penetration. Thus governments should expand the existing fixed network and utilize the latest technologies in this field. Furthermore, governments can explore the option of leasing the subscriber lines to open new markets for potential entrants in this telecom market segment. The issue of "build or buy" has caused a big debate among Telecom economists and policy makers regarding the advantages and disadvantages of allowing service based competition like local loop unbundling. Governments in these countries should definitely explore the option of service based competition more seriously. A set of policies like tariff rebalancing, collocation and interconnection arrangements should be addressed before the commencement of the unbundling of local loop policy.

Countries with high population density, should find it easier to increase broadband uptake compared to population that is scattered like in rural areas ceteris paribus. This is due to the fact that a large number of people would be connected to the MDF and thus it would be easier to a new entrant to lease the local loop from the incumbent and install his new

Equipment. In densely populated areas, i.e. urban areas, the distance between the local exchange and the subscriber i.e. the subscriber line is shorter which allows a better quality of broadband service to the end user.

This set of countries that constitute our sample are unique in that they are the target of many FDI and thus steps are taken toward transforming these economies to new economies by finding incentives to increase broadband uptake. This approach is considered an important signal to these new investors. Measures taken to accelerate this process would indicate how serious these economies are in entering the new paradigm of knowledge based economy.

Thus it is imperative to determine exactly what enhances broadband penetration especially given the idiosyncratic features of emerging economies.

Further empirical research is necessary to evaluate the policies implemented thus far by the governments in these countries such as subsidy on both the demand side and the supply side. The percent of population living in urban areas and the language of the content, like the arabization of websites to induce non English speaking people to use the Internet and thus increase the chances of broadband penetration. Market structure of telecom sector could also be controlled for in the following studies. However, with the increase of available data, more profound empirical research by economists will be fruitful for these countries in the future.

REFERENCES:

1. Aron, Debra J. and David E. Burnstein, 2003 " Broadband adoption in the United States an empirical study", SSRN .

2. Austan Goolsbee, 2002"**Subsidies, the value of broadband and the importance of fixed costs", 2002,** Broadband Should We Regulate High-Speed Internet Access? Edited by Robert W. Crandall James H. Alleman, AEI Brooking Joint Center for Regulatory Studies,Washington, D.C.

3. Bauer, J.M., Gai, P., Kim, J., Muth, T.A., Wildman, S.S., 2003. Broadband uptake in OECD countries. Paper presented at the 31st Research Conference on Communication, Information and Internet Policy, Arlington, VA, USA

4. Brynjolfsson, E., Hitt, L. M. and Yang, S. (2002) "Intangible Assets: Computers and Organizational Capital," Brookings Papers on Economic Activity: Macroeconomics (1): 137-199

5. Fernando A. Broner Guido Lorenzoni Sergio L. Schmukler, 2007, "Why do emerging economies borrow short term?", World Bank paper WPS 3389

6. George S. Ford, Lawrence J. Spiwak(September 2004), The positive effects of unbundling on broadband deployment, Phoenix Center for Public Studies

7. Gillett, S., and Lehr, W. (1999) "Availability of Broadband Internet Access: Empirical Evidence," paper presented at 27th Telecommunications Policy Research Conference, Alexandria, VA.

8. Greene, W. H. (2003). Econometric Analysis. 5th ed. Upper Saddle River: Prentice Hall

9. ITU, "*Core ICT Indicators,* Partnership on Measuring ICT for Development", 2005

10. ITU, "E-strategies, empowering development", 2006

11. ITU, "E-strategies, empowering development", 2006

12. ITU, "Trends in Telecommunication Reform 2006"

13. ITU, Internet Report, Digital life, 2006

14. Kedzie, C. (1997), "Communication and Democracy: Coincident Revolutions and the Emergent Dictator's Dilemma", RGSD-127, RAND Corporation, Santa Monica CA.

15. Kenneth Flamm , Anindya Chaudhuri, 2005, "AN ANALYSIS OF THE DETERMINANTS OF BROADBAND ACCESS", presented at the Telecommunications Policy - Research Conference Washington, DC, September 24, 2005

16. Lichtenberg, F. and Lehr, W. (1998), "Computer Use and Productivity Growth in Federal Government Agencies, 1987-92," *Journal of Industrial Economics*, 46(2), pp. 257-279.

17. Maria Michalis (2001), Local competition and the role of regulation: The EU debate and Britain's experience, Telecommunications Policy 25 (2001) 759–776

18. **Scott Wallsten "Broadband and Unbundling Regulations in OECD Countries" , Working Paper 06-16, June 2006,** AEI Brooking Joint Center for Regulatory Studies, Washington, D.C.

19. Scott Wallsten, June 2005 “Broadband penetration, an empirical analysis of state & federal policies,” ,Working Paper 05-12, June 2005, AEI Brooking Joint Center for Regulatory Studies.

20. Scott Wallsten, June 2005 “Broadband penetration, an empirical analysis of state & federal policies,” ,Working Paper 05-12, June 2005, AEI Brooking Joint Center for Regulatory Studies

21. UNCTAD report, “THE DIGITAL DIVIDE REPORT: ICT DIFFUSION INDEX 2005” United Nations New York and Geneva, 2006

22. Walter Distaso, Paolo Lupi , Fabio M. Manenti(2006) Platform Competition and broadband uptake: Theory and Empirical evidence from the European Union., Information Economics and Policy 18 (2006) 87–106.

23. William H. Lehr, Carlos A. Osorio, Sharon E. Gillett, Marvin A. Sirbu “ Measuring broadband’s economic impact” Massachusetts Institute of Technology Engineering Systems Division, Working Paper Series ESD-WP-2006-02

24. Wooldridge, 2002, “ Woolridge, J. (2002). Econometric Analysis of Cross-Section and Panel Data. MIT Press,

25. World Economic Forum , Agusto Lopez –Claros and Klaus Schwab (2005) The Arab World Competitiveness Report 2005.

Appendix:

Table one: Description of the Variables and their expected signs.

	The control variables	**Description of the variable**	**The expected signs A priori**
Economic Indicators	INC	GDP per capita measured in US$ or GDP per capita using PPP GNI per capita	Positive
Education Indicators	SCHOOL ENROLLMENT	% of population who have completed their tertiary education	Positive[34]
ICT Indicators	PCS/100	Pcs per hundred inhabitants	Positive
Demographics Indicators	POPD	Population density in square km	Positive
Internet penetration Indicators	INTERNET USERS	**Internet *User per 100 inhabitants***	Positive
Infrastructure Indicators	FIXED LINES/100	main telephone lines (fixed lines) per 100 inhabitants	Positive
Internet penetration Indicators	HOSTS	number of computers directly connected to the worldwide Internet network	Positive
Prices	P-1	Price of a 3-minute	Positive

[34] This hypothesized relationship is made by Gabel and Kwan (2000) and Madden, Savage, and Simpson (1996). Both studies uncover the anticipated coefficient, however, only the latter study finds a statistically significant relationship.

Indicators (price of dial up a substitute for BB)		fixed telephone local call (peak rate telephone –US$) one year lagged	
Capacity of the Internet	International bandwidth	International Internet Bandwidth (Mbps)	Positive
Broadband indicators	**Dependent variable** BP	Broadband penetration per 100 inhabitants	----------

Table Two: Summary Statistics:

Variable	Min	Max	Mean	Standard deviation
GDP per capita ($)	1.775	431110	7556.554	8979.485
GNI per capita ($)	1110	30630	6754.148	6831.16
SCHOOL ENROLLMENT (%)	9.95	70.67	30.52409	14.40877
PCS/100	1	75	38.94318	21.28048
POPD	1	56	27.30682	16.11621
INTERNET USERS	1.59454	42.36923	12.85715	8.815323
FIXED LINES/100	2.822633	30.95388	17.4811	7.828698
Internet HOSTS/	1	63	31.61364	19.2649
P-1 ($)	0	0.2452316	0.0627284	0.0591719
International bandwidth (Mbps)	16	29200	3646.21	6148.705
BP	0	3.634331	0.6400611	0.8214905

Table 3: Regression Results of Pooled Ordinary Least Square:

Dependent variable broadband penetration rate per 100 inhabitants:

	Model 1	**Model 2**	**Model 3**	**Model 4**
INC	**GNI_per_100** **-0.0006** **(0.0012)**	**GNI_per_100** **0.0001** **(0.013)**	**GDP_per_100** **0.0004** **(0.001)**	**GDP_per_100** **0.00106** **(0.001)**
SCHOOL ENROLLMENT	**0.0084336** **(0.006)***	**0.0189071** **(0.007)****	**0.199** **(0.072)*****	**0.022** **(0.008)****
PCS/100	**-0.0000554** **(0.003)**	**-0.001424** **(0.0037)**	**-0.0012959** **(0.004)**	**-0.0023106** **(0.004)**
POPD	**-0.0064313** **(0.005)**	**-0.0018035** **(0.005)**	**-0.0018** **(0.005)**	**0.00214** **(0.006)**
INTERNET USERS	**0.045351** **(0.010)*****	**0.0375** **(0.106)*****	**0.0375** **(0.10)*****	**0.0337** **(0.113)****
FIXED MAIN LINES/100	**0.259948** **(0.112)****	**0.220885** **(0.112)****	**0.0204** **(0.115)***	**0.017083** **(0.131)**
INTERNET HOSTS	**-0.0008898** **(0.005)**	**-0.00160** **(0.0046)**	**-0.0019** **(0.0046)**	**-0.0017461** **(0.005)**
PRICE OF DIAL UP T-1		**2.104908** **(1.216)***	**2.19782** **(1.231)***	**1.9448** **(1.29)***
INTERNATIONAL BANDWIDTH				**0.0000305** **(0.001)*****
CONSTANT	**-0.4057278** **(0.277)**	**-0.748408** **(0.3059)****	**-0.77363** **(0.29)****	**-.9844256** **(0.351)****
N	**88**	**84**	**84**	**70**
F-statistic	**9.10**	**8.55**	**8.59**	**6.55**
P >(F-statistic)	**0.00**	**0.00**	**0.00**	**0.00**
R-squared	**0.44**	**0.47**	**0.47**	**0.49**

Standard Error between brackets.

* significant at 90% significant level

** significant at 95% significant level

*** significant at 99% significant level

Table 4: Dependent variable BP per hundred inhabitants:

Fixed effects model

	Model 1	Model 2	Model 3
INC	Gdp per capita 0.000021 (0.00003)	Gni_per capita 0.000065 (0.00004) *	Gni_per capita 0.00005 (0.00004)
SCHOOL ENROLLMENT	0.065 (0.031) **	0.69 (0.0313) **	0.05 (0.28) *
PCS/100	-0.01 (0.004)	-0.005 (0.0038)	-0.0018 (0033)
POPD	0.01 (0.004) ***	0.011 (0.004) ***	0.013 (0.004) ***
INTERNET USERS	0.09 (0.026) ***	0.08 (0.27) ***	0.095 (0.024) ***
FIXED MAIN LINES/100	0.079 (0.034) **	0.09 (3.0) ***	0.08 (0.036) **
INTERNET HOSTS	0.009 (0.006)	0.009 (0.006)	0.01 (0.006) *
PRICE OF DIAL UP T-1	2.05 (1.101) *	1.62 (0.945) *	
CONSTANT	-4.45 (0.807)***	-4.9375 (0.869)***	-4.47315 (0.946)***
N	84	84	88
R-squared within	0.7130	0.722	0.697
F-statistics	11.52	13.61	12.11
P> F statistics	0.000	0.0000	0.0000
F-test P> F	7.21 0.000		

Between brackets are the standard errors. The within estimators have hetroscadastic robust standard errors.

* significant at 90% siginifcant level

** significant at 95% significant level

*** significant at 99% siginificant level

Table 5: Random Effects, LM test and Hausman Test:

	Model 1	Model 2	Model 3
INC	Gdp per capita_100 0.0014 (0.0013)	Gni_per capita_100 0.0006 (0.00214)	Gni per capita_100 -0.00008 (0.00224)
SCHOOL ENROLLMENT	0.0312 (0.014) **	0.0286 (0.015) **	0.01496 (0.0103)
PCS/100	-0.004 (0.0035)	-0.0035 (0.0035)	-0.0020 (-0.003)
POPD	0.004 (0.0038)	0.00397 (0.00397)	0.0012 (0.004)
INTERNET USERS	0.065 (0.17) ***	0.0689 (0.0189) ***	0.075 (0.173) ***
FIXED MAIN LINES/100	-0.0005 (0.018)	0.0033 (0.018)	0.0072 (0.0188)
INTERNET HOSTS	0.0028 (0.0056)	0.0038 (0.0054)	0.0047 (0.0049)
PRICE OF DIAL UP T-1	2..11 (1.976)	2.0144 (1.943)	
CONSTANT	-1.393 (0.4231)***	-1.377 (0.443)***	-1.013243 (0.3666)***
N	84	84	88
R-squared	0.4415	0.4406	0.3935
Breusch Pagan LM test	6.25		
Hausman Test	66.79		

The estimators have hetroscadastic robust, standard errors.

* significant at 90% significant level

** significant at 95% significant level

*** significant at 99% significant level

Table 6: THE DUMMY VARIABLE LEAST SQUARE MODEL: (LSDV)

	Model 1
INC	GDP _ PER _100 0.0014 (0.003)
SCHOOL ENROLLMENT	0.05 (0.025) **
PCS/100	-0.016 (0.003)
POPD	0.01 (0.006) **
INTERNET USERS	0.102 (0.020) ***
FIXED MAIN LINES/100	0.068 (0.0399)*
INTERNET HOSTS	0.010 (0.006)*
PRICE OF DIAL UP T-1	2.05* (1.86)
CONSTANT	-2.858 (0.769)***
N	88
R-squared	0.8482
F-statistics	11.77

Country Individual Effects

Algeria	1.038607 (0.453)**
Argentina	-2.60719 (0.9766527)***
Bahrain	-2.009598 (0.9154849)**
Brazil	-0.1114034 (0.8424158)
Colombia	-0.697141 (0.6824453)
Jordan	-1.470616 (0.489608)***
Kuwait	-1.583238 (0.8126848)**
Lebanon	-0.9131862 (0.7388813)
Malaysia	-3.995006 (0.8472238)
Mexico	0.2486153 (0.3703413)
Morocco	0.4591973 (0.6870918)
Oman	-1.418148 (1.172587)
Qatar	-1.8596 (1.194793)
Russia	-3.20506 (0.9463197)***
Saudi Arabia	-0.6767447 (0.5422591)
Syria	0.1469914 (0.5853474)
Tunisia	-0.3630942 (0.4436462)
Turkey	-1.78378 (0.9984924)**

UAE	-3.050677 (1.073251)***
Uruguay	-2.825692 (1.06753)***
Venezuela	-0.5968216 (0.4726513)