GSR 2010

Discussion Paper

10th Global Symposium for Regulators
10-12 November 2010
Dakar
SENEGAL

Comments are welcome and should be sent by 30 November 2010 to GSR@itu.int

ITU

International Telecommunication Union

GSR 2010 Discussion Paper

The impact of broadband on the economy: Research to date and policy issues

Work in progress, for discussion purposes

Please send your comments on this paper at: gsr@itu.int before 30 November 2010.

TABLE OF CONTENTS

1 THE IMPACT OF BROADBAND ON THE ECONOMY: RESEARCH TO DATE AND POLICY ISSUES

Author: Dr. Raul L. Katz[1], Adjunct Professor, Division of Finance and Economics, and Director, Business Strategy Research, Columbia Institute of Tele-information

1.1 Introduction

The diffusion of broadband, defined as the technology that enables high speed transfer of data, is inextricably linked to the emergence of the Internet. While at its initial stages the Internet was primarily accessed through dial-up means[2], consumer and enterprise demand prompted the development of technologies that facilitated access at higher speeds. As a result, starting around the mid-1990s, telecommunications and cable TV companies began offering services that significantly enhanced the experience of Internet use. Investment in and adoption of broadband soared around the world. Between 2004 and 2010, telecommunications and cable TV companies in the United States invested over 97.7 billion dollars in broadband deployment.[3] Chinese companies have invested US dollars 7.44 billion in broadband since 2009[4], while Malaysian operators invested US dollars 1.6 billion since 2009[5].

Given that such large amounts of capital have been dedicated to the technology, it is logical that researchers in the social sciences have begun to analyze the economic and social impact of broadband. This technology, however, poses challenges for researchers. First, its deployment has proceeded at an incredibly fast pace[6]. As a result, the length of time series data on broadband adoption is considerably shorter than for voice telecommunications, which already represents a methodological challenge to the estimation of its economic impact. Second, since broadband is an access technology for data communications, it only has an economic effect in combination with the adoption of information technology and the implementation of organizational and process changes in enterprises. Another research challenge is the lack of disaggregated data that would allow researchers to quantitatively establish the conditions under which broadband has a significant economic effect.

These challenges notwithstanding, the evidence accrued by research so far is beginning to support the hypothesis that broadband has an important economic impact. However, this impact only becomes significant under certain conditions. First, broadband exhibits a higher contribution to economic growth in countries that have a higher adoption rate of the technology; this is labeled the "critical mass theory".[7] Second, broadband has a stronger productivity impact in sectors with high transaction costs, such as financial services, or high labour intensity, such as tourism and lodging. Third, in less developed regions, as postulated in economic theory, broadband enables the adoption of more efficient business processes and leads to capital-labour substitution and therefore loss of jobs; this could be labeled the "productivity shock theory". Fourth, the impact of broadband on small and medium enterprises (SMEs) takes longer to materialize due to the need to restructure the firms' processes and labour organization in order to realize the gains from adopting the technology; this is called "accumulation of intangible capital". Finally, broadband's economic impact is higher when promotion of the technology is combined with stimulus of innovative businesses that are tied to new applications. In other words, the impact of broadband is neither automatic nor homogeneous across the economic system. This underlines the importance of implementing public policies not only in the areas of telecommunications regulation, but also in education, economic development and planning, science and technology, and others.

The purpose of this study is threefold. First, it presents the evidence generated by the different bodies of theory regarding the economic impact of broadband. The purpose is not only to summarize the evidence, but also to present the complexities and conditions under which broadband has an impact. In this regard, this study reviews the results of research conducted across the world measuring the impact of broadband on economic growth and employment creation, and presents additional research carried out by this author. Second, this study presents a methodology for calculating the investment necessary to implement national broadband plans. Finally, it outlines the public policy options for stimulating the deployment of broadband and for maximizing the positive economic impact of the technology.

1.2 Economic Impact of Broadband: a Review of the Literature

This section presents the research conducted to date on the economic impact of broadband. In reviewing the literature, it will become apparent that there is no single approach to assessing the economic contribution of broadband. Each methodology that has been utilized so far (input / output analysis, econometric modeling, measurement of consumer surplus, and microeconomics case studies) will be reviewed and the robustness of the evidence generated will be assessed. In reviewing the methodologies, it will also become apparent that the overarching condition guiding the selection of one approach over another is driven primarily by data availability.

1.2.1 Contribution to Economic Growth

Research aimed at generating hard evidence regarding the economic impact of broadband is fairly recent. The results of the research and the evidence generated so far fall into three categories:

- Contribution of broadband to the growth of GDP;
- Productivity gains; and
- Specific effects of broadband on economic growth.

While the research on the contribution of broadband to GDP growth has confirmed its positive impact, it has also yielded results that vary widely. Constrained by data availability, the analyses have primarily focused on OECD countries (generally those in Western Europe and North America) and states in the United States.

Table 1.1: Research results of Broadband Impact on GDP growth

Country	Authors – Institution	Data	Effect
United States	Crandall et al (2007) – Brookings Institution	48 States of US for the period 2003-2005	No statistically significant results
	Thompson and Garbacz (2008) – Ohio University	46 US States during the period 2001-2005	A 10% increase in broadband penetration is associated with 3.6% increase in efficiency
OECD	Czernich et al. (2009) – University of Munich	25 OECD countries between 1996 and 2007	A 10% increase in broadband penetration raises per-capita GDP growth by 0.9-1.5 percentage points
	Koutroumpis (2009) – European Investment Bank	2002-2007 for 22 OECD countries	An increase in broadband penetration of 10% yields 0.25% increase in GDP growth
High Income Economies	Qiang et al. (2009) – World Bank	1980-2002 for 66 high income countries	10 % broadband penetration yielded an additional 1.21 percentage points of GDP growth
Low & Middle income economies	Qiang et al. (2009) – World Bank	1980-2002 for the remaining 120 countries (low and middle income)	10 % broadband penetration yielded an additional 1.38 in GDP growth

Source: Author.

As the data in Table 1.1 indicates, most studies conclude that broadband penetration has an impact on GDP growth. However, one observes that such a contribution appears to vary widely, from 0.25 to 1.38 per cent for every increase in 10 per cent of penetration[8]. Explanations for this variance are manifold. Clearly, some of the discrepancies come from the usage of different datasets as well as model specifications. Many of the problems identified stem from data availability since researchers lack a host of useful variables and must work at high levels of aggregation.

1.2.2 Impact on productivity

It is logical to assume that productivity of information workers, defined as the portion of the economically active population whose working function is to process information (e.g., administrative employees, managers, teachers, and journalists), depends directly on the investment in ICT capital (and adoption of broadband).

For example, research on the impact of broadband on productivity has successfully identified positive effects. Waverman (2009) determined the economic effect of broadband on the GDP of 15 OECD nations for the time period of 1980 to 2007. Broadband impact on the productivity of the more developed nations in the sample was found to be .0013 and was statistically significant at the 5 per cent level[9]. In other words, Waverman estimated that for every 1 per cent increase in broadband penetration in high and medium impact income countries, productivity grows by 0.13 per cent. In another document, the authors commented upon the productivity effect in the countries in their sample with relatively low ICT penetration (Greece, Italy, Portugal, Spain and Belgium)[10]. They found that broadband impact on productivity was nil, which could be explained by the high adoption costs and critical mass thresholds.[11] In other words, for broadband to have an impact on productivity, the ICT eco-system must be sufficiently developed.[12] It would appear, therefore, that in developed countries with high broadband penetration, broadband technology has an impact on aggregate productivity levels.

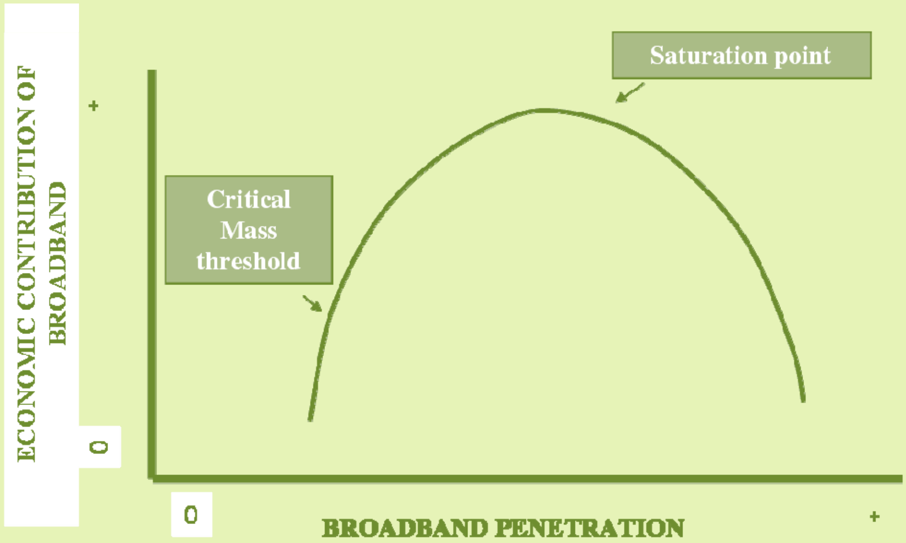
In addition to measuring the aggregate economic impact at the macro level, research on the economic impact of broadband has focused on the specific processes that underlie this effect. So far, two questions have been studied in detail:

- Does the economic impact of broadband increase with penetration and can we pinpoint a saturation threshold when decreasing returns to penetration exist?
- What explains the lagged effect of broadband on the economy?

A critical element of the evolving theoretical framework of network externalities of broadband is the impact infrastructure penetration levels may have on output. Is there a linear relationship between broadband adoption and economic growth? Or are we in the presence of a more complex causality effect? The "critical mass" findings of research on the impact of telecommunications on the economy indicate that the impact of broadband on economic growth may only become significant once the adoption of the platform achieves high penetration levels. However, Gillett et al. (2006) also contend that the relation between penetration and economic impact should not be linear "because broadband will be adopted (…) first by those who get the greatest benefit (while) late adopters (…) will realize a lesser benefit"[13] With both points of view in mind, it would appear that the strength of the relationship is highest once the technology has achieved a certain critical mass but before it reaches saturation (see figure 1.1).

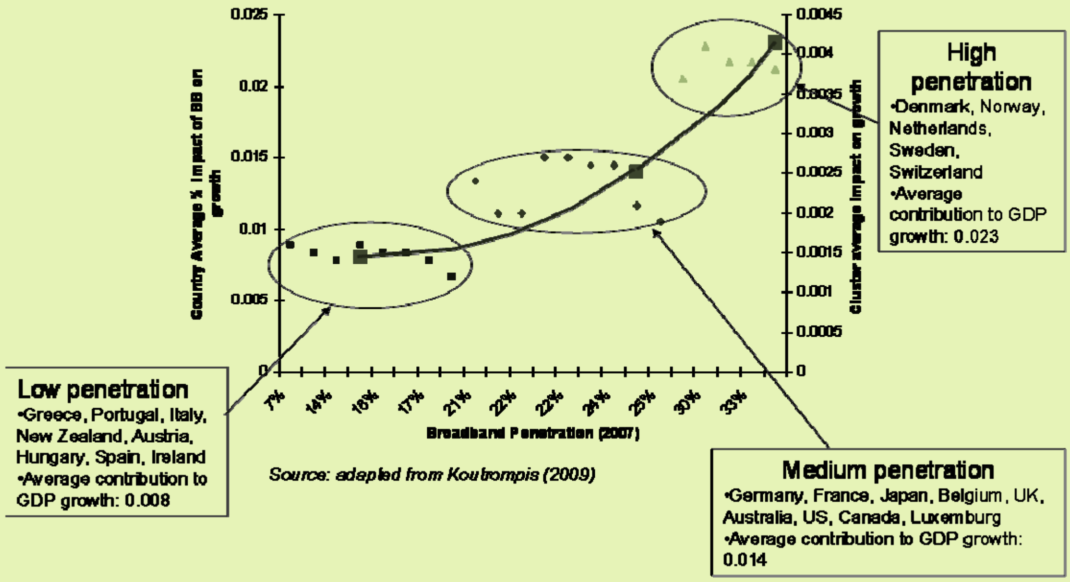
Theoretically, it appears that there is a non-linear (or inverted U shape) relationship between broadband penetration and economic output, as well as employment. At low levels of broadband penetration, we believe the impact of broadband on the economy is minimal due to the "critical mass" concept. According to this theory, the impact on economic output is maximized once the infrastructure reaches a critical mass point, generally associated with levels of penetration of developed countries. In fact, research suggests that in order to achieve a material level of economic impact, broadband must reach high levels of penetration. For example, Koutroumpis (2009) found that for OECD countries, the contribution of broadband to OECD economic growth increased with penetration (see figure 1.2).

Figure 1.1: Impact of broadband on output over diffusion process



Source: Adapted from Katz (2008a)

Figure 1.2: OECD: Percentage of Impact of Broadband on GDP Growth



Source: adapted from Koutrompis (2009)

As seen above, according to Koutroumpis' research, in countries with low broadband penetration rates (under 20 per cent), an increase of 1% in broadband adoption contributes to 0.008 per cent of GDP growth, while in countries with medium penetration rates (between 20 per cent and 30 per cent), the effect is 0.014 per cent of GDP growth, and in countries with penetration rates higher than 30 per cent, the impact of an increase of 1 per cent in broadband adoption reaches 0.023 per cent. The implication of this finding for developing countries is quite significant. Unless emerging economies strive to dramatically increase their broadband penetration rates, the economic impact of the technology will be quite limited.

At the same time, some authors have already pointed out a potential "saturation" effect.[14] They find that beyond a certain adoption level (not yet specified), the effect of broadband on the economy tends to diminish. There is evidence that supports this argument. Czernich et al. (2009)[15] found that a 10 per cent broadband penetration rate has a significant impact on GDP per capita: between 0.9 and 1.5 percentage points; however, this effect tends to diminish once penetration increases. The saturation evidence still needs to be carefully tested, particularly in terms of what the optimal point is, beyond which broadband has decreasing returns. For example, in a study conducted in Germany by this author (discussed below), it was not possible to identify a saturation point for broadband penetration.[16] Furthermore, even if evidence was found that confirmed the impact of broadband saturation on growth in GDP or employment creation, this evidence would not put into question the need to achieve universal access to broadband in terms of the other socio-economic benefits it yields to end users.

The final condition to be considered is that, in order to have an impact on productivity, the adoption of broadband needs to be complemented with "accumulation of intangible capital"[17]. Broadband does not in and of itself have an economic impact. It requires the introduction of a number of processes and organizational changes. These changes, as well as training and other cultural factors (such as entrepreneurial spirit and the willingness to take risks in an organizational transformation) are referred to as the accumulation of intangible capital. The accumulation of intangible capital enables the adoption of e-business processes that result in increased efficiency, such as streamlined access to raw materials and management of the supply chain or better market access. The public policy implications of this condition cannot be understated. To achieve the full economic benefit of broadband deployment, governments need to emphasize the implementation of training programs and, in the case of SMEs, offer consulting services that help firms capture the full benefit of the technology.[18]

1.2.3 Impact on job creation

This section reviews the evidence regarding the impact of broadband on job creation. It distinguishes between the research focused on measuring the impact of broadband deployment programs (e.g., the counter-cyclical impact of broadband network construction) and the spill-over effect that broadband can have in terms of generating employment across the economy once it is being deployed. As in the prior section, one sub-section focuses on specific effects that broadband penetration has on job creation, such as differential impact by industrial sector and/or regions.

1.2.3.1 Broadband construction effects and their counter-cyclical importance

Broadband network construction affects employment in three ways. First, network construction creates direct jobs necessary for the building of the facility such as telecommunication technicians, construction workers, and manufacturers of the required telecommunication equipment. Second, the creation of direct jobs has an impact on indirect employment; indirect employment includes jobs related to upstream buying and selling between metal and electrical equipment manufacturing sectors, for example. Third, the household spending based on the income generated from the direct and indirect jobs creates induced employment.

Four national studies have estimated the impact of network construction on job creation. They all relied on input-output matrices and assumed a given amount of capital investment: USD 63 billion (needed to reach ubiquitous broadband service in the United States) for Crandall et al. (2003); CHF 13 billion for Katz et al. (2008b) (to build a national multi-fibre network for Switzerland); USD 10 billion for Atkinson et al. (2009) (as a US broadband stimulus); and USD 7.5 billion for Liebenau et al. (2009) (needed to complete broadband deployment in the United Kingdom) (see Table 1.2).

While input-output tables are a reliable tool for predicting investment impact, two words of caution need to be given. First, input-output matrices are static models reflecting the interrelationship between economic sectors at a certain point in time. Since those interactions may change, the matrices may lead us to overestimate or underestimate the impact of network construction. For example, if the electronic equipment industry is outsourcing jobs overseas at a fast pace, the employment impact of broadband deployment will diminish over time and part of the counter-cyclical investment will "leak" overseas. Second, it is critical to break down employment effects at the three levels estimated by the input-output table in order to gauge the true direct impact of broadband deployment. Having said that, all these effects have been codified and therefore, with the caveat of the static nature of input-output tables, we believe that the results are quite reliable.

Table 1.2: Broadband Impact on Job Creation

Country	Authors – Institution(*)	Objective	Results
United States	Crandall et al. (2003) – Brookings Institution	Estimate the employment impact of broadband deployment aimed at increasing household adoption from 60% to 95%, requiring an investment of USD 63.6 billion	• Creation of approximately 140,000 jobs per year over ten years • Total jobs: approximately 1.2 million (including 546,000 for construction and 665,000 indirect)
	Atkinson et al. (2009) – ITIF	Estimate the impact of a USD 10 billion investment in broadband deployment	• Total jobs: 180,000 (including 64,000 direct and 116,000 indirect and induced
Switzerland	Katz et al. (2008b) – CITI	Estimate the impact of deploying a national broadband network requiring an investment of CHF 13 billion	• Total jobs: 114,000 over four years (including 83,000 direct and 31,000 indirect)
United Kingdom	Liebenau et al. (2009) – LSE	Estimate the impact of investing USD 7.5 billion to achieve the target of the *"Digital Britain"* Plan	• Total jobs: 211,000 (including 76,500 direct and 134,500 indirect and induced)

(*) Note:
ITIF: Information Technology and Innovation Foundation
CITI: Columbia Institute for Tele-Information
LSE: London School of Economics

Source: Author

1.2.3.2 Broadband externalities

Beyond the employment and output impact of network construction, researchers have also studied the impact of network externalities on employment; this impact is variously categorized as "innovation" or "network effects".[19] The study of network externalities resulting from broadband penetration has led to the identification of numerous effects:

- New and innovative applications and services, such as telemedicine, Internet search, e-commerce, online education and social networking;[20]
- New forms of commerce and financial intermediation;[21]
- Mass customization of products;[22]
- Reduction of excess inventories and optimization of supply chains;[23]
- Business revenue growth;[24] and
- Growth in service industries.[25]

Most of the research regarding the impact of broadband externalities on employment has been conducted using US data. The evidence regarding broadband employment externalities appears to be fairly conclusive (see Table 1.3).

While the impact of broadband on employment creation appears to be positive, the impact on employment growth varies widely: from 0.2 per cent to 5.32 per cent for every increase in 1 per cent of penetration. There are several explanations for this variance.[26] From a methodological perspective, these studies illustrate that, in order to properly measure the contribution of broadband to job creation, it is advisable to have datasets that include time series for employment level, broadband penetration, and related human capital statistics at a disaggregated level, such as counties, departments, or administrative district.[27]

Like the relationship between broadband and GDP growth, broadband penetration may have an uneven or negative impact on job creation under certain circumstances. Studies have particularly focused on two specific questions:

- Does broadband's impact on employment differ according to industry sector?
- Is there a decreasing return in employment generation linked to broadband penetration?

Table 1.3: Research results of Broadband Impact on Employment in the United States

Authors – Institution	Data	Effect
Crandall et al. (2007) – Brookings Institution	48 States of US for the period 2003-2005	For every 1% point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3 percent per year "assuming the economy is not already at 'full employment'"
Thompson and Garbacz (2008) – Ohio University	46 US States during the period 2001-2005	Positive employment generation effect varying by industry
Gillett et al. (2006) – MIT	Zip codes for the US for the period 1999-2002	Broadband availability increases employment by 1.5%
Shideler et al. (2007) – Connected Nation	Disaggregated county data for state of Kentucky for 2003-4	An increase in broadband penetration of 1% contributes to total employment growth ranging from 0.14% to 5.32% depending on the industry

Source: Author

As with output, the spill-over employment effects of broadband are not uniform across sectors. According to Crandall et al. (2007), the job creation impact of broadband tends to be concentrated in service industries (e.g., financial services, education, health care, etc), although the authors also identified a positive effect in manufacturing. In another study, Shideler et al. (2007) found that, for the state of Kentucky, county employment was positively related to broadband adoption in the construction, information intensive, and administrative sectors. The only sector where a negative relationship was found with the deployment of broadband was the accommodations and food services industry. This may result from a particularly strong capital/labour substitution process, whereby productivity gains from broadband adoption yields reduced employment. Similarly, Thompson and Garbacz (2008) conclude that, for certain industries, "there may be a substitution effect between broadband and employment"[28]. It should therefore be considered that the productivity impact of broadband can cause capital-labour substitution and may result in a net reduction in employment.

In summary, research is starting to pinpoint different employment effects by industry sector. Furthermore, broadband may create some jobs through innovation in services while simultaneously having a decreasing return in other employment generation due to a productivity effect in labour intensive sectors. However, we still lack a robust explanation of the precise effects by sector and the specific drivers in each case. Given that the sectoral composition varies by regional economies, the deployment of broadband should not have a uniform impact across a national territory.

1.2.4 Growth of consumer surplus

There are some specific economic effects of broadband that are not necessarily reflected in economic growth or employment creation. This is the case of consumer surplus, which has also been found to be affected by the positive externalities of broadband. Consumer surplus is defined as the amount that consumers benefit from purchasing a product for a price that is less than what they would be willing to pay.

The estimation of consumer surplus resulting from broadband penetration is important, although this economic benefit is not captured by GDP. Greenstein and McDevitt (2009) estimated the consumer surplus generated by broadband adoption in the United States. In their analysis for the period between 1999 and 2006, the authors determined that in 2006, the consumer surplus generated by broadband represented USD 7.5 billion (or 27 per cent of the total USD 28.0 billion in broadband surplus). This was calculated on the basis of what users would be willing to pay to adopt broadband in substitution for narrowband access. Consumer surplus can also be conceptualized in terms of the benefits that broadband represents to the end user. The variables driving willingness to pay include the rapid and efficient access to information, savings in transportation for conducting transactions, and benefits in health and entertainment.

1.2.5 Impact on firm efficiencies

Microeconomic analysis of the impact of broadband is converging with macroeconomic studies of the aggregate effects of the adoption of this technology on economic growth as a whole to provide a fuller picture of the economic externalities associated with increased broadband penetration. Microeconomic analysis of the impact of broadband has helped understand the multiple effects which broadband has on firm performance. Table 1.4 sets out the estimates of firm productivity enhancement, as has been found by microeconomic research.

In addition to the impact on productivity, other microeconomic studies have focused on the impact of broadband technology on business expansion, product innovation, and new business creation. With regards to business expansion, Clarke (2008) studied the impact of broadband access on exports of manufacturing and service firms. The author found that in the manufacturing sector, firms with Internet access enabled by broadband generate 6 per cent more foreign sales than the rest.[29] In the service sector, broadband-enabled firms generate between 7.5 per cent and 10 per cent more sales.[30]

In addition to increasing exports, broadband has been found to have a positive impact on the development of new businesses. This results from the network effects of connectivity. When a large enough number of households are connected to broadband, the incentive to develop new businesses around information search, advertising, and electronic commerce increases.

The results of microeconomic research have been used to estimate the impact of broadband on job creation. In a study mandated by the European Commission, Fornefeld et al. (2008) identified three ways that broadband impacts employment.[31] First, the introduction of new applications and services causes acceleration of innovation, which results in an increase in employment. Second, the adoption of more efficient business processes enabled by broadband increases productivity, which could either result in an increase in output at current employment levels or a decrease in employment. Third, the ability to process information and to provide services remotely makes it possible to attract employment from other regions through outsourcing. These three effects occur simultaneously. According to Fornefeld et al., the potentially negative impact on employment of broadband resulting from productivity gains productivity is offset by the increase in the rate of innovation and services, thereby resulting in the creation of new jobs. The third effect may result in two countervailing trends. On the one hand, a region that increases its broadband penetration can attract employment displaced from other regions by leveraging the ability to work remotely. On the other hand, by increasing broadband penetration, the same region can lose jobs by virtue of the outsourcing effect. While we are gaining a better understanding of these combined "network effects", the research is still at its initial stages of quantifying the combined impact.[32]

1.2.6 Conclusion

A review of the research on the economic impact of broadband indicates multiple effects. First and foremost, the evidence is fairly conclusive about the positive contribution of broadband to GDP growth. While the degree to which broadband contributes to economic growth varies in different studies, the discrepancies can be related to different datasets as well as model specifications.

Table 1.4: Broadband-induced Productivity Improvement

Industrial Sector	Study	E Business Impact on Firm Productivity	Share of Informational activities that involve external parties
Manufacturing	Atrostic and Nguyen (2006)	~5 %	~25 %
Services	Rincón-Aznar et al. (2006)	~ 10 %	~50 %
Information	Fornefeld et al. (2008)	~ 20 %	100%

Source: Fornefeld et al. (2008)

Secondly, broadband has been found to have a positive impact on the productivity at the firm level. Evidence generated both at the micro-economic and macro-economic level appears to confirm this effect. In addition, research has been successful in identifying the existence of a critical mass, indicating that there are increasing economic returns of broadband penetration, at least up to a saturation point. On the other hand, consistent with the research at the ICT level, the economic impact of broadband could be mediated by a lag effect, indicating that adoption of broadband does not automatically translate into growth but that it requires the accumulation of intangible capital. Intangible capital refers to the changes in business processes and firm culture that lead to the assimilation of improved business processes.

Thirdly, broadband does contribute to employment growth, both as a result of network construction programs and spill-over effects on the rest of the economy. While the deployment programs are, as expected, concentrated in the construction and telecommunications sectors, the impact of externalities are greater in sectors with high transaction costs (e.g., financial services, education, and health care).

Finally, beyond economic growth and job creation, broadband has a positive effect on consumer surplus in terms of benefits to the end user that are not captured in the GDP statistics. These benefits include efficient access to information, savings in transportation, and benefits in health and entertainment; these benefits can be measured in terms of the difference between consumers' willingness to pay for the broadband service and actual prices.

In addition, the review of the literature confirms the existence of multiple methodological approaches aimed at measuring the impact of broadband. Input-output analysis has proven to be highly reliable tool to estimate the counter-cyclical impact of broadband construction programs. Econometric analysis, while limited by data availability, has been proven effective in identifying the spill-over effects of broadband on the rest of the economy. These results have been confirmed by micro-economic research that has studied the impact of broadband on fostering efficiencies and value added opportunities at the firm level.

As this review indicates, most of the research so far has been conducted in developed nations, specifically, either the United States or Western Europe. The challenge going forward is to test for similar effects in developing countries, where data availability remains an even larger challenge. It appears to be particularly difficult to find data for African countries. For example, in seeking information to conduct the quantitative case studies presented below, this author encountered many obstacles to identifying adequate datasets for nations in Africa.

1.3 Economic Impact of Broadband in Developed Countries: Case Studies

The following section sets out the results of research conducted by the author in developed countries, aimed at measuring the impact of broadband on GDP growth and job creation. It includes the following case studies:

- United States: employment creation triggered by the Broadband Technology Opportunity Program;[33] and
- Germany: impact of the National Broadband Plan on economic growth and job creation.[34]

The following methodologies were used in the above two cases:

- Input/output analysis, as utilized by researchers at the Brookings Institution and the London School of Economics for similar studies, was applied for estimating the impact of broadband construction (in the United States and Germany) on employment and GDP;
- Micro-economic estimates, as utilized in the study mandated by European Commission, were used to estimate the contribution to employment resulting from broadband externalities in the United States case; and
- Econometric modeling, as utilized in several studies (including studies conducted by authors affiliated with the World Bank, the Brookings Institution, and MIT), was applied to estimate the impact of broadband externalities on GDP and employment in Germany.

1.3.1 United States: employment creation as a result of the economic stimulus program

In the last few years, spurred by the economic crisis, many governments around the world have implemented programs aimed at deploying broadband in order to stimulate employment (see Table 1.5).

Table 1.5: Counter-cyclical government programs

Country	Broadband Focus
United States	Launched the USD 7.2 billion Broadband Stimulus program focused on providing service to unserved and underserved areas
Australia	Government plans to spend A$11 billion of total A$43 billion required for construction of the National Broadband Network
Germany	Government has announced a National Broadband Strategy with the objective of having nationwide broadband access (1 Mbit/s) no later than the end of 2010 and provide 75 percent of German households access to a broadband connection of at least 50 Mbit/s by 2014 (estimated investment: EUR 36 billion)
Sweden	In order to promote broadband, government provides financial incentives to municipalities to fund two-thirds (2/3) of total Next Generation Network (NGN) investment (EUR 864 million)
Portugal	Government announced an EUR 800 million credit line for the roll-out of a Next Generation Access Network (NGAN); this is part of the first step in a EUR 2.18 billion plan to boost the country's economy
Ireland	The government will invest EUR 322 million in a National Broadband Scheme aimed at completing country coverage
Canada	Has relied on four programs to promote broadband development resulting in an overall investment of C$300 million
Finland	Government funds one-third of the NGN project cost (USD 130.73 million)
New Zealand	Government funds US 1.03 billion investment to boost fibre over the next five years

Source: Author

In 2009, this author attempted to estimate the jobs that could be generated as a result of the grants to be disbursed pursuant to the broadband provisions of the *American Recovery and Reinvestment Act*, enacted by Congress in February 2009. The study differentiated between jobs generated through capital spending in the form of grants allocated to unserved/underserved areas and employment created as a result of network externalities caused once the infrastructure was deployed.

The study found that approximately 127,800 jobs could be created over a four year period from network construction. According to the analysis, the investment of USD 6.390 billion[35] will generate 37,300 direct jobs over the course of the stimulus program (estimated to be four years). In addition, based on a Type I employment multiplier of 1.83, the bill could generate 31,000 indirect jobs, and based on a Type II multiplier of 3.42, the policy could generate additional 59,500 induced[36] jobs.[37]

In addition to network construction, the investment in broadband would trigger new jobs as a result of spill-over effects on the rest of the economy. The calculation of spill-over effects was performed by selecting those states in the US where the percentage of residential households which have access to at least one broadband supplier (that is to say, primarily telco or cable) is 93 per cent or less.[38] There are eighteen states that significantly lag behind the national average broadband penetration rate: while broadband in those states has been adopted by 47 per cent of households (or 21 per cent of the population), the US average is 62 per cent (or 25 per cent of the population). The assumption used to estimate the network effects of the stimulus program on employment was that the program would deploy enough lines to allow these eighteen states to reach the national average, meaning that 3,928,000 broadband subscribers would be added to the existing base.[39]

Network effect-driven job gains in the targeted regions result from three combined trends: innovation and the creation of new services, attraction of jobs (from either other US regions or overseas), and productivity enhancement.The impact of innovation on the professional services sector was estimated by applying the ratio of productivity gains to the creation of new employment.[40] Then this effect is applied to the economy of the targeted states as a whole. The impact of broadband on outsourcing operates in two directions: broadband can facilitate the attraction of new jobs and it can enable the relocation of others to regions other than the one being targeted. As a result of the uncertainty regarding the number of jobs that will be gained or lost, three scenarios were estimated: a pessimistic, a baseline and an optimistic scenario. In addition, increased adoption of broadband has an impact on productivity because it is an enabler of more efficient business processes. To calculate the productivity impact, the methodology derived by Fornefeld et al. (2008), which is based on empirical firm-level study of sectoral productivity improvements resulting from adopting online services, was applied. The jobs that could be lost as a result of broadband diffusion was calculated by differentiating the productivity impact in manufacturing, professional and information services and the rest of the service sector, and applying these ratios to sectoral employment.[41]

The compilation of all employment effects calculated through the above analysis results in the following estimates:

These estimates point to the following conclusions. The deployment of broadband resulting from the stimulus program has moderate direct employment effects (37,300 jobs over a four year period). Indirect and induced multipliers are important, generating a total of 127,800 jobs over four years. A mid-range estimate of the effect of externalities on employment results in 136,000 jobs. In sum, a USD 6.3 billion investment in broadband network deployment results in 263,800 jobs over the four years of the deployment program.

1.3.2 Germany: The impact of the National Broadband Plan on employment and economic growth

This case study quantifies the macroeconomic impact of investment in broadband technology on employment. It also quantifies the output of two sequential investment scenarios: first, the "National Broadband Strategy" announced by the German government in 2009 and second, an "ultra-broadband" scenario planned for 2015-2020. The National Broadband Strategy aims to provide 75 per cent of German households with access to a broadband connection of at least 50 Mbit/s by 2014. The ultra-broadband plan aims to provide 50 per cent of households with at least 100 Mbit/s and another 30 per cent with 50 Mbit/s by 2020.

Table 1.6: United States: Total Employment Impact of the Broadband Stimulus Plan

	2009	2010	2011	2012	Total
Direct effects	9,325	9,325	9,325	9,325	37,300
Indirect effects	7,750	7,750	7,750	7,750	31,000
Induced effects	14,875	14,875	14,875	14,875	59,500
Network effects (optimistic)	87,000	74,000	62,000	50,000	273,000
Network effects (mid-estimate)	46,000	37,500	30,000	22,500	136,000
Network effects(pessimistic)	5,000	1,000	(2,000)	(5,000)	(1,000)
Total (optimistic)	118,950	105,950	93,950	81,950	400,800
Total (mid-estimate)	77,950	69,450	61,950	54,450	263,800
Total (pessimistic)	36,950	32,950	29,950	26,950	126,800

Source: Adapted from Katz et al. (2009a)

It is estimated that fulfilling the 2014 objectives of the National Broadband Strategy will generate 304,000 jobs over five years (between 2010 and 2014).[42] In terms of direct employment related to the construction of broadband networks, 158,000 jobs will be created in equipment manufacturing, construction, and telecommunications. It is estimated that job creation will be apportioned among the sectors as follows: construction will benefit the most with 125,000 jobs, followed by telecommunications (28,400) and electronics equipment manufacturing (4,700).

Total indirect jobs generated by sector interrelationships will be an estimated 71,000. The key sectors that will benefit from the indirect effects of broadband network construction are distribution (10,700), other services (17,000), and metal products (3,200). Finally, household spending generated directly and indirectly, will result in 75,000 induced jobs. Based on these estimates, the Type I multiplier for employment is 1.45 and Type II is 1.92. Additionally, the implementation of the expected ultra-broadband evolution will generate 237,000 incremental jobs between 2015 and 2020. This figure can be broken down in a manner similar to the figure from the National Broadband Strategy: it comprises 123,000 in direct jobs, 55,000 indirect jobs and 59,000 in induced jobs. As expected, multipliers will be similar: the Type I multiplier for employment is 1.45 and Type II is 1.93.

In addition to estimating employment effects, industrial output and the impact on GDP were also calculated. The investment required to meet the targets of the 2014 National Broadband Strategy (EUR 20.243 billion) will generate additional production totaling EUR 52,324 million. This means that for each Euro invested in broadband deployment, 2.58 Euros will be generated in output. Of this, EUR 4,146 million (8 per cent of total output) will be based on imported goods. This indicates a relatively low level of output "leakage" to other national economies. Of the remaining production, EUR 18,733 million will be additional GDP (+0.15 per cent). Again, each Euro invested in broadband deployment will trigger 0.93 Euros in additional value added or incremental GDP.

To sum up, the incremental GDP growth achieved by investing in broadband deployment will amount to EUR 33,364 million, which represents +0.12 per cent of the German GDP. This amount does not include the additional impact that will be achieved once the network construction is completed.

The author also found that the network externalities of broadband (that is to say, the positive effects in employment and economic output resulting from enhanced productivity, innovation and value chain decomposition) are significant throughout Germany. The analysis of these effects examined the relationship between broadband penetration and economic growth and job creation. It found that the impact of broadband on economic stimulus is highest in the first year after deployment and tends to diminish over time.

Results of the regression analysis for national time series between 2000 and 2006 indicate with high significance levels that there is a strong impact of broadband penetration on GDP growth, which tends to diminish over time. On the other hand, results from the analysis of the impact of broadband penetration on employment creation carry a low level of significance. Therefore, they do not allow us to indicate the existence of causality with certainty.

In addition, the analysis tested whether the network effects of broadband varies by region, depending on the level of broadband penetration. The analysis split the national territory into two groups: counties with a 2008 average broadband penetration rate of 31 per cent of the population and counties with an average broadband penetration rate of 24.8 per cent. The analysis of the network effects in these two groups indicates that the type of network effects of broadband varies by region. In counties with high levels of broadband penetration, the short-term impact of the technology is very high both on GDP and employment, but it declines over time. This "supply shock" is believed to occur because the economy can immediately utilize the newly deployed technology. Furthermore, the fact that employment and GDP grow in parallel indicates that broadband has a significant impact on innovation and business growth, thereby overcoming any employment reduction resulting from productivity effects.

On the other hand, in counties with low broadband penetration, the impact of broadband penetration on GDP is lower than in highly-penetrated areas in the short term, but "catches up" to comparable levels over time. The impact of broadband on employment is slightly negative in the initial years. This indicates that the impact of broadband in areas with low levels of broadband penetration is more complex than in the areas with high penetration rates. It takes longer for areas with low penetration rates to realize economic growth from an increase in broadband penetration because the economies in these areas require more time to develop and to fully utilize the technology. However, after three years, the impact of broadband in areas with low penetration rates is as high as the impact of broadband in the more developed areas. Negative employment growth during the initial stages of broadband deployment appears to indicate that gains in productivity resulting from the introduction of new technology are the most important network effect at the outset. However, once the economy develops, the other network effects (innovation and value chain recomposition) start to play a more important role, resulting in job creation.[43] Therefore broadband deployment in areas with low penetration rates will likely generate high stable economic growth (the "catch up" effect), combined capital/labour substitution which initially limits employment growth (the "productivity" effect). Figure 1.3 presents in conceptual fashion a comparison of the impact of broadband in both regions.

These differentiated effects were used to estimate the impact of the broadband plan on economic growth and employment. It was stipulated by the author that, as a result of the National Broadband Strategy, broadband penetration in advanced areas will increase from 31 per cent in 2008 to 45.9 per cent in 2014, while in low penetration areas, the rate of broadband penetration will increase from 24.8 per cent to 37.4 per cent. This trend is largely driven by the coverage of "white spots" and an improvement of service in "grey spots".[44] Together, these improvements amount to an incremental increase in penetration of approximately 25 per cent in both regions between 2008 and 2011.[45]

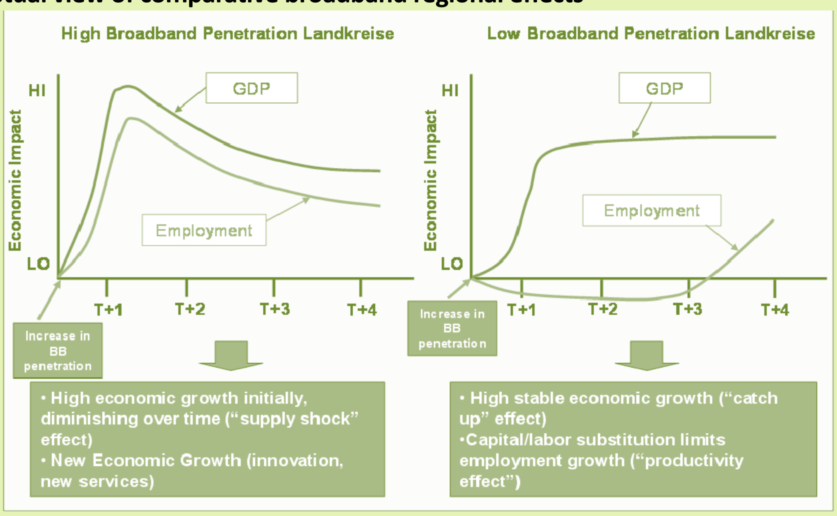
Following the same methodology, it is estimated that 162,000 jobs will be created. Areas with higher levels of broadband penetration are expected to gain 132,000 jobs, while areas with low penetration rates are expected to gain 30,000 jobs.[46] The differentials across regions are driven by the divergent effects of increased broadband penetration discussed above.

As discussed throughout the review of the study projections, the estimates were generated for several years and are dependent on stages of network deployment. For example, the projected creation of 541,000 jobs due to network construction does not occur all in one year but over a ten year period. Table 1.7 displays the yearly impact over time.

The net employment effects over two time periods were calculated using these figures. Between 2010 and 2014, 407,000 jobs will be created, while between 2015 and 2020, the number of jobs created will be 561,000 jobs.[47]

To sum up, the National Broadband Strategy and the expected evolution to ultra-broadband through 2020 will have a significant impact on jobs and the GDP of the German economy. It is estimated that a total investment of nearly EUR 36 billion will generate a total of 968,000 incremental jobs. Network construction will yield 541,000 jobs. An additional 427,000 jobs will be created after the network is deployed due to enhanced innovation and new business creation. From an incremental economic growth standpoint, network construction will yield additional value-added of EUR 33.4 billion, while network externalities will result in an additional EUR 137.5 billion.

Figure 1.3: Conceptual view of comparative broadband regional effects[48]



Source: Adapted from Katz et al. (2010a)

Table 1.7: Germany: Employment and Economic Impact per annum

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
EMPLOYMENT (in thousands)													
Network Construction	National Strategy	60.8	60.8	60.8	60.8	60.8							304.0
	Ultra Broadband						39.5	39.5	39.5	39.5	39.5	39.5	237.0
	Total	60.8	60.8	60.8	60.8	60.8	39.5	39.5	39.5	39.5	39.5	39.5	541.0
Network externalities				24.0*	35.0*	44.0*	54.0	54.0	54.0	54.0	54.0	54.0	427.0
Total		60.8	60.8	84.8	95.8	104.8	93.5	93.5	93.5	93.5	93.5	93.5	968.0
GROSS DOMESTIC PRODUCT (in Billion Euros)													
Network Construction	National Strategy	3.8	3.8	3.8	3.8	3.8							18.8
	Ultra Broadband						2.4	2.4	2.4	2.4	2.4	2.4	14.6
	Total	3.8	3.8	3.8	3.8	3.8	2.4	2.4	2.4	2.4	2.4	2.4	33.4
Network externalities				13.9*	14.5*	14.9*	15.7	15.7	15.7	15.7	15.7	15.7	137.5
Total		3.8	3.8	17.7	18.3	18.7	18.1	18.1	18.1	18.1	18.1	18.1	170.9

** Some overlapping of effects assumed*

Source: Adapted from Katz et al. (2010a)

1.4 Economic Impact in Developing Countries: Case Studies

This section summarizes research conducted by the author primarily at the aggregate macro-economic level. It aims to substantiate the existence of an economic impact of broadband on GDP growth and job creation in developing countries. It includes the following case studies:

- Latin America and the Caribbean: contribution of broadband to GDP growth;
- Brazil: the impact of broadband on employment and economic growth;[49]
- Chile: the impact of broadband on employment and economic growth;[50]
- India: the impact of broadband on employment and economic growth;
- Malaysia: the impact of broadband on economic growth; and
- Saudi Arabia: the impact of broadband on employment.

In all of these case studies, the analysis was conducted using econometric modeling similar to the one utilized for the studies conducted by researchers affiliated with the World Bank, MIT, and the Brookings Institution. In applying this approach in developing countries, the study was confronted with major methodological problems due to the lack of sufficiently large time series and sample sizes and sufficiently disaggregated indicators. First, the lack of availability of sufficiently large sample sizes for the selected cases impacts the robustness of the estimates. In the case of developed countries, for example, Katz et al. (2010a) were able to rely on over 424 observations regarding economic, control and broadband variables for German counties. The availability of this many observations is rare in the case in the developing world. Accordingly, the results presented in this section must be prefaced with a word of caution. Sample sizes lower than 30 observations limit the robustness of estimates. In only three of the nine models presented below (economic growth for Latin America and economic growth and employment creation models for Chile), the number of observations exceeded this threshold.

Secondly, the lack of a sufficiently large time series prevents the construction of models based on simultaneous equations, such as the one developed by Koutroumpis (2009). As a result, it is difficult to control for endogeneity. The only approach that could be reliably used for this issue was a cross-lagged regression. The authors recognize that this methodology has some limitations regarding endogeneity control.

Thirdly, in light of the fact that the contribution of broadband to GDP growth increases with penetration, it is important to note that the economic effects of broadband in developing countries could be quite limited, given the low levels of broadband adoption in these countries prior to 2008.[51]

1.4.1 Latin America: contribution to the Continent economic growth

In a prior paper, this author presented a simple regression model linking Latin American broadband penetration and economic development.[52] In that case, this author attempted to advance the research by developing a multi-variate equation based on the endogenous growth model[53]. This model has been used by several authors to assess the impact of broadband and other telecommunications technologies on a country's economic growth.[54]

According to the model results[55], an increment of 1 per cent in the penetration rate of broadband services could impact the GDP growth of the region by 0.0158 per cent.[56] This estimate was used to calculate the contribution of broadband to the growth of GDP in Latin America and the Caribbean. Based on IMF projections, the economic growth in the region between 2009 and 2010 will be 3.4 per cent, resulting in an aggregate GDP of US 3,925 billion. The model specified above indicates that the elasticity of broadband with regard to GDP growth is 0.0158 per cent.[57] In light of the possibility of sample bias and given the lack of time series, it is advisable to define a reasonable elasticity range. The author believes that an appropriate choice would range from the estimate derived in this study to that derived by Koutroumpis (2009) for countries with broadband penetration lower than 20 per cent: 0.008 per cent. Thus, by relying on both estimates and considering the growth of broadband in the region (37 per cent per annum), we can conclude that the technology contributed between USD 6.7 billion to USD 14.3 billion. This economic impact includes direct effects from the telecommunications industry and indirect spill-overs.

1.4.2 Brazil: the impact of broadband on economic growth and employment

To estimate the economic impact of broadband in Brazil, an attempt was made to replicate the analysis conducted at the country level for Germany in the context of a developing country. However, the lack of disaggregated data prevented the specification of a model with robust estimates. As a result, the model built to estimate the impact of broadband on Brazilian GDP growth relied on a database for the 27 states of Brazil.[58]

The coefficient for broadband penetration rate of change is not statistically significant, which demonstrates that its impact is not uniform across all Brazilian states. However, the author believes the estimation is valid because it is consistent with the results of similar studies (e.g. Koutroumpis, 2009). Thus, while recognizing the model's limitations, it is expected that in Brazil, when controlling for education level and departing point of economic development, an increase of 1 per cent in the rate of broadband penetration could contribute 0.008 percentage points to GDP growth.

In addition to estimating the impact of broadband on GDP growth, this author also studied the impact of broadband on Brazilian employment. In this case, a cross-sectional sample similar to that one utilized by Katz et al. (2010a) for Germany was constructed, where the dependent variable was the rate of change of unemployment. According to the model results, a change of 10 per cent in the broadband penetration rate could reduce the unemployment rate by 0.06 percentage points. It is estimated that Brazilian unemployment in 2009 was 7.7 per cent, and that by 2010, it would fall to 7.4 per cent[59], which would imply a reduction of 3.89 per cent. According to these estimates, if broadband penetration were to grow by 20 per cent, the impact on the rate of change of unemployment would be a further 0.138 per cent. Thus we would expect a rate of decrease of unemployment from the original 3.89 per cent to 4.03 per cent.

1.4.3 Chile: the impact of broadband on employment and economic growth

The availability of an extensive database of quarterly data for Chile allowed the development of a panel of time series data for each of Chile's administrative regions from 2001 until the fourth quarter of 2009. A model including level of economic activity and broadband penetration was specified.[60] In addition, an alternative model was proposed which aimed to study the possible effects of human capital and specialization on the level of employment. According to the methodology used, other specific characteristics of each region that could have an impact on the labour market are controlled by the fixed effects of the panel data.

The economic activity variable remained unaltered between the two specifications; in both cases, it was significant and positive. The coefficient of broadband penetration is significant[61] and positive in both specifications. The small variation between the two specifications suggests that the contribution of 1 percentage point in broadband penetration would contribute nearly 0.18 percentage points to the employment rate. Today, the Chilean workforce comprises 6,500,000 individuals, which translates to a 93 per cent employment rate. It is estimated that broadband deployment, which reached a penetration rate of 9.78 per cent, contributed 1.76 percentage points to the employment rate; this amounts to the creation of 114,426 direct and indirect jobs.

In addition to estimating the impact of broadband on job creation in Chile, this author estimated its contribution to the country's GDP growth. Broadband penetration was found to be statistically significant and with the expected sign in terms of contributing to GDP growth in Chile. Accordingly, a 10 per cent increase in broadband penetration would result in an increase of 0.09 percentage points in regional GDP.

1.4.4 India: the impact of broadband on employment and economic growth

In the case of India, a data availability problem similar to the one encountered for Brazil was identified. Therefore, the analysis had to be conducted at an aggregate level, which impacted the robustness of estimates. In order to estimate the impact of broadband on Indian employment, a database containing information for India's 20 circles was compiled.[62] According to the model, an increase in 1 percentage point in broadband penetration results in 0.028 percentage points increase in the employment rate.

Broadband’s contribution to India’s GDP growth was also estimated. For this purpose, a dataset for India's 20 circles was built. Broadband penetration was found to be statistically significant and exhibited the expected positive sign. According to the coefficient of broadband penetration, a 10 per cent increase in penetration would result in an increase of 0.3128 percentage points in regional GDP.

The results of this model should be carefully interpreted because of the potential bias. It is possible that the causal casual relationship between the dependent variable (GDP growth 2007-2008) and the independent variable, (broadband penetration growth 2007-2008)[63] runs in both directions, which would yield biased and inconsistent estimates of the structural parameters. This endogeneity problem seems to cause a strong upwards bias, producing a high coefficient in comparison to those of other studies and prior models.

In conclusion, while the econometric models of the impact of broadband on Indian employment have yielded strong estimations, the one focused on understanding the contribution of the technology to GDP growth has to be discarded until better data sets are available.

1.4.5 Malaysia: the contribution of broadband to economic growth

This case study estimates the contribution of broadband to GDP growth in Malaysia.[64] The independent variable, growth in broadband penetration per household, has a statistically significant coefficient with the expected positive sign. It indicates that an increase of 10 per cent in broadband penetration would contribute 0.7 percentage points to regional GDP growth. This result has to be put in the context of an economy in which the service sector contributes more than 55 per cent to the GDP. It should be noted that this estimation, based on penetration per household, is lower than the 1.78 per cent contribution to GDP growth per 10 per cent of broadband penetration per household estimated for Malaysia by McKinsey and Co Inc (2009).[65]

1.4.6 Saudi Arabia: the impact of broadband on employment

To estimate the impact of broadband on Saudi employment, a database containing information for its thirteen provinces was compiled.[66] The control variables (the amount of institutions authorized to provide health services and percentage of households with public provisioning of potable water) had statistically significant coefficients with positive signs.

The independent variables (the change in broadband penetration, change in the number of domestic tourism trips, change in the number of projects publicly funded, and change in the value of publicly funded projects) had a negative impact on the level of unemployment. We found that a 10 per cent increase in broadband penetration decreases the change in the unemployment rate by 2.4 percentage points. This coefficient seems high in comparison to those found in studies for other countries and it should be noted that because of lack of reliable data, a human capital variable could not be included. Thus the effect of the broadband variable could be capturing the effect of the missing human capital variable.

1.5 Analysis of Case Study Results

The results of the above analyses validate the positive contribution of broadband to GDP growth for developing countries and regions. While limited in the number of countries studied, these analyses safely confirm that broadband has a directionally positive economic impact. While it is not optimal to compare model results across geographic units, the following conclusions can be drawn. All studies, with the exception of Brazil, yielded statistically significant coefficients. However, due to data limitations, some of the country cases are based on a low number of observations which may jeopardize the consistency of estimators. However, Koutroumpis (2009), Katz et al. (2010a), the cross-sectional Latin American model and the Chilean models exhibit higher levels of reliability.

The results of the analyses also validate the positive contribution of broadband on employment creation for less developed countries and regions. In this case, all prior research, as well as the results of this study, indicates that broadband has a positive impact on job creation. In particular, the German study and the Chilean case, which are based on extensive datasets, yield statistically significant positive coefficients. The other cases (India, Brazil, and Saudi Arabia) have also yielded statistically significant coefficients for the explanatory variable (broadband penetration) with sensible signs – positive when the independent variable is employment and negative when it is unemployment.

1.6 Estimation of Broadband Gaps and Investment Requirement

The previous section provided an assessment of the economic returns, both in terms of growth and employment creation, of broadband deployment. It is obvious that the construction of the infrastructure comes at a cost, which needs to be calculated. Policy makers have taken three approaches to the issue of investment costs calculation. The first is the conventional engineering approach, which is based on estimating the coverage requirements, and then using those estimates to project the necessary investment to fulfill them. This is the methodology followed for the investment estimation of Australia's National Broadband Plan. The second approach, labeled "top-down", begins by first determining the amount of financial resources to be invested and then sizing the amount of coverage that will be achieved given those resources. To some degree, this is the approach that has been followed in the United States with the Broadband Technology Opportunity Program. Since this Program was part of the stimulus package passed by the US Congress, specific plans for the construction of broadband networks were not specified in the relevant legislation. Instead, the funds available for broadband deployment are assigned through grants, with the specific construction plans defined as the grants are given out. The third approach does not estimate an investment amount. Labeled the "public policy" framework, it defines targets, (such as coverage and speeds), but leaves the amount of investment required unaddressed. This is the approach adopted in Germany's and Brazil's National Broadband Plan and, to some degree, in the United States.

1.6.1 The National Broadband Plan in Germany

According to estimates based on publicly available data published in the German National Broadband Strategy, of all 39.7 million German households[67], 39 million – approximately 98 per cent of all households – have access to some type of broadband technology. Of these households, 36.7 million have DSL capability, 22.0 million are passed by cable TV networks (and therefore are potentially connected via a cable modem), and 730,000 can access the Internet via fixed wireless or satellite technology. Furthermore, it is estimated that 10.9 million households are able to connect to the Internet via VDSL, while only 240,000 household connections could be based on FTTH. These estimates are based on announcements of fibre optics technology being deployed by telecommunications operators and municipal networks.

In addition to improving coverage, Germany plans to increase the access speed of residential broadband users. As of 2009, the National Broadband Strategy reports that 98 percent of all German households have access to broadband Internet with transmission rates at a minimum of 384 Kbps, and 92 percent of households are served by lines with speeds of at least 1 Mbit/s. About 2.8 million households are in “grey spots”, meaning that they have broadband access of between 384 Kbps and 1 Mbit/s. The remaining "white spots", which comprise 730,000 households, or two percent of all German households, are located in areas with low population densities or near the outer boundaries of already connected areas.

The Federal Government of Germany has agreed on the following two broadband strategy targets:

- Nationwide capable broadband access (1 Mbit/s) no later than the end of 2010, and

- The provision of access to a broadband connection of at least 50 Mbit/s to 75 per cent of German households by 2014, specifically with the goal that such access lines should be available as soon as possible throughout the country.[68]

There are four deployment actions required to meet these targets. First, the 730,000 unserved households (white spots) will be covered by a mix of wireless and wireline technology. The second action will be to upgrade the 2.8 million "grey spot" households to broadband access of at least 1 Mbit/s. The third target of the National Broadband Strategy is that 75 percent of households will have broadband access of at least 50 Mbit/s by 2014, with higher bandwidths to follow. This objective is structured in two stages:

- Upgrade to FTTH: Given that VDSL technology deployed in dense cities is limited to 50 Mbit/s, it is assumed that 9.92 million households (representing 25 percent of the total number of German households) will be upgraded to FTTH. Since the current number of households served by VDSL is 10.9 million and given that these households are located in the major 50 German cities, it is assumed that the majority of them will be migrating from VDSL to FTTH.
- Upgrade to VDSL: It is assumed that the remaining 50 percent of households will be upgraded from DSL to VDSL.

Longer term "ultra-broadband" aspirations, as mentioned in other government reports[69], foresee the completion of a national ultra-broadband network infrastructure by 2020. While this aim has not been defined in terms of clear policy objectives in the National Broadband Strategy, one can assume a set of "aspirational" targets for 2020:

- Deploy FTTH to 50 percent of households;
- Deploy VDSL to the next 30 percent of households; and
- Offer broadband services under 50 Mbit/s to the remaining 20 per cent of the population.

The action required to meet these targets is to upgrade an additional 25 percent of households to FTTH, which, when added to the 25 percent upgraded by 2014, reaches a total 50 percent.

The calculation of total investment required to meet these targets has been conducted for each objective by relying on costs per line. The combined wireline and wireless costs required to cover the unserved households will total EUR 924 million, which is broken down in Table 1.8.

The calculation of VDSL and FTTH deployment relies on cost per line data gathered from a number of sources.[70] The cost calculation relies on figures that assume increasing cost per household as deployment of the technology network increases.[71] Based on these figures and the number of lines to be deployed, the investment required to meet the FTTH target is EUR 12,236 million, and the investment required to meet the VDSL target is EUR 6,747 million. The total investment required to fulfill the 2014 National Broadband Strategy will be EUR 20,243 million. (See Table 1.9.)

As a result, the incremental investment required to meet the FTTH target of 50 percent households served by 2020 will be EUR 15,690 million.[72]

Table 1.8: Investment required to cover unserved households

Technology	Number of households	Cost per line EUR	Total Investment (EUR in millions)
DSL	250,000	1,200	300
Wireless	480,000	1,300	624
Total	730,000		924

Source: Katz et al. (2010a)

Table 1.9: Total Investment required to achieve objectives for 2014	
Target	**Amount (EUR in millions)**
Address the unserved "white spots"	924
Upgrade the "grey spots"	336
Deploy FTTH to 25% of households	12,236
Deploy VDSL to 50% of households	6,747
Total	20,243
Source: Katz et al. (2010a)	

1.6.2 The National Broadband Plan in Brazil

Broadband infrastructure in Brazil is still underdeveloped. There are 11,489,000 broadband lines in the country, which represent 7.1 per cent penetration per person or 18.88 per cent per household[73]. Broadband deployment is uneven, ranging from 52 per cent of households in states like the Federal District to 0.30 per cent of households in Roraima. In addition, service download speeds exhibit significant shortfalls (see Table 1.10).

While no public information is available regarding broadband coverage (e.g. households being passed by broadband infrastructure), it is assumed that the demand gap amounts to 20 per cent. This means that in addition to the population that currently subscribes to broadband, an additional 20 per cent of households can purchase service but do not due to economic, educational or device accessibility reasons. Pursuant to this assumption and considering the 40 per cent growth in broadband that has taken place since 2008, the last year that household penetration data were collected, we estimate that broadband coverage amounts to approximately 49 per cent of households.

Brazil's National Broadband Plan does not define coverage targets. For the purposes of this estimate, it is stipulated that the country will achieve universal access of 1 Mbit/s. With this in mind, it is necessary to estimate how many existing lines need to be upgraded to 1 Mbit/s and how many lines need to be deployed to achieve universal access. Assuming that current coverage is 49 per cent of households and that 57 per cent of total lines are under 1 Mbit/s, it is estimated that 16,260,000 lines would need to be upgraded. In addition, assuming that coverage reaches 49 per cent of households, the supply gap would amount to 26,469,000 households. In sum, the fulfillment of the stipulated target will require upgrading 16,260,000 lines and deploying 29,470,000 additional lines.

The calculation of the total investment required has been conducted for each program (upgrades and deployment of new lines) by relying on costs per line. It is estimated that the cost per upgraded line is USD 300, while the cost to deploy a new broadband line would average USD 450.[74] As such, the combined wireline and wireless costs required to cover the unserved households are summarized in Table 1.11.

Table 1.10: Brazil: Breakdown of download speeds (2009)	
Speed	**Percent of lines**
128 kbps-255 kbps	9.5 %
256 kbps – 511 kbps	21.2 %
512 kbps – 0.99 kbps	26.6 %
1 Mbit/s – 1.99 Mbit/s	24.3 %
> 2 Mbit/s	18.5 %
Source: Cisco/IDC (2010)	

Table 1.11: Investment required to fulfill targets

Program	Number of house-holds	Cost per line USD	Total Investment (USD)
Upgrade	16,290,000	USD 300	4,887,000,000
New deployment	29,470,000	USD 450	13,261,500,000
Total			18,148,500,000

Source: Author

As a result, in order to achieve universal access to broadband and to upgrade lines providing speeds of under 1 Mbit/s to lines providing speeds of 1 Mbit/s, Brazil will require an investment of USD 18 billion.

1.6.3 Conclusion

This section presented a methodology for estimating investment requirements to meet deployment targets as stipulated in national broadband programs. By applying the methodology to the German and Brazilian cases, it was possible to gauge the significant funding requirements of these plans. Assuming that a large portion of that investment will come from the private sector, it is pertinent to explore the policy frameworks that will be relied upon to stimulate the funding of future deployment.

1.7 The Role of Public Policy and Regulation in Boosting the Development of Broadband

We turn now to a consideration of the policy tools necessary to promote broadband deployment and adoption in order to realize broadband's potential to contribute to economic growth and the creation of jobs. The policy tools required to stimulate the deployment of broadband range from the formulation of national broadband plans to the enactment of competition policies and the identification of cases where the government should intervene in order to address specific market failures. In addition to supply-oriented policies, additional measures need to be enacted to promote adoption of broadband by certain social groups and firms that may not be naturally inclined to adopt the technology. This section is based on a review of best practices in countries that have succeeded in reaching a high level of performance in the development of their broadband sector. In particular, best practices in the broadband policy domain will be reviewed for certain European countries (Germany, Sweden, Netherlands), Asia (Republic of Korea, Japan, Singapore), and Latin America (Chile and Brazil).

1.7.1 National broadband planning as a tool

In recent years, several countries in the developed and developing worlds have formulated national broadband plans; these plans outline both coverage and service targets, as well as policies, with the purpose of achieving near or complete universal broadband service. National broadband plans touch upon four broad policy areas:

- **The assignment of government assets necessary to reach universal broadband service coverage**: the primary focus in this policy area is spectrum allocation. As indicated in the previous section, wireless broadband is the primary platform for reaching unserved and underserved geographic regions in developed countries (also called "white" and "grey" zones). It is also widely recognized that wireless broadband will be the primary technology used to provide ample broadband coverage in developing countries. By definition, wireless requires wide spectrum bands to be able to provide broadband access at adequate quality levels, which is primarily an issue of download speeds. In this sense, national broadband plans tend to focus, in many cases, on policies aimed at reassigning frequency bands (in particular, allocating the "digital dividend" spectrum resulting from the digitalization of broadcasting) or searching for "white spaces" (unutilized bands) and assigning them to the wireless mobile communications sector.
- **Investment in promotion of adoption programs:** primarily oriented at addressing demand gaps, these programs focus on: universal service policies; the stimulation of the adoption of broadband through digital literacy; economic subsidies; deployment of public access centres; and the devel-

opment of eGovernment applications in order to promote adoption of broadband.

- **Adoption of a competition policy:** based on the premise that competition among service suppliers is the right model to stimulate broadband supply, national broadband plans, either implicitly or explicitly, tend to define the most appropriate way to develop market competition in the supply of this service. This involves an endorsement of either facilities-based competition (also referred to as platform-based competition) between vertically-integrated players such as the telecommunications incumbent and the cable operator or service-based competition (through unbundling of the telecommunication network of the incumbent operator and the sharing of incumbent facilities). If competition between fixed broadband suppliers does not exist or is not feasible, policies could outline performance rules (e.g., rules related to coverage and quality of service) that must be followed by the monopoly provider.
- **Removal of any potential supply obstacles**: related to the aforementioned belief that that competition among service suppliers is the right model to stimulate broadband supply, national broadband plans focus on how to lower economic barriers to entry. Relevant policy initiatives could include infrastructure sharing policies, which can range from stipulating rules for duct, mast ,and tower sharing to lowering pole attachment costs (in aerial networks) to joint trenching rules. This policy area could even lead to potential investment by government to deploy national backbones aimed at lowering backhaul costs for broadband wireless players.

In addition to formulating policies in the four areas mentioned above, broadband plans tend to stipulate targets to be achieved in terms of deployment, adoption, and quality of service. It should be noted however, that there still is not complete agreement among countries about what the appropriate goals for broadband should be. (See Table 1.12.)

As Table 1.12 indicates, the primary area of consensus around national plans is the need to achieve universal (or near-full) penetration of broadband service, which implies the recognition of broadband as a public good requiring full adoption by the population. In this context, developing countries that are at a lower rate of broadband penetration than developed countries tend to define coverage targets that, while ambitious, shy away from full coverage. In terms of quality of service (as defined by download speeds), there does not seem to be full agreement across countries.

Table 1.12: Coverage and speed targets of selected National Broadband Plans

Country	Coverage Targets (as percent of households)	Speed Targets for Percent Households
United States	100 % (2012)	• 4 Mbit/s (100%) (2012) • 50 Mbit/s
Germany	100 % (2014)	• 1 Mbit/s (100%) (2014) • 50 Mbit/s (75%) (2014)
Singapore	100 % (2012)	• 100 Mbit/s (95%) (2012)
Australia	100 % (2012)	• 12 Mbit/s (100%) (2012)
United Kingdom	100 % (2012)	• 2 Mbit/s (100%) (2012)
Malaysia	75 % (2010)	• (33%) 50-100 Mbit/s • (42%) 1.5 Mbit/s
Brazil	50% of urban and 25% of rural households	• 75% (512-784 kbps)
European Union	100 % (2013)	• 30 Mbit/s (100%) (2020) • 100 Mbit/s (50%) (2020)

Sources: Author with reference to National Broadband Plans of specified countries

There is no shared conception among the plans about what the minimum acceptable download speed should be or what an appropriate "ultra-broadband" target is. Part of the reason why there is not full consensus on such targets is because the stipulation of such targets is, in many cases, based on political imperatives rather than substantiated on careful quantitative analysis of costs and social and economic returns. For example, national broadband plans rarely discuss the expected economic payoff of achieving universal broadband service or the relative benefits of deploying high speed access in certain regions of a given country. The need to ground the setting of targets on careful technological and economic analysis is particularly important since, as shown in the previous chapter, targets have a logical impact on investment requirements.

Despite the lack of agreement on targets and policy tools, national broadband plans represent an initiative that can have a high impact at multiple levels:

- They create awareness, both within civil society and government entities, about the economic and social importance of broadband service;
- The plans represent a way of building consensus and promoting coordination between all areas of government that may have an impact on deployment and utilization of broadband;
- National broadband plans have the potential to become state-level policies that transcend the political electoral cycles; and
- They help build accountability for plan fulfillment at the highest levels of government, particularly the executive branch.

Each of these four areas will be further discussed in sections 1.7.1.1, 1.7.1.2, 1.7.1.3, and 1.7.1.4, below.

1.7.1.1 Creating awareness at the highest national level

The national broadband plan represents a valuable policy tool for articulating a vision of why universal broadband service represents a critical societal challenge from an economic growth perspective. From a practical standpoint, the development of such a vision comprises four sequential steps. First, governments need to publicly reaffirm the collective imperative of deploying broadband as a means of supporting social and economic development goals. This requires defining a consensus around objectives and values that link technology adoption to economic and social development. Once this vision is developed, it is critical to build consensus between policy makers and civil society around the criticality of broadband usage. This should be part of a public debate among all parties that have an impact on deployment and assimilation of broadband technology. Using this shared vision as a foundation, the definition of targets based on rigorous analysis of investment and social and economic returns, as well as policy tools, should be formulated. The targets provide the context for the development of specific projects and programs. Using the integrated vision as an overarching target development goal, proactive, multi-year government planning represents the next step.

Some countries embody what can be considered best practices in the field of national ICT (and broadband) planning. In the Republic of Korea, for example, starting in 1995, the government began preparing and implementing five year plans with objectives ranging from broadband universalization to becoming a global IT leader. A significant feature of the Korean government-sponsored ICT planning process remains its holistic character.[75] ICT Master Plans are conceived as tools for facilitating the transition into an advanced information society. This implies that planning vectors include not only the deployment of broadband infrastructure but also address services, applications and demand promotion policies. This last point represents a critical point of departure from the broadband development plans in other developed countries. Planning efforts in other nations tend to have a heavy focus on broadband deployment and, while recognizing the positive spillovers that networks will have on other sectors, they leave promotional efforts in these related components of the broadband eco-system to market forces; this approach could be labeled as "build it and they will come". Contrary to this philosophy, Korean policy makers tend to use their planning tools (influenced by industrial policy considerations) to address all the components of the eco-system in an inter-connected fashion, generating incentives for broadband adoption in the areas of applications and services to follow through the build-up of broadband networks. Additionally, with support of a government research institute, the Korean Information Society Development Institute (KISDI), policy makers in this country were able to develop and refine a broadband technology strategy based on rigorous economic analysis.

A country with a sector-wide planning tradition similar to the Republic of Korea is Japan. The initial push for strategic planning in the broadband area started in 2001, when the government developed the first e-Japan Strategy. The strategic planning process enabled the formulation of annual priority policy programs focused on implementing of objectives such as the universalization of broadband. Similarly, in Sweden, the *Information Society for All* bill led to the development of the Broadband Support Program (2001-2007) which focused funding on deploying broadband in rural and isolated areas and building a national backbone. In 2007, the telecommunications regulator issued a broadband strategy with the objective of achieving universal service, and finally, in November 2009, the government released its National Broadband Strategy.

In Estonia, the first integrated effort to create an information society occurred in 1998, when the parliament adopted the Principles of Estonian Information Policy. This principles and objectives set out in this bill were further refined by the Principles of Estonian Information Policy 2004-2006, which was adopted in 2004, and the Estonian Information Society Strategy 2013*,* which was approved in 2006. The Estonian Information Society Strategy 2013 established the objective that by 2013, 75 per cent of Estonian residents will be able to access the Internet, while household broadband penetration will amount to 70 per cent.

As these examples, particularly that of the Republic of Korea, indicate, best practices in national broadband plan formulation include the articulation of a vision providing a context for the formulation of targets based on economic analysis; the integration of broadband goals with the fulfillment of objectives in other areas of the ICT eco-system (applications and services); and a follow-up and continuity built around the ongoing formulation of plans and programs.

1.7.1.2 Coordinating policies from different private and government entities

As indicated above, national broadband plans need to be complemented with detailed blueprints for their implementation. These roadmaps are helpful in generating the appropriate frameworks for introducing changes in the regulatory arena. In particular, the adoption of a clear blueprint guiding broadband development is critical in terms of defining the respective roles of the public and private sectors and the potential construction of public-private partnerships. As mentioned in the introduction of this study, the private sector is expected to assume primary responsibility for investing in the development of broadband. Along these lines, it is important to determine what the right policy mechanisms are for stimulating investment from the private sector. Additionally, it is important to determine what the role of the public sector will be in addressing potential market failures in achieving universal broadband deployment.

Most broadband plans address the models of private and public investments according to a segmentation of geographic areas. The model, popularized by the regulatory authority in the United Kingdom, Ofcom, in 2006, differentiates between "black" areas (where platform-based competition and good broadband service is expected), "gray" areas (where at least one service provider is expected to offer service although quality might not be consistent) and "white" areas (where service is not available). Based on this categorization, broadband national strategies, as adopted in countries such as the United Kingdom, Germany, Spain and Brazil, outline principles of private competition in “black” and some "gray" areas while stipulating that public-private partnerships and/or outright government investment will address the market failure in "white" zones. Numerous broadband plans have articulated the principle of geographic segmentation, ranging from the European Union State Aid guidelines to the National Broadband Plans in Brazil, Germany and the United States. The role of the government in broadband deployment will be addressed in detail below in section 1.7.3.

In addition to defining the respective public and private sector roles, national broadband plans can articulate the respective roles of specific government entities that may contribute either on the demand or supply side to meet broadband penetration targets. As such, national broadband plans serve to outline the government responsibilities in areas as diverse as Science & Technology (for deployment of broadband in support of research programs), Education (for promoting digital literacy), Health (to foster adoption of eHealth programs), and General Administration (to promote eGovernment applications). For example, the National Broadband Plan of the United States spells out that more and better targeted funding for research and development (R&D) can have an impact on broadband supply. As such, the plan considers making R&D tax credits permanent to stimulate development of ultra-broadband technologies. At the same time, it proposes coordinating the creation of development test-beds with the National Science Foundation and the Department of Defense.

1.7.1.3 Developing state policies that go beyond electoral cycles:

In addition to plan formulation and program development, a related best practice in the area of national broadband planning has to do with continuity and discipline in follow-up. Broadband plans may be more effective when not subject to political imperatives or the need to address an infrastructure-based counter-cyclical policy at times of economic crisis. If endorsed by policy-makers as a primary component of the vision of the country's future, national broadband plans should become a permanent and ongoing fixture of economic development.

Several countries have reached this level of performance in broadband planning. In Chile, for example, the government is undertaking its third iteration of an updated Digital Agenda; each version of the Digital Agenda comprises an evaluation of results of past measures and the formulation of new targets and policy tools. In the Republic of Korea, each plan is assessed in terms of its results at the end of the planning horizon and the results of the assessment are fed back into the formulation of the next iteration. In that sense, ICT planning in the Republic of Korea has become the embodiment of state policies that capture a strategic vision, which in itself represents a consensus of all societal forces in the country. Similarly in countries with a different political system like China, institutional centralization of broadband policy making was reinforced with government sponsored planning. Senior leadership performance reviews are tied in tangible ways to achieving detailed annual planning targets that specify network capacity expansion, coverage, penetration, and quality standards.

1.7.1.4 Building ownership and accountability of the executive branch

Complementing multi-year planning and disciplined follow-up, leadership at the highest levels of government in the promotion and oversight of broadband policy appears to be another best practice. This places responsibility for steering the development of the broadband sector squarely in the hands of the President. In doing so, the Executive Branch can act as a coordinator among government entities and foster a single national objective to be followed. Broadband deployment and penetration is the result of the combined intervention of many government entities, which requires a higher coordinating figure to make sure all departments proceed according to the same guidelines. In addition, by placing the fulfillment of national broadband objectives within the realm of the executive branch, the government conveys to the public and private sectors the importance that broadband holds for the future of the country. For example, in Brazil, the National Broadband Plan was developed by the Secretariat of Strategic Affairs of the President of the Republic and directly approved by the President of the country. In China, strong leadership from the top has been a key feature in China's broadband plan development. The Ministry of Information Technology reports to the country's State Council and is a member of the State Information Leading Group (SILG). The SILG approves and modifies the regulatory framework and future directions for the telecommunications industry.

In some cases, governments at their highest levels extend their sector intervention beyond multi-year planning by actively shaping the broadband industry structure. In the Republic of Korea, the government intervened in the market "in a focused and strategic way"[76] at several points in the development of the sector, shaping industry structure either with the purpose of creating national champions, fostering export-led industries, or addressing sector sustainability. The Korean government often negotiated with the giant conglomerates (called *chaebols*) over their participation in the broadband sector.[77] Similarly, the government fostered the consolidation of alternative broadband service providers at times of financial crisis.

In another example, the Brazilian executive led a process aimed at the creation of a national champion by promoting the merger of two of the three major regional local exchange carriers, Brasil Telecom and Oi, into a single Brazilian-owned company. This required the modification of the original *Telecommunications Law*. The Japanese experience also represents an example of a fine-tuned combination of top-down sector planning with the creation of a set of incentives to stimulate facilities-based competition. While not explicit, the Japanese government has constantly adapted the regulatory framework to facilitate the moderate consolidation of the broadband sector in order to build a competitively sustainable regime.

1.7.2 Competition policies to stimulate infrastructure investment

Recognizing that the private sector has primary responsibility[78] for funding broadband network deployment, policy mechanisms need to define what the appropriate incentives are to promote private sector investment. In that regard, this section focuses on articulating the appropriateness of platform-based competitive models. It proceeds first by reviewing the main tenets of platform-based competitive models and then provides examples of countries that have implemented such regulatory frameworks.

The development of facilities-based competition, also labeled inter-platform or intermodal competition, is one of the major overarching objectives of the deregulation of the telecommunications industry. This model is based on competition between vertically-integrated operators that manage their own network infrastructures and have sufficient stand-alone capacity for investment and innovation.

The classic example of inter-platform competition is that of the cable TV operator that supplies services such as audiovisual content distribution, broadband access, and telephone services in direct competition with the telecommunications operator, which supplies the same range of services[79]. The benefits of this model include the possibility of multidimensional competitive dynamics (prices, services, user service quality), while stimulating each operator to increase its level of investment (and, consequently, innovation) in its own network. The arguments against this modal suggest that insofar as it typically involves only a few firms, inter-platform competition, does not generate sufficient static efficiencies. In other words, it can lead to tacit collusion between players, with the resulting sub-optimization of prices for end consumers.

Inter-platform competition stands in contrast to service-based competition, which is defined as the model where industry players without infrastructure deliver services to the market by leasing capacity from an incumbent network operator at a regulated wholesale price. By gaining access to the dominant operator's infrastructure at a regulated wholesale price, new entrants can enter the market and set themselves up as viable competitors. Once this occurs, the new entrant will start investing in its own infrastructure when it reaches a certain critical mass of subscribers. Accordingly, infrastructure acquisition from the wholesaler becomes the first step in the 'investment ladder'. Thus, at least conceptually, service-based competition is a temporary stage in the transition to inter-platform competition.

In contrast to platform-based competition, which tends to meet the objectives of dynamic efficiency (such as product innovation), service-based competition is not as effective in fostering infrastructure investment. Owing to the strategic behavior of vertically-integrated operators, wholesale access negatively affects these operators' rate of investment and their rhythm of product innovation tends to decline. This is what economic theorists refer to as the 'inverted U' behaviour[80], which means that, in determining asymmetrical regulation over an incumbent operator (e.g. the obligation of wholesale access), there is an optimal level of competition that encourages innovation and investment. Beyond that point, the level of innovation tends to decline because it does not hold strategic value for the integrated operator to share with its competitors any innovation capable of generating competitive advantage. The implications of this point are fundamental. First, if the regulatory obligations reach beyond this optimal level, they can have negative social and macroeconomic consequences in terms of limited broadband infrastructure investment and product innovation. Second, if the new entrants do not "climb up" the investment ladder, the competition model must be reconsidered. This is why the determination of the appropriate competitive model is critical for the broadband industry's future development. An examination of the industry structure (not only the existence of cable, but also of an independent wireless player) is an important step in this determination.

Two caveats need to be made at this point. First, a temporary stage of service-based competition is certainly better than no competition at all. Service-based competition models could work as temporary boosters of broadband penetration, as the European experience indicates. Second, since in general inter-platform competition is the best model to promote economically-sustainable broadband sectors, some countries with no cable presence might have to consider a mixed model where service-level features are combined with a wireline versus wireless platform.

These two competition models assume different policy approaches when it comes to broadband promotion. Infrastructure-based competition is based on the competition between vertically-integrated operators with access to non-replicable passive infrastructure (e.g. ducts, poles, and in-house wiring). This model recognizes, however, that broadband economics do not allow for full competition in all geographies and therefore defines principles for state aid and public backhaul in underserved areas. On the other hand, broadband service-based policies foster competition among horizontally-integrated operators which have access to wholesale resources (e.g. bitstream, radio access spectrum sharing). It assumes the existence of a single network shared across players competing on the basis of service and pricing.

Table 1.13 presents information from five countries around the world that have implemented inter-platform competition for broadband resulting in 2 or more independent vertically-integrated service providers.

The industry structure in the countries depicted in Table 1.13 not only includes a facilities-based telecommunications operator and one (or more) cable operator, but also a second mobile/landline telecommunications operator and at least one mobile operator competing with the landline operators on an intermodal scale.

Those who propose service-based competition argue that the countries mentioned above represent the exception to the rule of building viable competition. Indeed, the argument is based on the fact that in these countries, the position of cable TV is quite developed and has created a natural inroad for the creation of inter-platform competition. Yet, it is interesting to note that while this is true, the regulatory authorities in these countries did not adopt the inter-platform competition model by building on cable TV's position, but rather adopted the inter-platform competition model after experimenting with service-competition models and identifying its limitations. Accordingly, beyond any structural determinism (based on the axiom "service-based competition was never given any consideration because there is a strong cable industry") or an orderly progression in the 'investment ladder' process, the countries that have adopted the platform-competition model have done so on the basis of experimentation and testing, which led them to recognize its advantages. All the regulatory authorities of the cases studied tried initially to implement a service-competition model. The industry's initial response to these regulatory intentions included the entry of a large number of virtual competitors and a reduction in prices but at the same time, a deceleration of investment (as in the United States and Chile).[81] At the same time, the industry started a process of consolidation giving rise to players who competed in every sector of the industry (primarily, telephony, broadband, mobile and content distribution), demonstrating the actual viability of inter-platform competition.[82] The consolidation of the cable and mobile industry in the Netherlands is one example of a phenomenon that can also be seen in the mobile industry in Chile, the telecommunications and cable industry in the United States and the broadband sector in Korea.

Table 1.13: Selected Countries: Broadband Market Shares(*) (1Q2010)

	United States	Netherlands	Republic of Korea	Chile	Canada
Broadband	• Telco 1 (20.3%) • Telco 2 (11.8%) • Cable (35.5%)	• Telco 1 (41.7%) • Cable (36.6%)	• Telco 1 (42.7%) • Telco 2 (23.4%) • Telco 3 (15.6%)	• Telco 1 (44.3%) • Cable (38.5%) • Telco 2 (1.2%) • Telco 3 (6.4%)	• Telco 1 (20.3%) • Cable (16.1%) • Telco 2 (11.1%)
Content Distribution	• Cable (39.9%) • Telco 1 (4.49%) • Telco 2 (3.25%)	• Cable (68.7%) • Telco 1 (14%)	• Cable (85%) • Telco 1 (7.3%) • Telco 2 (4.9%)	• Cable (51.7%) • Telco 1 (17.0%) • Telco 3 (17.5%)	• Telco 1 (17.1%) • Cable (20.0%) • Telco 2 (1.7%)
Companies	• Telco 1: ATT • Telco 2: Verizon • Telco 3: T-Mobile • Telco 4: Sprint • Cable: Comcast, Cablevision and TWC	• Telco 1: KPN • Telco 2: Vodafone • Telco 3: T-Mobile • Cable: UPC, Ziggo	• Telco 1: KT • Telco 2: SK / Hanaro • Telco 3: LG	• Telco 1: Telefonica • Telco 2: ENTEL • Telco 3: Telmex / Claro • Cable: VTR	• Telco 1: Bell Canada • Telco 2: Telus • Cable: Rogers

(*) Number in brackets depicts market share

Sources: Author, based on national regulatory agencies and telecom and cable operator reports

In view of this consolidation, the national regulator in those countries recognized that the process for creating strong competitors with good financial health and a capacity for maintaining a certain rate of innovation and investment had to do less with an 'investment ladder' and more with the creative destruction associated with competition and returns to scale that characterize a capital-intensive industry such as telecommunications. At the present time, the platform-competition model has finally been adopted by the regulatory authorities in all four of these countries. In short, the adoption of the inter-platform competition model arises not so much from structural determinism as from the combination of the regulator's pragmatism and industry consolidation processes, resulting in an industry model that is both viable and balanced and that ultimately allows for achieving universal broadband policy targets.

The question that still needs to be asked at the present time is to what extent have these countries sacrificed static efficiencies in favour of consolidation? In other words, are we witnessing a situation where the joint dominance of a few operators is leading to market failures in terms of broadband development? Again, the study of the above cases shows that this is not the case. The following Table indicates that in the transition towards the inter-platform competition models, the end user interest in innovation and low prices has been preserved.

The table illustrates that in countries in which the inter-platform competition model was adopted, there were no noticeable market failures with regard to the development of broadband. First, the four developed countries tend to have a high level of penetration. Canada, while being in 11th position within OECD countries, has a broadband penetration of 82 per cent of households. The United States, which holds the 15th in terms of OECD broadband ranking position among OECD countries, has a penetration rate in excess of 80 per cent in 35 states comprising 85 per cent of the country's population. Similarly, Chile exhibits the highest broadband penetration among its Latin American peers. Second, with respect to pricing, the US, Canada and Netherlands are within the mid-range of OECD countries; while the Republic of Korea has high minimum broadband prices, these prices do not appear to have materially impacted on the level of adoption relative to other OECD countries. Finally, with the exception of the United States and Canada, access speeds in the other countries are among the highest of their peer groups.

Table 1.14: Performance metrics of platform-based competition countries (December 2009)

	Metrics	United States	Netherlands	Republic of Korea	Chile(*)	Canada
Broadband penetration	Population	26.4 %	37.1 %	33.5 %	10.4 %	29.59 %
	Households	63.5 %	77 %	95.9%	31.5%	82 %
	Relative position	OECD:15	OECD: 1	OECD: 5	LATAM: 1	OECD: 11
Broadband pricing	Minimal subscription ($ PPP)	$ 19.99	$ 20.83	$ 27.48	$ 30.47	$ 22.49
	Relative position	OECD: 14	OECD: 16	OECD: 29	LATAM: 2	OECD: 22
Average download speed	Advertised download speed (Mbit/s)	14.3	32.8	100.0	1.5	19.6
	Relative position	OECD: 23	OECD: 5	OECD: 4	LATAM: 1	OECD: 15
Fibre as a percentage of broadband accesses		4.9 %	11.3 %	48.8 %	0 %	0 %

(*) Note: While Chile is an OECD country since May 2010, this author considers it more pertinent to evaluate it against its Latin American neighbours.

Sources: Author, based on data from OECD and National Regulatory Authorities

This anomaly can be explained by the peculiarities of the two North American countries. While as advertised download speed, the US lags other OECD countries, both telecommunications incumbents and cable operators offer services in excess of 20 Mbit/s, while deployment of fiber and DOCSIS 3.0 is well ahead than most service based competition countries. Canada's delay in introducing higher speed offerings and deploying fibre is explained by the specific failed privatization of Bell Canada which delayed any infrastructure upgrade plans of this incumbent[83].

In spite of the different industrial contexts and in the absence of imitation or the 'export' of a certain regulatory framework, there appears to be a convergence towards a similar model of competition. Even in the context of the development of Next Generation Networks, while it is uneconomic to build more than one fiber optic network, infrastructure competition to the telco results from either cable-based DOCSIS 3.0 systems such as in the United States, Korea, and Netherlands, or high speed wireless broadband networks, such as LTE. This indicates that the market dynamics and economic structure of the industry[84] play a determinative role in the migration to infrastructure-based competitive models. Furthermore, beyond the 'American and Dutch exceptions', this model is gaining in prominence all around the world. For example Hong Kong, China, Canada, Portugal, Argentina, and Brazil have been implicitly moving toward regulatory models entailing inter-platform competition that simply formalize pre-existing competitive dynamics. Finally, these models do sacrifice the consumer interest in favour of a consolidated industry, but rather end users will benefit from static and dynamic efficiencies provided by healthy competition systems. It is important to underline, however, that while this might be applicable to more mature markets, the situation of developing countries might require temporary regulatory intervention aimed at guaranteeing appropriate levels of competition.

1.7.3 Role of government intervention in promoting broadband deployment

Should the government actively intervene in the development of broadband? The role of government in promoting the deployment of broadband can be inferred from the paradigms governing the application of universal service policies to wireline communications. Nevertheless, the broadband challenge might require new types of government intervention.

While agreeing that private sector investment is the primary funding of broadband development, one should recognize that, in some cases, broadband markets are not sufficiently developed to offer sound financial investments for carriers. If one assumes that the government needs address this potential market failure, the question remains as to what is the best way for the government to intervene. It is assumed that private sector investment tends to gravitate to areas where demand and demographic density guarantee an appropriate rate of return (see Table 1.15).

Table 1.15. Market structure and demand characteristics

		MARKET STRUCTURE			
		MORE THAN 3 OPERATORS	2-3 OPERATORS	ONE OPERATOR	NO OPERATOR
DENSITY AND SIZE OF DEMAND	HIGH	Dense urban areas with high business and residential density	X	X	X
	MEDIUM	X	Urban areas/towns with primarily residential density	X	X
	LOW	X	X	Rural areas with sparse residential density	X
	VERY LOW	X	X	X	Rural areas with very low density

Source: Author

According to the geographic segmentation principle, determining where government involvement is necessary is the first policy decision. Communities in a specific country need to be divided into one of three groups: those that are, or can be, served by market forces; those that can become self-sustaining if they are given assistance with initial investment; and those that cannot become self-sustaining and require ongoing funding.

There are two potential routes that government can take in order to address this particular market failure. The first is to directly enter the unserved regions as a service provider. The second approach is to generate the necessary stimuli in order to render the market more attractive to private sector investment. In general, state-owned facilities are the less desirable option. They tend to be less innovative, lack checks and balances, require more regulation (especially to enforce open access), and may have unintended consequences for utility behaviour (e.g., pricing distortions, "erosion of public good" syndrome[85], etc.). Some of these risks will be addressed below.

If the generation of appropriate incentives to ease the burden of private investment is the more suitable approach, how can those areas of stimuli be determined? A sustainable broadband business is predicated on the number of potential subscribers, the average revenue to be derived per user, the capital investment required to enter the market, and its recurring operating expenses. In this context, a broadband business case faces two structural market challenges (or "choke points") and two strategic and/or operational constraints. To begin, the broadband market in a small community may be too small. If primary demand is not sufficient, even if a company is a monopoly and completely controls the market, network deployment may not be profitable. The demand challenge has to do with building critical mass and, consequently, leveraging the industry economies of scale. While larger company size does not necessarily lead to lower costs, companies that have higher market share in the communities tend to have lower unit costs.

Second, investment in equipment may be too high relative to operating profits. This leads to lengthy horizons for a positive return on the investment, or, in other words, puts a heavy burden on businesses in the short run. Strategically, businesses can also face challenges if a low market share in a structurally small market negatively affects revenue streams. Thus, because of competition, a large investment may not have a profitable return unless a business is able to capture a sufficient share of demand. The capital expenditure structural challenge differs according to the type of network: in fixed broadband networks, construction costs are the largest cost item. In wireless broadband networks, the primary cost category is backhaul infrastructure.[86]

Government intervention can render a private sector business case sustainable by taking several initiatives that positively impact the investment model. First, governments can put in place mechanisms in order to reach the level of critical mass that makes entering the market a worthwhile venture for providers. It can do this directly by adding its own demand to the natural market, or indirectly by subsidizing subscribers to make prices more affordable. If demand is low because there is little interest or too few people, the former is probably the best the course of action. If the area is too poor to afford broadband at prices sustainable to providers, the latter strategy may be the best course of action. Government can also help lower the capital expenditures in the targeted area by providing low-cost real estate for central facilities. Alternatively, it can provide grants to fund capital investments or reducing the costs of obtaining rights of way and/or spectrum access. Some of these policy tools are reviewed below.

Bundled demand

Generally, the best way to induce private investment in broadband infrastructure is to “bundle demand”. The government does not need to artificially intervene in the market; it can act as an anchor user to guarantee revenues during the ramp-up phase of broadband installation. Local governments can proactively coordinate demand for broadband access from public administration, public safety, local schools, and health care facilities in order to create an "anchor tenant". Once the demand "consortium" is structured, the government negotiates a wholesale rate and long-term contract with a broadband service provider in order to create a flow of revenues that eases the initial economic pressure and reduces investment risk. Additionally, the government can stimulate demand from the private sector by working at the grass-roots level. Centralized efforts such as the establishment of Broadband Expertise Centres and library access and demonstrations are also helpful. Such efforts are particularly useful to spreading broadband knowledge, conducting training, and developing interest among organizations that do not utilize broadband. This will be discussed in more detail in the sections below.

Subscriber subsidies

Subscriber subsidies should be used sparingly. However, in certain cases they can be very beneficial. As mentioned above, a subsidy targeted at economically-disadvantaged subscribers is one of the appropriate uses of this approach. Such a subsidy addresses the social inclusion problem that faces governments that are seeking to ensure universal service. Fiscal incentives are also a useful form of subsidy: a reduction in taxes to small and medium enterprises has been found to stimulate broadband adoption in industries that have a strong impact on economic output. In Sweden, for example, tax incentives are given to businesses and residential tax- payers who signed up for broadband services: 50 per cent of the costs are deductible up to a maximum of 5000 SEK (or roughly USD740).[87]

Infrastructure sharing

In order to reduce backhaul costs, infrastructure sharing (e.g., backbone and towers) should be allowed and encouraged. Infrastructure sharing alleviates cost pressures on competing providers. If multiple broadband providers are not sustainable, sharing or consolidation may produce a broadband access “utility”. It allows operators to capture economies of scale and reduce investor risk, which is tantamount to lowering costs.

There are several other ways to reduce costs to network providers in a given area. Regulators may reduce right of way or access costs (e.g. spectrum costs or pole attachment fees). They may also attempt to regulate backhaul costs, although in general, states do not have the capacity to do so. A way to address this last issue is to provide grants for capital investment, particularly backhaul capital costs or recurring expenses. These grants could take several forms: a subsidy for purchasing backhaul services (e.g. T-1 lines) from an operator or direct underwriting of government-owned backhaul facilities that could offer services at a lower-than-market pricing to remote operators.

Government as a risk taker

In the last resort, if private investment does not flow after suitable incentives are provided, governments can act as a risk taker without resorting to public ownership. One possibility is to subsidize the incumbent telecommunications carrier and upgrade broadband to the “utility” status. In greenfield situations, governments can contract for the construction of a universal access network. This may induce strong competition for government contracts and lower the initial costs of the operation. Afterward, the government can auction the right to operate the broadband infrastructure to highest qualified operator. This process gives the government the option of creating a monopoly for wholesale-only or an open access “utility” operator. In effect, any loss that is sustained upfront is a one-time infrastructure subsidy much like building a highway system.

In most countries, local governments already play a role in broadband deployment. In the US, there is a legal framework allowing municipalities to operate a broadband operator in response to a failure of the private sector to deliver service. By 2009, there were 66 municipalities that are already operating fibre networks and over 40 more that are planning to do so. In Sweden, there were 136 municipalities with fibre-based networks in 2009. In Germany, there were 25 city networks in 2009, some of which controlled 50 per cent of the local market (e.g., Cologne and Hamburg). Finally, in the Netherlands, there are currently 16 municipal fibre projects covering most major cities (e.g., Amsterdam, Rotterdam, and Almere).

There is no single business model driving municipal broadband networks. Municipal networks can follow one of the following schemes: 1) closed networks, where the municipality directly provides retail services; 2) the municipality is a wholesaler to a single retail service provider; 3) the municipality offers open access or wholesale transport to multiple retail service providers; and 4) the municipality offers dark fibre.

It should be noted that public investment in broadband could come at the expense of three risks:

- First, municipal networks have the potential to create access bottlenecks. While funding is typically provided to municipalities in order to deploy infrastructure in areas where infrastructure competition is not feasible, these broadband service providers can start behaving as commercial entities, either by deploying infrastructure in areas where competition was feasible or regularly refusing to provide dark fibre or access to their infrastructure to competitors. In Sweden, for example, where funding was provided to municipalities in order to deploy infrastructure in areas where infrastructure competition was not feasible, these municipal broadband service providers begun to behave as commercial entities. As the regulator noted, providers deployed infrastructure in areas where competition was feasible or regularly refused to provide dark fiber or access to their infrastructure to competitors[88].

- Second, municipal networks may shift their mission from public to commercial service. In a display of non-competitive behaviour, municipalities can post broadband investment in their wholly-owned electric utility's balance sheet to benefit from lower borrowing costs. That has been the case with municipal networks in Germany and Switzerland
- Finally, even if the public service mission is not violated, some municipal networks experience difficulties serving their customers. This may take the form of operating inefficiencies (which prevent them from showing a positive financial profile), cumbersome customer provisioning in a multi-provider system, and/or difficulty in managing the network and resolving service problems. That has been the experience in the United States with some of the municipal fiber networks[89].

In a risk profile similar to the one linked to direct entry into local access networks, direct state investment in backbone networks may also be problematic. To begin, the government entry in the provisioning of long-haul fibre optics can be jeopardized by the lack of coordination between the time of policy formulation and the launch of the company, resulting in lengthier delays. Furthermore, the public broadband provider may lack operating and business independence and the ability to assume institutional responsibility. The terms and conditions of network access might not be clearly specified, and the regulatory authority could be overstretched. In sum, a lack of coordination and coherence may cause deregulation and liberalization of telecommunications to conflict with government re-entry into the broadband market[90].

International experience is helpful in outlining the areas of opportunity for and the risks associated with government intervention. The evidence above indicates that the only case where government intervention is sustainable is when it aims to alleviate the constraints of businesses and stimulate private investment. Government intervention that aims to preempt private investment is not likely to prove sustainable. (See Table 1.16.)

According to Table 1.16, government intervention in situations where a broadband enterprise is sustainable and profitable could result in the "crowding out" of private investment; this has been the case with some municipal networks in European countries, such as Germany and Switzerland. On the other hand, if the broadband business is not profitable or sustainable, the more appropriate form of government intervention is the alleviation of the "choke points" or structural constraints of the business case. Finally, government intervention could be conceived as appropriate in cases where, even after incentives are put in place, the private sector would not invest.

Table 1.16: Options for government intervention in broadband provisioning

		IS PROJECT SUSTAINABLE AND PROFITABLE?	
		YES	NO
IS GOVERNMENT INTERVENING?	YES	• Preemption ("crowding out") of private investment (Germany, Switzerland, Netherlands)	• Alleviate the constraints of the business case to stimulate private investment • Re-creation of access bottlenecks (US) • Erosion of the public utility model (US, Sweden)
	NO	• Market addresses the need of public good	• Supplier of last resort

Source: Author

In sum, government should intervene in broadband and wireless deployment, but only by facilitating market forces, not by preempting them. This process requires strong cooperation between governments, communities, businesses, and operators to identify supply and demand conditions and tailor services to unmet needs. Specifically, in the areas where broadband is deployed, it is important to identify the barriers to consumer adoption; in the areas where there is no broadband service, it is important to identify the barriers to sustainable market entry. The next step would be to develop a plan that incentivizes private investment, for example, by promoting public-private partnerships, encouraging market competition, refining supportive regulation, and modifying spectrum management policies.

1.7.4 Stimulating innovation in applications and services

Countries that have succeeded in building a highly developed broadband sector have transitioned from developing policies on a sector-by-sector basis (telecommunications, software, science and technology, and computing) to an integrated and comprehensive mode of policy-making. An integrated approach to ICT policy development recognizes the interconnected domains of ICT (infrastructure, demand, production, and adoption) and sectors (telecommunications, broadcasting, and IT applications and devices). This integrated policy approach has two primary dimensions.

Outline overarching objectives for the ICT sector

An integrated policy approach translates initially into the formulation of a vision of the future of ICT for the country; this vision then guides the multi-year planning effort. In the Republic of Korea, for example, each of the multiple plans formulated by the Government has been guided by an overarching visionary objective such as "reach world class ICT performance levels by 2010" (*1996-2000 First National Informatization Promotion Plan*), "build a knowledge-based society" (*Cyber Korea 21*), "development of broadband leadership" (*Broadband IT Korea Vision 2007*), and "broadband convergence and ubiquitous networks" (*u-Korea Master Plan*).

In Japan, the government developed an overarching strategic policy in 2006 labeled *u-Japan*, which was guided by three targets:

- Elimination of non-broadband served areas, establishing that by the end of 2010, broadband service should be available to 100 per cent of the population, while high speed broadband should be available to 90 per cent of the population.
- By the same year (2010), 80 per cent of the population should value ICT as a tool to address social needs; this should be measured by the level of adoption and assimilation of applications and services, particularly in the eGovernment domain.
- Finally, in the same year (2010), 80 per cent of the population would be ICT literate in order to feel at ease accessing the Internet and computer technologies.

Interestingly, the goals in Japan's 2006 strategy comprise infrastructure, digital literacy and social objectives.

Link broadband deployment to industrial policy objectives

In addition to formulating an overarching vision for the ICT sector, moving from a sector-specific regulatory policy to a comprehensive industrial policy recognizes that the development of a telecommunication sector and the creation of export-oriented IT services and software industries have to be linked. In the Republic of Korea, policy makers determined that meeting demand domestically and leveraging the industrial power of big conglomerates could allow the country to build an export base in electronics, IT, and communications. Initially, however, objectives were articulated in terms of meeting internal demand for an upgraded telecommunication infrastructure and entering the electronics arena. According to this approach to ICT sector development, incubation of an export-oriented industry is linked to funding adoption of its products in the domestic market. A key policy objective of all Korean master plans has been the articulation of industrial policies such as R&D promotion, the development and diffusion of industry standards, training of ICT resources, the promotion of e-Government applications, and the provision of seed capital for infrastructure deployment. The Development Fund benefits from private sector contributions through spectrum licensing fees, a percentage of revenues from operators, and interest earning loans. As such, one of the fund's primary objectives is to reinvest the profits of the ICT sector in the sector itself. Over time, the guiding principle for the formulation of policies evolved toward "building the information society". Based on the overarching goal of developing an advanced information society, Korea formulated several successive master plans, which featured both supply and demand-side policies. Finally, Korea's policies regarding broadband development were always focused on the development of an applications and services sector both benefiting and acting as a stimulus for infrastructure usage. As a result, the development of broadband acted as a stimulus for the creation of a content industry. Among the newly-created industries, Korea counts an $8.3 billion online gaming industry, a $ 3.4 billion domestic content industry, as a well as a home-grown Internet search sector.[91]

With a similar objective of promoting the development of an equipment manufacturing industry, the Ministry of Information and Communication in Japan set up the *ICT International Competitiveness Enhancement Program* in 2007 aimed at promoting Japanese products and developing world markets through a collaboration of industry, academia, and government. This program has been actively endorsed by the ICT manufacturing sector. In addition, the development of ICT strategies has been constantly supported by large domestic high technology companies such as Canon, Mitsubishi, Nintendo, Panasonic, Sony, and Toshiba.

1.7.5 Stimulating broadband demand

Thus far, the debate surrounding the digital divide in the use of Internet and broadband has been primarily focused on the statistics regarding computer ownership and broadband penetration. The major issue in the eyes of public policy and public opinion has been the need to increase the adoption of the service through the increase of the technological coverage. The underlying assumption is that by reducing the obstacles for infrastructure investment, the digital divide challenge would disappear. Yet, while without a doubt supply-side issues such as the gap in investment contribute heavily to the digital divide, demand for broadband services also plays a key role in explaining service penetration. The following section identifies the causes of the demand gap and outlines a set of policies aimed at tackling these issues.

1.7.5.1 Inhibitors of broadband adoption the broadband demand gap

For the purposes of this study, the digital demand gap is defined as the number of households that choose not to purchase a subscription to broadband services even though they are served by a network. Historically, this statistic has not been easy to calculate because broadband coverage (in other words, the amount of households that have the capability to access broadband services) is usually not measured by public or regulatory agencies. However, the last year has seen the development of numerous national broadband strategies[92] which have necessitated a thorough analysis of the broadband coverage gap. For example, in the United States, according to the FCC, 92 per cent of all US households were capable of broadband access via cable modem and 82 per cent could purchase service via DSL. However, penetration statistics indicate that only 62 per cent of US households subscribed to the service. Thus, 30 per cent of households that had the capability of broadband access chose not to subscribe.

This gap in broadband service demand was also identified in Germany. According to the National Broadband Strategy, published in 2009, 98 per cent of all households (39.7 million) in Germany are capable of purchasing broadband access. Coverage is divided as follows: 36.7 million households have access to DSL platforms; 22 million are served by cable television (and therefore could access the Internet through cable broadband); and 0.73 million are capable of subscribing to wireless broadband through satellites, etc. Table 1.17 estimates the gap for a number of countries.

As Table 1.17 indicates, the broadband demand gap in the developed world ranges from between 7 per cent in the Republic of Korea to 40 per cent in Germany and Italy. While statistics for developing countries are not available, the broadband demand gap is expected to be higher. In Argentina, for example, the two telecommunications carriers could provide broadband to 91 per cent of households, while cable TV operators could offer service to 82 per cent. In this country, broadband household penetration is 29 per cent, which means that the demand gap is 62 per cent.[93]

It is evident that in all countries, a significant portion of the population does not subscribe to broadband Internet for reasons beyond service availability, such as affordability, lack of digital literacy, or limited interest. An understanding of this problem and its causes is critical in order to put in place an appropriate set of policy tools for promoting broadband.

Table 1.17: Broadband Demand Gap

Country	Households passed(*)	Households connected	Demand Gap
Australia	89 %	69 %	20 %
Denmark	96 %	76 %	20 %
France	100 %	77 %	23 %
Germany	98 %	58 %	40 %
Israel	100 %	83 %	17 %
Italy	95 %	55 %	40 %
Republic of Korea	100 %	93 %	7 %
Spain	93 %	61 %	32 %
Sweden	100 %	89 %	11 %
United Kingdom	100 %	68 %	32 %
United States	92 %	62 %	31 %

(*) Note: Household passed is defined as a residence where the broadband network is deployed; this differs from connected, which means the residence is linked to the network for provisioning the service.

Sources: Analysis by the author, based on data from EU; FCC; BMWi; OECD; PTS – Sweden; and Israel Minister of Communication.

In a study on ICT adoption inhibitors in Spain,[94] it is argued that individuals respond to the introduction and spread of ICT either by adopting a technology after being exposed or by not adopting the technology. Within those that adopt the technology, another subgroup exists – the “sporadic users”.[95] We believe that these two groups, the exposed non-users and the “sporadic users”, are at the heart of the demand-side digital divide.

Though the percentage of people who do not use the Internet and who consequently do not subscribe to broadband service varies by country, the figure is generally significant. The study on Spain referenced above estimates that in July 2007, non-users (outsiders and sporadic users) accounted for 52.9 per cent of the adult population. Research conducted by Pew Internet & American Life indicates that in June 2009, non-users accounted for 21 per cent of the US population. In the UK, the figure was 26 per cent in March 2009. However, this last figure reflects the state of adoption within the population; in Spain, the equivalent is 40.2 per cent.

What are the reasons cited by non-users for not adopting the Internet? Studies in the United Sates and the United Kingdom place the reasons into four categories (see Table 1.18).

Table 1.18: United States and the United Kingdom: Reasons for not accessing to the Internet (2009)

Reasons	Percentage of answers	
	United States	United Kingdom
Relevant (lack of interest, busy doing other tasks, other reasons)	45 %	60 %
Price (the cost of broadband is too high, does not have a computer)	15 %	28 %
Service availability	16 %	14 %
Easy to use (difficulty – senior citizen – physical handicap)	22 %	16 %

Source: Horrigan, J. (2009); Ofcom (2008)

As shown above, both the order of importance and the percentage of responses in each category are fairly consistent: limited relevance is the most important factor, followed by service price, availability of service, and comfort or knowledge required for use of the service. The American and the United Kingdom cases illustrate the reasons for non-adoption in developed economies. In developing countries, however, availability and affordability of serv ices are likely to be more important than, for instance, the lack of interest. While there are no studies to this author's knowledge, absence of relevant content could also be a major constraint.

With the exception of the availability of service (discussed above in section 1.7.3), it is important to understand the reasons that inhibit broadband adoption. Is there a socio-demographic profile that can help explain the limited relevance (or lack of interest), the cost barrier, and the difficulty in usage? Studies from the United States, the United Kingdom, and Spain have found that the reasons for not adopting the Internet or broadband are remarkably consistent. Inhibitors to broadband adoption are clustered around: 1) level of education (completion not above secondary school); 2) age above 65 (related, in some cases to absence of children in the household); 3) location in rural areas; 4) disadvantaged socio-demographic groups, which is also correlated with level of education and employment status (unskilled workers, retirees and homemakers); and 5) income (less than net EUR 900 per month).

The effects of socio-economic status on the process of technological adoption have already been studied elsewhere[96]. However, education merits further analysis because it can be influenced by public policy. According to OECD statistics, at 93 per cent, South Korea is the country with the highest level of broadband penetration. While telecom regulatory factors (referred to above) explain the absence of a supply-side digital divide in the Republic of Korea, the education level in this country is a key explanatory variable that accounts for the minimal demand-side divide. The Korean population is comparatively more educated than the Japanese or United States population. The average number of years of education completed in South Korea is 15, one more than the Japanese average. Moreover, this figure is 50 per cent higher than the average for US households.[97] The spill-over effects of education on broadband adoption are a factor that should influence public policy-making both in education and in ICT. In that regard, it is important to emphasize that broadband penetration is not only a result of technology-based policy, but should also be addressed in educational policy objectives.

Finally, the affordability issue, which is so important in developing countries, must be emphasized. This has been also highlighted in the context of the economic crisis, which indicates how significant the effect of income could be on the decision to adopt broadband at the household level.[98]

1.7.5.2 Relevant policies aimed at addressing the broadband demand gap:

In addition to deploying policies to stimulate infrastructure development aimed at achieving wide service coverage of key technologies, leading information societies implement several demand-side policies aimed at promoting broadband adoption.

Introduction of tax incentives

In the first place, governments of countries with high performing ICT sectors tend to introduce tax incentives designed to encourage the purchase of equipment. In addition to the Swedish example described above, in Japan, firms investing in ICT solely for their own use have the option of either taking a 10 per cent credit from corporate tax or a special depreciation equivalent to 50 per cent of the acquisition cost.

Developing e-government services

Second, by actively developing e-government services, governments can generate additional incentives for consumers and small businesses to join the information society. Such e-government services could include, for example, the electronic submission of tax returns, an e-procurement service for small and medium enterprises selling goods and services to the government, platforms for tele-commuting, and the development of platforms that allow the interaction between the government and enterprises for e-business transactions.

This initiative is generally complemented by the implementation of digital literacy programs that include subsidies for acquiring PCs and online education programs targeted at the elderly and disabled, such as the programs implemented in the Republic of Korea. In the case of small businesses, the Japanese government encourages small and medium enterprises to voluntarily install new IT platforms to reform business management and improve productivity by providing training, collecting and disseminating best practices, and supporting collaboration with local communities.

Enabling environment for SMEs

In the Small and Medium Enterprise (SME) sector of developing countries, the implementation of business processes and applications enabled by broadband is still limited. Productivity and global competitiveness of the SME sector are affected negatively by limited broadband adoption. Conversely, broadband adoption by large enterprises is high due to affordability, abundance of training, and spill-over factors.

As discussed by the author in prior studies[99], the primary reasons for the low level of broadband uptake among SMEs are: limited access to investment capital; comparatively high technology costs; and lack of training. Regarding capital investment and monthly service costs, it is important to note that a significant proportion of SMEs, particularly in the developing world, do not receive fixed monthly income because they operate outside of the formal economy. Their income is generally daily or weekly and is dependent upon the type of labour performed; thus they cannot borrow long-term or purchase products that require a fixed monthly payment such as PCs, servers or Internet access. These enterprises are generally forced to use prepaid wireless, Internet booths or cybercafes, and rented PCs.

In addition, many of the entrepreneurs that run SMEs (which are primary microenterprises) have a very limited level of technological training. In developing countries, a large number of SME owners are subject to a generational gap because they were not exposed to Internet technology as they grew up. Therefore, they lack the necessary training to operate a computer or to use broadband to improve business efficiency. This lack of education translates into a fear of using technology and ignorance of its capability to create economic value.

Both the public and private sector must address this obstacle. The private sector must redefine product development processes so that the services marketed toward SMEs are not simply "impoverished" versions of those offered to larger companies. Products developed for the SME sector must be tailored to its needs for processing and transmitting information, its economic capacity for acquisition and operation, and the level of training it will require to operate the technology. The specific needs of the sector will only be met if these dimensions are properly understood. On the other hand, governments must actively contribute to the extension of technology training and education. Continuing education courses that focus on owners and employees can vastly improve productivity.

ICT adoption by SMEs is also limited by cultural-educational factors. In emerging countries, SMEs tend to restrict the use of ICT to accounting and finance, while neglecting its application to production processes. A survey by the Chilean Ministry of Economy found that only 2.6 per cent of Chilean companies used ICT to increase the efficiency of business processes other than accounting and finance. Yet the most worrisome observation in the survey was the following: 80 per cent of companies reported that they did not implement ICT in areas other than finance and accounting because they lacked of the technological expertise necessary to understand how it would be useful. Hence, in order to successfully stimulate SME adoption of broadband, it is necessary to take steps beyond offering incentives to the sector and creating the right conditions. SMEs must also be informed and educated about the strategic capabilities of ICT.

Another obstacle facing SMEs is the difficulty in access to and retention of skilled ICT workers. Because of a systemic shortage of technical personnel, large companies offer wages to graduates of higher education that SMEs cannot match. Even where SMEs manage to hire graduates, retention rates are very low.

Lastly, ICT adoption by SMEs is obstructed by geographical asymmetry. As a result of infrastructure asymmetry, SMEs that operate in urban centres tend to have better access to broadband infrastructure and technological capital, whereas those that operate outside of such areas are marginalized.

ICT adoption is not only marred by undeveloped broadband networks, but also by a lack of incentives. For example many governments of emerging countries have failed to enact laws that promote ICT adoption such as tax incentives, subsidies for remote telecommunications, and so forth. The lack of incentives impacts SMEs in two ways: it affects both supply and demand. On the demand side, high adoption costs restrict the adoption of platforms that allow SMEs to enhance efficiency.

On the supply side, small retail providers of ICTs (mainly in products and services) cannot compete with suppliers of goods or services that control a large share of the market. Consequently, small firms supplying ICT products and services tend to mimic the behaviour of market leaders. This behaviour restricts the adoption of ICT among SMEs because it increases the costs of promotion for suppliers. The second problem on the supply side concerns the provision of telecommunications services. Competition must be stimulated in the telecommunications services industry in order to reduce access prices.

The agenda promoting ICT adoption by SMEs should have the following focus: economic issues (such as cost reduction and incentivization); education; and the development of products specific to SME needs. As the economic factor represents a fundamental obstacle for ICT promotion, governments must prioritize the search of solutions in this field. In this vein, the adoption of tax benefit programs, special financing, and subsidies are recommended, following models of universal telephony service that have been adapted for the SME segment.

Second, since training is such an important factor in ICT adoption, investment in continuing education programs is recommended. These programs can teach SMEs how to take advantage of new technologies, for example how web pages can be used to market products worldwide. Another measure to be considered is the development of participatory applications (such as Facebook, but targeted to SMEs). This medium would allow small businesses to share experiences and form alliances to improve market access. This mechanism should promote the best practices of companies or government administrations.

The support of consultancy services regarding the installation and exploitation of ICT plays a crucial role in creating awareness about the potential of these technologies for SMEs. Finally, in the new products segment, the development of ICT packages for SMEs that include computers, with maintenance support and usable software, voice communication and broadband services is recommended. These packages would be financed in monthly payments, including the fee for the use of the services.

Promoting deployment of basic infrastructure

While the deployment of basic broadband infrastructure is necessary for ICT adoption, it is equally necessary to provide stimuli and incentives for the purchase and installation of products and services for the residential and corporate markets. In order to achieve these goals, experts in the field have proposed a vast number of measures that will contribute to ICT adoption.

First, in the context of promoting the adoption of wireless handsets, this author has established the importance of lowering taxes on purchases of hardware. (See the discussion below.) This tariff reduction on equipment should be extended to fiscal programs that tax the usage of telecommunication services. Such tariffs and taxes negatively affect the rate of ICT adoption. Therefore, the income these taxes and tariffs generate for national treasuries should be evaluated in the context of the negative impact that these tariffs and taxes have on the adoption of ICTs and thus on enhancements to productivity. In the same vein, to speed the rates of acquisition and modernization of equipment, experts recommend allowing the use of accelerated depreciation. Finally, experts recommended the establishment of discounts or rewards for enterprises that use ICT for their transactions with the government. This will have a positive impact on the use of e-government and on the use of ICTs by SMEs. In order to stimulate the use of credit for the acquisition of ICT equipment, SMEs should be provided with financial forecast tools, certified by financial institutions, which will help enterprises in the process of requesting a loan from a bank. Another important point is the increase in the number of telecentres. For example, even countries such as Brazil, which boasts 5,000 centres, should increase their number. Regarding specific recommendations, experts suggest the extension of opening hours in order to serve schools, communities, and businesses. Schools could also serve as community ICT centres.

What can we expect if a region is not successful in promoting ICT adoption by SMEs? Given the importance of SMEs in Latin American economies, for example, a policy failure will have a significant negative impact. The capacity of the SME sector to enter international production networks and to export to other markets will be greatly reduced. Thus, overall economic growth will also be reduced. This task is extremely urgent: a failure to promote ICT adoption will jeopardize competitiveness in international markets. As studies by the World Economic Affair have indicated, there is a strong correlation between the development of ICT infrastructure (as measured by the Network Readiness Index) of a country and its level of competitiveness.

It is the responsibility of governments to stimulate the adoption of ICT by SMEs. The government apparatus is capable of generating spillover effects similar to those generated by the South Korean chaebols. Chile

Compras is a good example. This is a portal designed to promote SMEs' sales of primary inputs to the government. To participate in the eco-system of Chile Compras, the SMEs must adopt Internet platforms. Thus, the program benefits SMEs, as well as the government. Companies must adopt technology, which leads to improvements in productivity and sales, and the state benefits from access a greater number of suppliers of inputs.

The resolution of the digital divide entails solving coverage problems in neglected economic corridors and meeting the needs of SMES. These challenges can be met directly by municipal and provincial governments. These levels of government are capable of more efficient allocation of resources than national governments, and tend to be directly responsible for the accumulation of intangible capital, (e.g., education), which is one of the foremost barriers to technology adoption by SMEs.

It is important to analyze the experience of countries where SMEs represent the nucleus of production. In the Republic of Korea, SMEs account for 99.8 per cent of enterprises and are responsible for 87 per cent of jobs. In Malaysia, they account for 96 per cent of enterprises, and in India , 90 per cent of enterprises are SMEs and 86 per cent of jobs in the formal economy are found in SMEs.

In Asia, three important sets of public policies have been implemented in order to increase ICT adoption by SMEs.

First, improve SME awareness of the critical role that ICT plays in improving performance. The primary focus of this policy, which is promoted by chambers of commerce and provincial government agencies, is training SME entrepreneurs.

Second, provide training that not only focuses on ICT, but also focuses on changes in structure and processes that will help SMEs absorb the value of ICT, i.e. what we called the accumulation of intangible capital in section 1.1. These training projects must be tailored so they address the application of ICT specifically to the SME sector

Third, create an environment that incentivizes ICT adoption by SMEs. This category of policy refers to the provision of tax incentives and financial tools that allow SMEs to access technology. Some incentives directly stimulate ICT adoption by SMEs (through subsidies, etc.) However, an ICT friendly environment can also be achieved through indirect incentives. For example, tax deductions can be offered to large enterprises that, in the course of their purchasing operations, help small companies acquire ICT. Other indirect incentives include subsidies for broadband installation in industrial parks. This practice is extremely common and successful in India and Malaysia.

1.7.6 Addressing taxation as a barrier to broadband adoption

The developing world lags significantly when it comes to broadband penetration (see Table 1.19).

Cognizant of this wide disparity, many governments in the developing world are implementing public policies aimed at stimulating broadband deployment and adoption. For example, in Malaysia, the government objective is to reach a household broadband penetration rate of 50 per cent[100]. Wireless broadband is the technology of choice to achieve this target. For this purpose, the government has issued new spectrum licenses to four companies that will roll-out new wireless broadband services based on Wimax platforms.

Table 1.19: Comparative Broadband Penetration (per population) (2010)

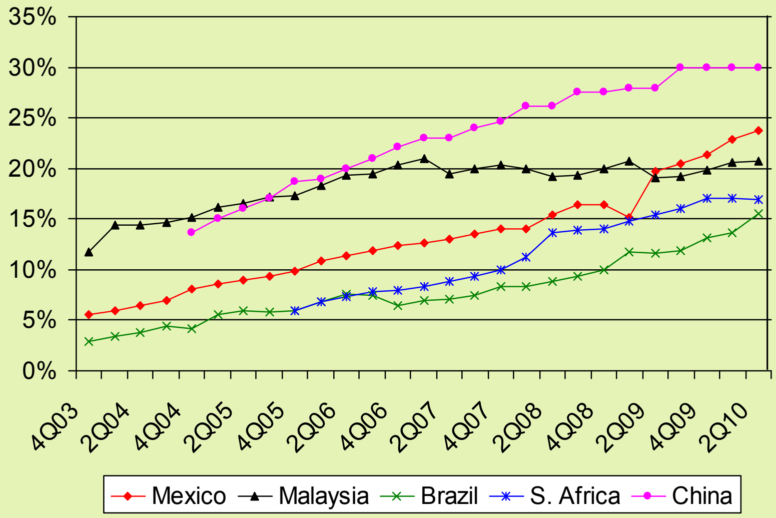
Continent/Country	Population Penetration
Western Europe	19.7 %
North America	27.7 %
Asia	4.9 %
Latin America	6.5 %
Africa and Middle East	1.6 %

Sources: ITU; Euromonitor; World Bank; analysis by the author

Furthermore, to rationalize capital investment, the government has imposed sharing requirements for towers among HSDPA and Wimax operators. Finally, as an incentive for operators to roll-out their broadband networks, the government also approved tax allowances on expenditures on last-mile broadband equipment.

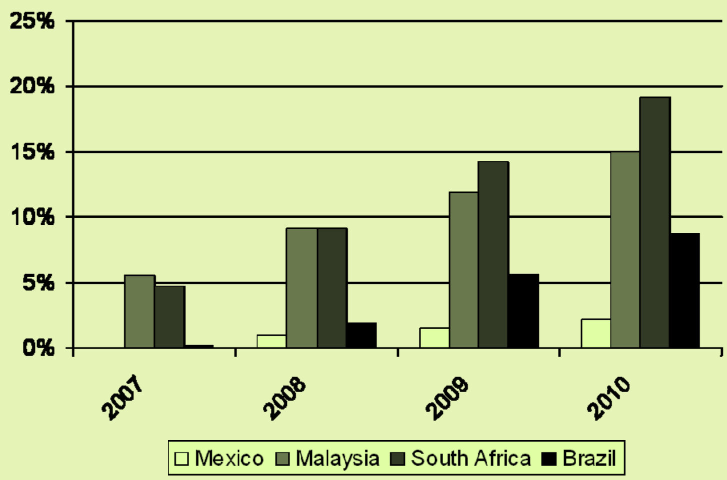
In general terms, most developing countries' policy makers now envision mobile broadband as a key lever to address the digital inclusion gap. With the exception of countries where 3G licenses have not yet been auctioned, all countries register a continuous increase in wireless broadband services combined with the deployment of 3G-enabled handsets and devices. (See Figures 1.5 and 1.6.)

Figure 1.5: Mobile data as a percentage of service revenues (2003-10)



Source: Adapted from Katz et al. (2010c) from Merrill Lynch (2010)

Figure 1.6: 3G Phone subscribers as a percentage of all mobile subscribers (2007-2010)



Source: Adapted from Katz et al. (2010c)

In this context, high taxation on mobile devices and services could have a detrimental effect on the public policy strategy aimed at deploying broadband. With the few exceptions of some countries like Malaysia, which has implemented a benign system based on extremely low value-added tax, many developing countries have introduced taxes that could negatively affect service diffusion. (See Table 1.20.)

The impact of these different taxation approaches on the total cost of ownership of mobile service varies widely. For example, in Mexico, the impact of taxes on total cost of ownership is 18.4 per cent; in South Africa, it is 15.2 per cent; in Brazil, it reaches 29.8 per cent, while in Bangladesh it is 54.8 per cent. On the other hand, in Malaysia, the effect of taxes on mobile cost of ownership amounts to only 6.1 per cent.

Taxation of mobile services appears to have an impact on the deployment of mobile broadband. For example, all things being equal, there may be some association between the very high level of taxes in Brazil and its very low penetration level of 3G handsets. On the other hand, Malaysia has a low level of taxes and a high 3G penetration rate. Similarly, an inverse relationship appears to exist between tax burden and adoption of data services when measured by wireless data as percent of service revenues (see figure 1.7).

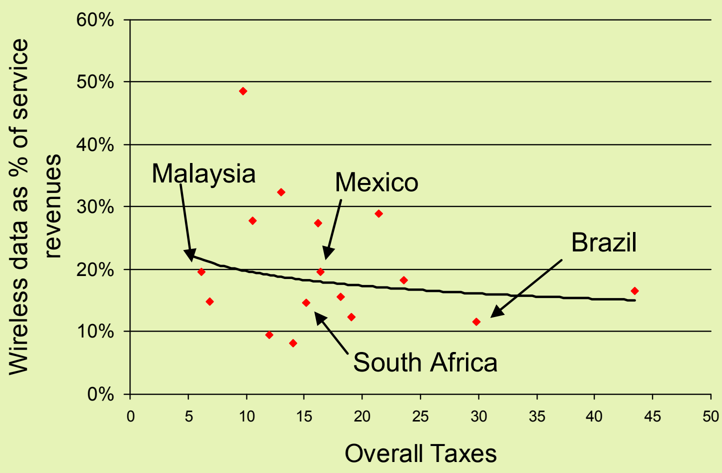
If taxes limit the adoption of wireless broadband, it is important to ask what the ultimate impact of reduced penetration might be on economic growth. According to a study by this author, the wealth creation generated by the lowering of taxes was higher than the accumulated loss in tax collection given the positive spillover effects of broadband diffusion.[101] To conclude, it is safe to assume that a reduction in the adoption of broadband services and technology as a result of incremental taxation could yield a negative impact on GDP growth.

Table 1.20: Mobile Taxation approaches in selected economies

Country	Services			Handset			
	VAT	Other Taxes	Fixed Taxes	VAT	Customs Duty	Other Taxes	Fixed Taxes
Argentina				21 %	0-20 %	- - -	- - -
Burkina Faso	18 %		$0.04-0.10	18 %	13.30 %	1 %	- - -
Bangladesh	15 %	35 %	$ 11.76	15 %	20 %	- - -	$ 11.63
Brazil	18 %	3.70 %	- - -	18 %	16 %	9.30 %	$ 13.35
Ghana	12.50 %	2.50 %			12.50	9.50 %	5.50
Iran	6 %		$ 4.33			60 %	
Malaysia	5 %	- - -	- - -	10 %	- - -	- - -	- - -
Mexico	16 %	3 %	- - -	16 %	0.10 %	- - -	- - -
South Africa	14 %	- - -	- - -	14 %	7.60 %	- - -	- - -
Sri Lanka	15 %	2.50 %				33 %	
Tunisia	18 %	5 %		10 %		8 %	
Venezuela	14 %		$1.56-6.25	14 %	14 %		

Source: Adapted from Katz et al. (2010c)

Figure 1.7: Taxation vs. Adoption of Data Services



Source: Adapted from U.S. Department of Justice, International Cooperation in Cybercrime Investigations.

1.8 Conclusion

The objective of this study was first to provide evidence on the economic impact of broadband, while recognizing that the discipline aimed at measuring these effects is still in its infancy, primarily due to the limitations in data, but also resulting from continued evolution of analytical tools. In spite of this situation, the research has already generated a considerable amount of evidence suggesting that broadband has considerable positive spill-over effects on the economy, both in terms of fostering growth and creating employment.

This study also introduced a methodology aimed at calculating the investment required to achieve full broadband penetration. This methodology was demonstrated in the cases of a developed and a developing country. The results indicate that, while the economic effects are substantial, the level of investment required to achieve the targets outlined in national broadband plans is also substantial. Accordingly, the next step should be the development of the social and economic "business cases" of such an investment. In other words, what is going to be the return of a national broadband plan and its associated price tag?

Finally, this study focused on the policies that have proven to be most successful in stimulating investment in broadband and also in promoting the adoption of broadband by population and businesses. The toolkit is wide-ranging and includes not only national broadband plans, but also the definition of competition models and the development of demand stimulation tools, which should also extend to fiscal policies. The purpose of this study has been to outline challenges and opportunities of what we believe to be a critical task for the years to come.

Bibliography

Aghion, P., Bloom, N., Blundell, R., Griffith, and Howitt, P. (2005). Competition and innovation: an inverted-U relationship. *Quarterly Journal of Economics*, vol. 120(2): pp. 701-728.

Atkinson, R., Castro, D. & Ezell, S.J. (2009). *The digital road to recovery: a stimulus plan to create jobs, boost productivity and revitalize America*. The Information Technology and Innovation Foundation, Washington, DC.

Atkinson, R. and Schultz, I. (2010). *Broadband in America. New York*, NY: Columbia Institute for Tele-Information.

Atrostic, B.K. & Nguyen, S.V. (2006). *How businesses use information technology: insights for measuring technology and productivity.* U.S. Bureau of Census, Washington, DC.

Battese, G. & Coelli T. (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics*, 20 (2), 325-332.

Barro, R. (1991). Economic Growth in a Cross Section of Countries. *The Quarterly Journal of Economics,* 106 (425), 407-443.

Basu, S. & Fernald J. (2006). Information and communications technology as a general-purpose technology: evidence from U.S industry data (Working Paper Series 2006-29). Federal Reserve Bank of San Francisco. Retrieved from www.frbsf.org/publications/economics/papers/2006/wp06-29bk.pdf.

Bundesnetzagentur (2009). *Jahresbericht 2008.* Retrieved from www.bundesnetzagentur.de/media/archive/15901.pdf.

BMWi (2009a). *Breitbandstrategie der Bundesregierung, Stand* (2009, February). Retrieved from www.bmwi.de/Dateien/BBA/PDF/breitbandstrategie-der-bundesregierung,property=pdf,bereich=bmwi,sprache=de,rwb=true.pdf.

BMWi (2009b). *Der Breitbandatlas des BMWi*. Retrieved from www.zukunft-breitband.de/BBA/Navigation/breitbandatlas.html.

BMWi (2009c). *Konjunkturgerechte Wachstumspolitik Jahreswirtschaftsbericht 2009*, www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/jahreswirtschaftsbericht-2009,property=pdf,bereich=bmwi,sprache=de,rwb=true.pdf.

Cisco/IDC (2009). *Barometro de la banda ancha: Brasil*.

Clarke, G. (2008). Has the Internet Increased Exports for Firms from Low and Middle-Income Countries? *Information Economics and Policy 20.*

Crandall, R., Jackson, C., & Singer, H. (2003). *The Effect of Ubiquitous Broadband Adoption on Investment, Jobs, and the U.S. Economy*. Washington DC: Criterion Economics.

Crandall, R., Lehr, W., & Litan, R. (2007). The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data. *Issues in Economic Policy*, *6*.

Czernich, N., Falck, O., Kretschmer T., & Woessman, L. (December 2009). Broadband infrastructure and economic growth (CESifo Working Paper No. 2861). Retrieved from www.ifo.de/DocCIDL/cesifo1_wp2861.pdf.

de Vries, G. & Koetter, M. (2008). *How does ICT enhance productivity? Evidence from latent retail technologies in Chile.*

de Vries, G., Mulder, N., Dal Borgo, M. & Hofman, A. (2007) *ICT Investment in Latin America: Does it Matter for Economic Growth?* CEPAL.

Dreher, A, Noel G., & Pim M. (2008). *Measuring Globalization – Gauging its Consequences*. (New York: Springer).

Fornefeld, M., Delaunay, G. & Elixmann, D. (2008). *The Impact of Broadband on Growth and Productivity*. A study on behalf of the European Commission (DG Information Society and Media), MICUS.

Garcia-Murillo, M. (2005). *International broadband deployment: The impact of unbundling*. Communications & Strategies, 57. 83-108.

Galperin, H. and Jordan, V. (2010). *Speeding up the digital revolution: broadband in Latin America and the Caribbean*. Santiago: Chile, Economic Commission for Latin America.

Gillett, S., Lehr, W., and Osorio, C., & Sirbu, M. A. (2006). *Measuring Broadband's Economic Impact.* Technical Report 99-07-13829, National Technical Assistance, Training, Research, and Evaluation Project.

Gordon, R. (1998). Monetary Policy in the Age of Information Technology: Computers and the Solow Paradox. Paper prepared for the conference Monetary Policy in a World of Knowledge-Based Growth, Quality Change, and Uncertain Measurement. Bank of Japan, Corrected version, 3 June 1998.

Greenstein, S. & McDevitt, R. (2009). *The Broadband Bonus: Accounting for Broadband Internet's Impact on U.S. GDP* (NBER Working Paper 14758). Retrieved from www.nber.org/papers/w14758.

Islam, N. (1995). Growth Empirics: A Panel Data Approach. *The Quarterly Journal of Economics, MIT Press,* 110 (4), 1127-70.

Horrigan, J. (2009). *Home broadband adoption 2009*. Pew Internet and American Life Project.

IPEA (2010). *Analise e recomendacoes para as politicas publicas de massificacao de acceso a internet em banda larga*. Brasilia, Brasil, Comunicados de IPEA. 26 abril 2010.

Jorgenson, D., Ho, M., Stiroh, K. (2006a). *The industry origins of the American productivity resurgence*. October 2006.Jorgenson, D., Ho, M., Samuels, J., Stiroh, K. (2006b). Productivity growth in the new millennium and its industry origins. Paper presented at the 2006 Intermediate Input-Output Meeting 26-28 July, Sendai, Japan.

Jorgenson, D., Ho, M, Samuels, J., Stiroh, K. (2007). Productivity growth in the new millennium and its industry origins. Paper presented at Sloan Industry Studies Conference, Boston.

Kalba, K. (2006). *Korea, Japan and the U.S. Broadband Gap*. Unpublished manuscript.

Kaplan, (2007). *The economic and societal benefits of ICT use: an assessment and policy roadmap for Latin America and the Caribbean*. Arlington, VA: CompTIA.

Katz, R.L. (2008a). *La competencia entre plataformas: teoría y resultados*. Editorial Enter, Madrid.

Katz, R. L., Zenhäusern, P. & Suter, S. (2008b). *An evaluation of socio-economic impact of a fiber network in Switzerland.* Polynomics and Telecom Advisory Services, LLC.

Katz, R., L. & Suter, S. (2009a). *Estimating the economic impact of the broadband stimulus plan* (Columbia Institute for Tele-Information Working Paper). Retrieved from www.elinoam.com/raulkatz/Dr_Raul_Katz_-_BB_Stimulus_Working_Paper.pdf.

Katz, R. L. (2009b). *La Contribución de las tecnologías de la información y las comunicaciones al desarrollo económico: propuestas de América Latina a los retos económicos actuales*. Madrid, España: Ariel.

Katz, R. L. (2009c). The Economic and Social Impact of Telecommunications Output: A Theoretical Framework and Empirical Evidence for Spain, *Intereconomics*, 44 (1), 41-48.

Katz, R. L. (2009d). *Estimating broadband demand and its economic impact in Latin America.* Paper submitted to the ACORN REDECOM Conference 2009, Mexico City, 5 September 2009. www.acorn-redecom.org/program.html.

Katz, R. L., Vaterlaus, S., Zenhäusern, P. & Suter, S. (2010a). The Impact of Broadband on Jobs and the German Economy. *Intereconomics*, 45 (1), 26-34.

Katz, R. L. (2010b). *La banda ancha: un objetivo irrenunciable para Brasil*. Paper presented at 54o Panel Telebrasil. Guaruja, Agosto.

Katz, R.L., Flores-Roux, E. & Mariscal, J. (2010c). *The impact of taxation on the development of the mobile broadband sector*. GSM Association, London.

Kim, Yongsoo; Kelly, Tim; Raja, Siddhartha (2010). *Building broadband: Strategies and policies for the developing World*. Global Information and Communication Technologies Department, World Bank, Washington, DC.

Kolko, J. (2010). Does Broadband Boost Local Economic Development? (Public Policy Institute of California Working paper). Retrieved from www.ppic.org/content/pubs/report/R_110JKR.pdf.

Kotelnikov, V. (2007). *Small and medium Enterprises and ICT*. Bangkok: Asia-Pacific Development Information Programme.

Koutroumpis, P. (2009). The Economic Impact of Broadband on Growth: A Simultaneous Approach. *Telecommunications Policy*, 33, 471-485.

Krugman, P. (1993). The age of diminished expectations, 1993, Cambridge, MA: The MIT Press.

Liebenau, J., Atkinson, R. D., Kärrberg, P., Castro, D. & Ezell, S. J. (29 April 2009). The UK's Digital Road to Recovery. Retrieved from: http://ssrn.com/abstract=1396687.

Merrill Lynch (2010). *Global Wireless Matrix*, 3Q2010. 24 September 2010.

Ministry of Economy and Planning of Saudi Arabia, (2010). *The Eighth Development Plan.*

Ofcom (2008). *Access and Inclusion Summary of Ofcom research on internet access, use and attitudes.* London, England: OFCOM.

Qiang, C. Z., & Rossotto, C. M. (2009). Economic Impacts of Broadband. In *Information and Communications for Development 2009: Extending Reach and Increasing Impact*, 35–50.Washington, DC: World Bank.

Red.es. (2007). *Inhibidores de uso de las TIC en la sociedad española*. Madrid: Enter.

Roeller, L-E, & Waverman, L. (2001). Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. *The American Economic Review*, 91 (4), 909-923.

Rincón-Aznar, A., Robinson, C., & Vecchi, M. (2006). *The productivity impact of e-commerce in the UK, 2001: Evidence from microdata*. The National Institute of Economic and Social Research, United Kingdom.

Sangwon, L. & Brown J. (2009). *A cross-country analysis of fixed broadband deployment: Examination of adoption factors and network effect*. Warrington College of Business Administration working paper.

Saudi Arabian Monetary Agency. Annual Reports (2005-2009). *The Latest Economic Development*.

Shideler, D., Badasyan, N., & Taylor, L. (2007, September 28-30). The economic impact of broadband deployment in Kentucky. *Telecommunication Policy Research Conference*, Washington D.C.

Shiu, A. & Lam, P-L. (2008). Causal relationship between telecommunication and economic growth: a study of 105 countries. Paper presented at the 17th Biennial Conference of the International Telecommunications Society (ITS). Montreal, 24-27 June.

Solow, R. (1987, July 12). We'd better watch out. *New York Times Book Review*, 36.

Thompson, H., & Garbacz, C. (2008). Broadband Impacts on State GDP: Direct and Indirect Impacts. Paper presented at the International Telecommunications Society 17th Biennial Conference, Canada.

van der Ark, B., Inklaar, R. & McGuckin, R. (2002). "Changing Gear" Productivity, ICT and Services: Europe and the United States, GGDC Research Memorandum Nr. 60.

van der Ark, B., Inklaar, R. & McGuckin, R. (2003). ICT and Productivity in Europe and the United States, Where Do the Differences Come From? *CESifo Economic Studies*, 49 (3), 295-318.

Varian, H., Litan, R., Elder, A. & Shutter, J. (2002). *The net impact study: the projected economic benefits of the internet in the United States, United Kingdom, France and Germany*, Available from: www.cisco.com.

Waverman, L., Meschi, M. & Fuss, M. (2005). The Impact of Telecoms on Economic Growth in Developing Countries. *Vodafone Policy Paper Series*, 2, London, United Kingdom.

Waverman, L. (2009, February 29). *Economic Impact of Broadband: An Empirical Study.* London: LECG.

APPENDIX A

LATIN AMERICA: BROADBAND CONTRIBUTION TO ECONOMIC GROWTH

Table A.1: Latin America: Variables utilized to measure broadband impact on economic growth

Type of variable	Data set	Source	Rationale
Economic growth	GDP (2004-6) and GDP (2007-9)	World Bank and Central Banks	Dependent variable
Control for level of development	GDP per capita for 2003 and 2006	World Bank	Measure for starting point of growth
Control for Investment	Average Investment / GDP for (2001-3) and (2004-6)	World Bank	Measure for differences in investment levels
Control for population growth	Population growth for (2004-6) and (2007-9)	World Bank	Measure for differences in population size
Control for Human Capital	Tertiary education (2002)	Unesco, Earthtrends, University of West Indies, Euromonitor, Government of the Commonwealth of Dominica	Measure for differences in human capital
Control for globalization	Average globalization index for (2001-3) and (2004-6)	Dreher et al. (2008)	Measure for differences in level of openness (economic, social and political)
Broadband penetration growth	Broadband penetration growth (2003-4) and (2005-6)	ITU and National Regulatory Agencies	Independent variable

Table A.2: Latin America: Broadband impact on economic growth in Latin America

GDP growth	Coefficient	Standard error	T-statistic	P>[t]	95% Conf. interval	
Broadband penetration growth	.0158715	.0080104	1.98	0.054	-.0002942	.0320372
Average Investment / GDP	-.0471624	.1689699	-0.28	0.782	-.3881575	.2938328
Population growth	-.4469177	1.40418	-0.32	0.752	-3.280668	2.386832
Tertiary education	.2139614	.1108325	1.93	0.060	-.0097076	.4376304
GDP per capita	-.0006957	.0001806	-3.85	0.000	-.0010602	-.0003313
Average globalization index	-.0653024	.1929498	-0.34	0.737	-.4546908	.324086
Constant	13.02883	12.04659	1.08	0.286	-11.28217	37.33982

Number of observations	49
F(6,42)	7.18
Prob>F	0.0000
R^2	0.3814
Root MSE	7.024

APPENDIX B

BRAZIL: THE IMPACT OF BROADBAND ON ECONOMIC GROWTH AND EMPLOYMENT

Table B.1. Brazil: Variables used to measure the impact of broadband on GDP growth

Variable	Series	Source	Observations
Economic growth	Regional GDP per capita (2006-7)	IBGE	Dependent variable
Control for level of development	GDP per capita (2002)	IBGE	Variable used to determine the starting point of development
Control for human capital	Illiteracy rate 2002	IBGE	Variable to determine differences in human capital
Control	Cost index for inter-state trade costs	Newton de Castro (2004)	Variable to determine differences in cost of transportation of goods
Control	Costs to create a new business	Lima Chagas	
Control	Average of Gini coefficient (2004-5)	IBGE	
Growth of household broadband penetration	Growth in broadband penetration (2005-6)	Household Survey (IBGE)	Independent variable

Source: Adapted from Katz (2010b)

Table B.2: Brazil: Impact of broadband on GDP growth

GDP Growth (2006-7)	Coefficient	Standard error	T-statistic	P>[t]
GDP per capita (2002)	-.0007415	0.0002883	-2.57	0.018**
Illiteracy rate 2002	-.4950848	0.2323575	-2.13	0.046**
Cost index for inter-state trade costs	-.0004711	0.0009957	-0.47	0.641
Costs to create a new business	-.0009246	0.0072004	-0.13	0.899
Average of Gini coefficient 2004-5	32.67246	46.25561	0.71	0.488
Growth in broadband penetration (2005-6)	0.0082117	0.0500811	0.16	0.871
Constant	10.06483	19.50307	0.52	0.611

Number of observations	27
F(6,20)	5.84
Prob>F	0.0012
R^2	0.2880
Root MSE	4.4716

Table B.3: Brazil: Variables utilized to estimate the impact of broadband on job creation

Variable	Series	Source	Observations
Change of unemployment rate	Change in unemployment rate (2006-7)	IBGE	Dependent variable
Control for level of development	GDP per capita (2003)	IBGE	Variable to determine the point of departure of state economic growth
Growth in household broadband penetration	Growth rate in broadband penetration (2005-6)	Household survey (IBGE)	Independent variable
Control for human capital	Years of schooling	IBGE	Variable to differentiate the level of human capital by state
Control for population growth	Population growth (2006-7)	IBGE	Variable to differentiate the level of population growth by state

Table B.4: Brazil: Impact of Broadband on Job creation

Unemployment Rate	Coefficient	Standard error	T-statistic	P>[t]
Control for level of state economic development	-.0449243	.0259892	-1.73	0.098
Growth in household broadband penetration	-.0069189	.003575	-1.94	0.066
Control for human capital	.1095254	.0940011	1.17	0.256
Control for population growth	.2009585	.1213108	1.66	0.112
Constant	-.1925308	.5035225	-0.38	0.706

Number of observations	27
F(4,22)	3.76
Prob>F	0.0178
R^2	0.4058
Root MSE	0.27016

APPENDIX C

CHILE: THE IMPACT OF BROADBAND ON EMPLOYMENT AND ECONOMIC GROWTH

Table C.1: Chile: Variables used to estimate the broadband impact on job creation

Variable	Series	Source	Observations
Employment	Quarterly employment rate (2002-9)	Regional Institutes of Statistics	Dependent variable
Control for level of economic activity by region	Quarterly Index of economic activity (2001-9)	Regional Institutes of Statistics	
Growth in broadband penetration	Quarterly growth in broadband penetration (2002-9)	Subtel	Independent variable
Human Capital	Schooling Years (population 15 years old and older)	Employment Survey, INE	Independent variable
Dominant Sectors	Contribution of the mining and financial sector to regional GDP (2002-2008)	Central Bank of Chile	Variable to control for regional specialization in dominant economic activities
Dynamic Sectors	Contribution of the agricultural and trade sector to regional GDP (2002-2008)	Central bank of Chile	Variable to control for regional specialization in dynamic economic activities

Table C.2: Chile: Broadband impact on job creation

Employment rate	Model 1		Model 2	
	Coefficient	**t-statistic**	**Coefficient**	**t-statistic**
Level of economic activity by region	0.000353	5.90	0.000353	5.72
Growth in broadband penetration	0.18118	3.85	0.1774	2.56
Human Capital			-0.0042	-1.87
Dominant Sectors			-0.00133	-1.66
Dynamic Sectors			0.001743	1.27
Constant	0.8682527	109.03	0.913817	25.95
	Number of observations	**324**	**Number of observations**	**276**
	F(2,310)	60.89	F(5,259)	20.78
	Prob>F	0.0000	Prob>F	0.0000
	R^2	0.2820	R^2	0.2863
	F(11,310)	33.89	F(11,259)	24.41
	Prob>F	0.0000	Prob >F	0.0000

Table C.3: Chile: Variables used to measure the impact of broadband on GDP growth

Variable	Series	Source	Observations
Economic growth	Average annual growth of GDP per capita (2003-4; 2005-06;2007-08)	Central Bank of Chile	Dependent variable
Control for level of development	Regional GDP (2000;2001;2002)	Central Bank of Chile	Variable to control for point of departure in economic development
Control for human capital	Percentage of population with some level of tertiary education (2003-2006)	Casen Survey	Variable to control for the level of human capital
Control for population size	Region population as a percent of country population (2002)	National Institutes of Statistics – Chile	Variable to control for level of density
Control for population growth	Regional population growth (2002-2008)	National Institutes of Statistics – Chile	Variable to control for differences in rate of population growth
Control for economic dynamics	Contribution of the agricultural and trade sector to regional GDP (2002)	Central Bank of Chile	Variable to control for regional specialization in dynamic economic activities
Control for Urban Centres	Percentage of people living in urban centres by region (2002)	National Institutes of Statistics – Chile	
Growth of broadband penetration	Growth in broadband penetration (2002-3: 2004-05; 2006-07)	Under-Secretariat of Telecommunications (Subtel)	Independent variable

Table C.4: Chile: Contribution of broadband to GDP growth

GDP Growth (2006-7)	Coefficient	Standard error	T-statistic	P>[t]
Initial Regional GDP	-1.35E-06	7.67E-07	-1.76	0.088
Tertiary Education	1.62164	0.942361	1.72	0.095
Population Size	0.529056	0.292309	1.81	0.08
Population growth	2.068497	1.091899	1.89	0.068
Dynamic Sector	-0.00809	0.080571	-0.1	0.921
Urban Population	-0.05128	0.080926	-0.63	0.531
Broadband Growth	0.00927	0.003716	2.49	0.018
Constant	-2.08091	6.80365	-0.31	0.762

Number of observations	39
F(7,31)	2.98
Prob>F	0.0165
R^2	0.4021

APPENDIX D

INDIA: THE IMPACT OF BROADBAND ON EMPLOYMENT AND ECONOMIC GROWTH

Table D.1: India: Variables used to estimate the broadband impact on job creation

Variable	Series	Source	Observations
Broadband penetration	Growth in broadband penetration (2007-8)	Indiastat	Independent variable
Employment	Employment growth (2008-9)	Indiastat	Dependent variable
Control for economic development	GDP per capita by region (2005)	Indiastat	Variable to explore the relationship of GDP and employment
Measure of economic activity	Number of micro, small and medium enterprises (2006)	Indiastat	Variable to explore the relationship of employment and development of micro, small and medium enterprises
Control for financial development	Number of banking offices per Lakh (100,000 of Population) 2002	Indiastat	
Control for financial development	Bank credit per capita by region 2002	Indiastat	
Control for infrastructure development	Total road length per hundred sq. Km by area (km.) 2001	Indiastat	
Control for population growth	Average population growth by province 2001-11	Indiastat	

Table D.2: India: Broadband impact on job creation

Employment rate	Coefficient	Standard error	T-statistic	P>[t]
Growth in broadband penetration 2007-2008	.0282529	.0151963	1.86	0.090
Number of micro, small and medium enterprises 2006	.0000461	.0000216	2.14	0.056
GDP per capita by region 2005	-.0002114	.0001056	-2.00	0.071
Number of banking offices per Lakh (100,000 of Population) 2002	.4333618	.2778866	1.56	0.147
Bank credit per capita by region 2002	-.0003247	.0001892	-1.72	0.114
Total road length per hundred sq. Km by area (km.) 2001	.0102269	.0059689	1.71	0.115
Average population growth by province 2001-11	1.73853	.7382998	2.35	0.038
Constant	-5.14944	3.834851	-1.34	0.206

Number of observations	19
F(4,14)	1.16
Prob>F	0.3983
F(2,310)	0.4237
R^2	0.4237
Adjusted R^2	0.0570
Root MSE	1.6382

Table D.3: India: Variables used to measure the impact of broadband on GDP growth

Variable	Series	Source	Observations
Economic growth	Per capita GDP growth by region 2007-2008	Indiastat	Dependent variable
Control for infrastructure	Total road length per hundred Sq. Km. of are (Km.) 2001	Indiastat	Variable to control the contribution of physical capital to economic growth
Broadband penetration	Growth of broadband penetration 2007-2008	Indiastat	Independent variable
Control for human capital	Participation rate in secondary schooling 2001	Indiastat	Variable to control for contribution of human capital to economic growth
Control for population growth	Average population growth by province 2001-2006	Indiastat	
Control for point of departure of economic growth	GDP per capita by region 2000	Indiastat	

Table D.4: India: Contribution of broadband to GDP growth

GDP Growth (2007-8)	Coefficient	Standard error	T-statistic	P>[t]
Total road length per hundred Sq. Km. of are (Km.) 2001	.00300	.0006727	4.46	0.001
Growth of broadband penetration 2007-2008	.031284	.0158414	1.97	0.070
Participation rate in secondary schooling 2001	.0133936	.0803297	0.17	0.870
Average population growth by province 2001-2006	-1.075241	1.272319	-0.85	0.413
GDP per capita by region 2000	.0000278	.00007	0.40	0.698
Constant	2.753619	7.668025	0.36	0.725

Number of observations	19
F(5,7)	8.02
Prob>F	0.0012
R^2	0.3241
Root MSE	2.2265

APPENDIX E

MALAYSIA: THE CONTRIBUTION OF BROADBAND TO ECONOMIC GROWTH

Table E.1. Malaysia: Variables used to measure the impact of broadband on GDP growth

Variable	Series	Source	Observations
Economic growth	GDP Growth 2007-2008	Department of Statistics – Malaysia	Dependent variable
Broadband penetration	Growth of broadband household penetration 2006-7	Under Secretariat ICT Policy Division	Independent variable
Control for infrastructure	Hospitals per million population 2005	Ninth Malaysia Plan (2006-2010)	Variable to control for physical capital
Control for infrastructure	Beds in hospitals per million population 2005	Ninth Malaysia Plan (2006-2010)	Variable to control for physical capital
Control for infrastructure	Construction projects funded by the government 2004	Ninth Malaysia Plan (2006-2010)	Variable to control for physical capital
Economic activity	Added value of construction sector 2004	Ninth Malaysia Plan (2006-2010)	Variable to study the relationship between government funding and economic development
Control for Human Capital	Literacy rate 2000	Ministry of Education	Variable to control for human capital
Control for Infrastructure	Road development index 2005	Ninth Malaysia Plan (2006-2010)	Variable to control for physical capital

Table E.2. Malaysia: Contribution of broadband to GDP growth

GDP Growth (2007-8)	Coefficient	Standard error	T-statistic	P>[t]
Growth of broadband household penetration 2006-2007	0.077024	0.013247	5.81	0.001
Hospitals per million population 2005	-0.54338	0.146033	-3.72	0.007
Beds in hospitals per million population 2005	0.007824	0.002203	3.55	0.009
Construction projects funded by the government 2004	-0.02375	0.0089983	-2.64	0.033
Added value of construction sector 2004	0.005661	0.001693	3.34	0.012
Literacy rate 2000	0.789125	0.126412	6.24	0.000
Road development index 2005	-10.6963	2.126227	-5.03	0.002
Constant	-52.836	9.339643	-5.66	0.001

Number of observations	15
F(7,7)	107.27
Prob>F	0.0000
R^2	0.9010
Root MSE	1.1898

APPENDIX F

SAUDI ARABIA: THE IMPACT OF BROADBAND ON EMPLOYMENT

Table 33. Saudi Arabia: Variables used to estimate the broadband impact on job creation

Variable	Series	Source	Observations
Unemployment	Change rate in unemployment rate (2007-2008)	Forty Fifth Annual Report – Saudi Arabia Monet	Dependent variable
Broadband penetration	Change in broadband penetration per population (2007-8)	Communications and Information Technology Commission	Independent variable
Control for infrastructure	Facilities authorized to provide health services (2008)	Annual Report – Saudi Arabia Monetary Agency	
Incidence of tourism	Change in the number of domestic tourism trips (2007-2008)	Annual Report – Saudi Arabia Monetary Agency	Independent variable
Control for infrastructure	Percentage of households with access to potable water	Annual Report – Saudi Arabia Monetary Agency	
Importance of government spending	Change in the number of projects funded by the government (2007-2008)	Annual Report – Saudi Arabia Monetary Agency	Independent variable
Importance of government spending	Change in the value of projects funded by the government (2007-8)	Annual Report – Saudi Arabia Monetary Agency	Independent variable

The model results are as follows (see Table 34):

Table 34. Saudi Arabia: Broadband impact on job creation

Unemployment rate	Coefficient	Standard error	T-statistic	P>[t]
Change in broadband penetration per population 2007-8	-0.2434	0.02935	-8.29	0.000
Facilities authorized to provide health services (2008)	0.899473	0.170589	5.27	0.002
Change in the number of domestic tourism trips (2007-8)	0.337701	0.093622	3.61	0.011
Percentage of households with public access to potable water	0.652031	0.13798	4.73	0.003
Change in the number of projects funded by the government (2007-8)	-2.31629	0.761245	-3.04	0.023
Change in the value of projects funded by the government (2007-8)	-0.92765	0.341837	-2.71	0.035
Constant	-16.1099	14.306	-1.13	0.303

Number of observations	13
F(6,6)	34.84
Prob>F	0.0002
R^2	0.9400
Root MSE	7.8648

---

1 The author would like to acknowledge the support of Javier Avila, Giacomo Meille and Julian Katz-Samuels, all researchers at the Columbia Institute for Tele-Information.

2 Dialup technology refers to Internet access over conventional voice telephone lines at speeds that do not exceed the 56 Kbps.

3 See Atkinson and Schultz (2010). Broadband in America. New York: Columbia Institute for tele-Information.

4 See Sinopac (2009). Taiwan Research.

5 See AM Research (2010). Telecommunications: CAPEX risk from escalating competition in broadband.

6 Within 12 years, broadband has been adopted by over 60% of households in the United States, 80% in the Netherlands and 91% in Korea (ITU, 2010; OECD, 2010).

7 According to the “critical mass theory”, the economic impact of broadband increases exponentially with penetration of the technology as a result of network effects.

8 Or 0.36% if we make the standard assumption that 1% increase in productivity or efficiency results in 1% increase in GDP.

9 The original regression yielded a coefficient of 0.0027 for the 2/3 more developed countries in the sample and negative effect for the lower third. A negative effect did not make sense so the authors constrained the effect for the lower third to zero. At that point the coefficient for the full sample moved to 0.0013.

10 See Waverman, L. and Dasgupta, K. Broadband and Growth. Presentation to the Columbia Institute for Tele-Information Conference "State of Telecom: National Next-Generation Broadband Plans", October 23, 2009, Columbia University, New York.

11 See Waverman, 2009.

12 For example, Waverman (2009) estimated that in the United States broadband penetration contributed approximately to 0.26% per annum to productivity growth, resulting in 11 additional cents per hour worked (or USD 29 billion per year).

13 Gillett et al. (2006) at 10.

14 See e.g., Gillett et. al, 2006.

15 Op. cit. above.

16 See Katz et al. (2010a).

17 See Basu & Fernald (2006).

18 For additional details, see section 1.7.5.

[19] See Atkinson et al., 2009.

[20] Op. cit.

[21] Op. cit.

[22] Op. cit.

[23] Op. cit.

[24] See Varian et al, 2002; Gillett et al, 2006.

[25] See Crandall et al. (2007).

[26] As Crandall indicated, the overestimation of employment creation in his study is due to employment and migratory trends that existed at the time and biased the sample data.

[27] See examples in case studies of Germany and Chile included in Sections 1.3.2 and 1.3.4.

[28] This effect was also mentioned by Gillett et al. (2006).

[29] See Clarke (2008).

[30] *Ibid.*

[31] See Fornefeld et al. (2008).

[32] The study by Fornefeld et al. (2008) is probably the first attempt to build a causality chain. It applies ratios derived from micro-economic research to estimate the combined impact of all effects.

[33] This analysis is based on prior research contained in R. Katz and S. Suter (2009a). *Estimating the economic impact of the broadband stimulus plan*. Columbia Institute for Tele-Information Working Paper presented at a conference on "Spending the Broadband Stimulus: Maximizing the benefits and monitoring performance" held at the National Press Club in Washington, D.C. on 19 February 2009.

[34] This analysis is based on prior research contained in Katz, R. L., Vaterlaus, S., Zenhäusern, P., Suter, S. (2010a). The impact of broadband on jobs and the German economy. *Intereconomics*, January-February, Volume 45, Number 1, 26-34. The results were originally presented at the Confederation of German Industries in Berlin on 17 June 2009.

[35] An estimate of funds dedicated primarily to broadband deployment, as opposed to ancillary activities such as broadband mapping.

[36] Induced employment refers to job creation resulting from additional household consumption generated by direct and indirect jobs created by network construction.

[37] For methodology, see Katz et al (2009a).

[38] See FCC Table 14 of HSPD1207. We have been informed that Table 14 actually overestimates the accessibility percent by approximately 2% because cable TV operators tend not to report accurate deployment numbers.

[39] There is a large gap between households served by at least one broadband technology (average 89%) and broadband penetration (47%).If the ratio households served/adopted (1.90) remains, the capacity to serve 7,463,200 additional households should be deployed in order to increase the subscriber base by 3,928,000. This is well within the bounds of the total grants of the program.

[40] Innovation is assumed to occur in the sectors and functions where productivity improvement takes place.

[41] See methodology in appendix B.2 of Katz et al. (2009a).

[42] Given the static nature of I/O-matrix it is not possible to project job creation over time. This could be done, however, if yearly investment data is available.

[43] This said, the available data sets do not enable us to test this last point at this time.

[44] "White spots" are defined as areas lacking wireless service, while "grey spots" are the areas with uneven coverage.

45 A cautionary note should be made that in order to translate infrastructure deployment programs into increased broadband penetration, network construction should be complemented with very targeted demand promotion programs (be they community aggregation programs such as the ones of the Dutch government, tax deductions such as the ones implemented in Sweden, and, potentially, subsidies) that stimulate adopters to sign up for service.

46 In contrast to the case of network construction, it is not possible to determine what type of sectors would be mostly impacted by network externalities. However, experience indicates that higher developed areas will generate knowledge-intensive occupations such as research and development (R&D) and product development, while less developed regions will attract low-end information intensive jobs, such as virtual call centres.

47 These figures are subject to three important notes. First, it is obvious that, while total projections have been split evenly over time, one would expect yearly projections to vary. For example, more jobs are generated in the beginning of network deployment than in the back-end. This would require further refinement of these projections that takes into account construction plans. Second, as mentioned above, in order to avoid double counting with respect to network construction effects in the first years and to assure a conservative calculation, some of the totals have been reduced. Third, we assume that the regression model is capable of projecting economic impact over a three year period with effects through 2020 following suit.

48 Only effects up to t + 3 are estimated.

49 This analysis is based on prior research contained in Katz, R. L. (2010b). *La banda ancha: un objetivo irrenunciable para Brasil* presented at the 54o Panel Telebrasil. Guaruja, on August 18, 2010.

50 This analysis was originally prepared for Galperin and Jordan (2010). *Speeding-up the digital revolution: broadband in Latin America and the Caribbean*, published by the Economic Commission for Latin America and the Caribbean (ECLAC).

51 In this vein, it was only at the beginning of the current century, after more than forty years of intense adoption of computers, that growth accounting economists were able to finally show the impact of ICT on US productivity. See Jorgenson et al., 2007.

52 See Katz, 2009d.

53 See Barro, 1991.

54 See Qiang & Rossotto, 2009; Crandall et al, 2007; Garbaz et al., 2008.

55 The variables used and model results are included in Appendix A.

56 Alternative specifications were used, including primary and secondary education enrollment rates, as a proxy for human capital, but only the model including tertiary education yielded significant results.

57 This figure is indicative for a period without major economic crises, since the model was run for the period 2004-2009.

58 The data utilized and the model results are included in Appendix B.

59 According to a consensus forecast compiled by EMIS.

60 The data utilized and the model results are included in Appendix C.

61 It was significant at the 1% level on the first specification and at the 5% level on the second one.

62 While there were 20 telecom circles defined by the government for 2006, lack of information made it necessary to consolidate two circles into one. Data and model results are included in Appendix D.

63 Though we are aware of this problem, the lack of information in this case made estimation by Instrumental Variables or Simultaneous Equations an impossible task.

64 Data and model results are included in Appendix E.

65 The study by McKinsey forecasts that 10 percent increase in broadband penetration per population will yield .4 contribution to GDP growth. In order to compare this estimate to ours, penetration per population was converted to households by multiplying 0.4 by 4.45, which is the average number of persons per household in Malaysia. The same study forecasts that an increase of 10% in broadband penetration per inhabitant would have an impact of 0.6% to 0.7% on the GDP of Asia.

66 Data and model results are included in Appendix F.

67 Total households: 39.7 million, Federal Statistical Office Germany 2006.

68 Federal Government of Germany (2009) "Breitbandstrategie der Bundesregierung", 3.

69 See BMWi, 2009c, *38*.

70 See Katz et al. (2010a).

71 For example, in the case of FTTH the initial 10 percent of households (3,972,000) will cost EUR 1,150 per household to deploy; the next 10 percent will require EUR 1,287; and the next 10 percent will require EUR 1,425. In the case of VDSL, providing access to the first 10 percent of households will cost EUR 300, while deploying beyond 50 percent of households will require EUR 450.

72 The difference between the first 25% achieved in 2014 (EUR 12,236 million) and the second 25% tranche achieved in 2020 (EUR 15,690 million) is due to two factors: 1) the first tranche benefits from the 240,000 households already served by municipal networks roll-out and, more importantly, 2) the cost per line in the second phase rises from EUR 1,150-1,425 to EUR 1,500-1,700.

73 Cisco/IDC. *Barometro de Banda Larga*. Sao Paulo, 2010.

74 The deployment cost is an approximate estimate that averages the deployment costs of ADSL in relatively dense areas ($300) and the construction of broadband wireless infrastructure in rural areas. (In the US, the estimate approximates $1,800/line.)

75 See Kim et al., 2010.

76 Kim et al., 2010.

77 For example, in the last tranche of privatization of Korea Telecom, the government agreed with SK Telecom the acquisition of 11.3% of shares, while LG acquired 2.3%.

78 One should not forget stimulus plans, universal service funds and public-private partnerships being also initiatives to channel government funding. This is particularly the case in , in many developing countries.

79 In this context, it is important to discuss whether a broadband platform-based competitive model can develop in countries that lack a highly developed cable TV operator. In this case, wireless carriers (or Wimax-based new entrants) offering broadband access could provide the necessary competitive stimulation for wireline carriers to invest in deploying broadband networks.

80 See Aghion et al., 2005.

81 See Katz, 2008.

82 See Yoo, 2008.

83 Prompted by competition from the cable TV operators, Bell Canada plans to have VDSL2 cards available to 100% of its network by YE2010, while beginning in 2H10, all new neighborhoods in Quebec City will get FTTH with 100 Mbps capability.

84 The high capital intensity of telecommunications is naturally conducive to a certain level of consolidation and vertical integration.

85 We define this as the gradual transformation of the mission and operating paradigm of a municipal broadband network from a public service not for-profit utility to that of a private commercial enterprise.

86 Backhaul service, which includes the lines required to interconnect the base station to the network, also represent a high recurring expense.

87 This represented a key stimulus in a country where the average taxpayer has a marginal tax rate 20%.

88 See PTS (2008). Dark Fiber: market and state of competition. Stockholm, Report PTS-ER-2008:9, p. 23.

89 See Mitchell, Christopher (2008) "Municipal Broadband: Demystifying wireless and fiber optic options", *Broadband properties*, February, p. 42.

90 See the experience of Infacom in South Africa, as described in Gilliwald, Allyson (2009). Presentation to Alternatives for Broadband Infrastructure and Access Development, Brasilia, 16 November 2009.

91 See Kim et al. (2010).

92 See Katz et al, 2009.

[93] Investment prospectus of Multicanal and Telecom Argentina (2010).

[94] See Red.es, 2007.

[95] These individuals make use of the technology, but only on a periodic basis (such as biweekly, monthly or quarterly).

[96] See, for example, Rogers, Everett. And Shoemaker, F. (1971). Communication of Innovation. New York: Free Press and, Stoneman, P. (1976) "Technological Diffusion and the Computer Revolution, the UK experience", department of Applied Economics Monograph 25, Cambridge University.

[97] See Kalba, 2006.

[98] For example, the Pew Research study indicates that during 2009, 9% of Internet users in the United States have canceled or downgraded their Internet service due to economic pressures.

[99] See Katz, 2009b.

[100] See Malaysia Communications and Multimedia Commission. The National Broadband Plan, 2006.

[101] See Katz *et al.,* 2010.