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IMPACT OF BROADBAND ON THE ECONOMY

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Impact of Broadband on the Economy:

Research to Date and Policy Issues

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This study on the impact of broadband on the economy was prepared by Dr. Raul Katz, Director, Business Strategy Research, at the Columbia Institute for Tele-Information (CITI) at Columbia University, under the direction of the BDT Regulatory and Market Environment Division (RME). 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, and Fernando Callorda, consultant at Telecom Advisory Services, LLC. ITU wishes to express thanks to Jim Holmes, Incyte Consulting and Denis Villalobos from ICE, Costa Rica for their comments and advice.

This report is part of a new series of ITU reports on broadband that are available online and free of charge at the ITU Universe of Broadband portal: www.itu.int/broadband.

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Preface

The past twenty years has been an extraordinary time for the development of information and communication technologies (ICTs) – and with the 'mobile miracle' we have brought the benefits of ICTs within reach of virtually all the world's people. ITU has been in the forefront of this transformational ascent and is today committed to continue to driving positive change in the sector and beyond. It is now time to make the next step, and to ensure that everyone – wherever they live, and whatever their circumstances – has access to the benefits of broadband. This is not just about delivering connectivity for connectivity's sake – or even about giving people access to the undoubted benefits of social communications. It is about leveraging the power of broadband technologies – and especially mobile technologies – to make the world a better place.

In 2010, ITU, in conjunction with UNESCO, launched the Broadband Commission for Digital Development – to encourage governments to implement national broadband plans and to increase access to broadband applications and services. The Commission is co-chaired by President Paul Kagame of Rwanda and Carlos Slim, President of the Carlos Slim Foundation. We have around 60 Broadband Commissioners – all top-level leaders in their field – representing governments, industry, academia and international agencies. At the Broadband Leadership Summit held in October 2011 in Geneva, the Broadband Commission recognized broadband as a critical modern infrastructure contributing to economic growth and set four clear, new targets for making broadband policy universal and for boosting affordability and broadband uptake. Out-of-the-box models that promote competition, innovation and market growth are now needed to make the broadband opportunity reachable for all world citizens.

At ITU, the United Nations specialized agency for ICTs and telecommunications, we are committed to playing a leading role in the development of the digital economy through extending the benefits of advances in broadband and embracing the opportunities it unleashes. The three ITU sectors – Radiocommunications, Standardization and Development – are working together to meet these challenges and our collective success will be a key factor in ensuring the provision of equitable broadband access throughout the world. The ITU Broadband Reports are one contribution towards this commitment.

Dr. Hamadoun I. Touré

Secretary-General, ITU

Foreword

Broadband has become a key priority of the 21st Century, and I believe its transformative power as an enabler for economic and social growth makes it an essential tool for empowering people, creating an environment that nurtures the technological and service innovation, and triggering positive change in business processes as well as in society as a whole. Increased adoption and use of broadband in the next decade and beyond will be driven by the extent to which broadband-supported services and applications are not only made available to, but are also relevant and affordable for consumers. And while the benefits of broadband-enabled future are manifest, the broadband revolution has raised up new issues and challenges.

In light of these developments, ITU launches a new series of ITU Broadband Reports. The first reports in the series launched in 2012 focus on cutting edge policy, regulatory and economic aspects of broadband. Other related areas and themes will be covered by subsequent reports including market analysis, broadband infrastructure and implementation, and broadband-enabled applications. In addition, a series of case studies will complement the resources already made available by ITU to all its many different types of readers, but especially to ICT regulators and policy-makers.

This new series of reports is important for a number of reasons. First of all, the reports will focus on topical issues of special interest for developed and developing countries alike. Secondly, the various reports build on ITU's recognized expertise in the area augmented by regular feedback from its Membership. Last but not least, this series is important because it provides a meaningful contribution to the work of the Broadband Commission for Digital Development. The findings of the ITU Broadband Reports will trace paths towards the timely achievement of the ambitious but achievable goals set recently by the Commission as well as provide concrete guidelines. As broadband is a field that's growing very fast, we need to constantly build knowledge for our economies and societies to thrive and evolve into the future.

For these reasons, I am proud to inaugurate this first series of the ITU Broadband Reports and look forward to furthering ITU's work on the dynamic and exciting broadband ecosystem.

Brahima Sanou

Director, ITU Telecommunication Development Bureau

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[1], 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 and adoption soared around the world. By 2009, there were 1.8 billion Internet users and 471 million broadband subscriptions[2]. Between 2004 and 2010, telecommunications and cable TV companies in the United States invested over USD 97.7 billion in broadband deployment[3]. Broadband capital is not only restricted to industrialized nations. In some emerging countries broadband investment is also increasing exponentially. Chinese companies have invested USD 7.44 billion in broadband since 2009[4], while Malaysian operators invested USD 1.6 billion since 2009[5].

With these amounts of capital being dedicated to the technology, it is natural that policy makers and researchers in the social sciences have begun to analyse the economic and social impact of broadband. In fact, social scientists and policy makers had been researching the economic contribution of information and communication technologies for quite a while. The first analyses of the impact of fixed telephone density on economic growth were conducted in the mid-1970s by World Bank researchers[6]. Ever since, enhancements both in the quality of data and sophistication of econometric tools have yielded continuous improvement in tackling the question of economic impact of telecommunications.

Broadband, however, represents a new challenge for researchers. First, its deployment has proceeded at an incredibly fast pace. Within 12 years, broadband has been adopted by over 62 per cent of households in the United States, 80 per cent in the Netherlands and 95.9 per cent in Korea (ITU, 2010; OECD, 2010)[7]. Consequently, the length of time series data of broadband adoption is considerably shorter than for voice telecommunications. Second, only the countries that have understood early on its economic potential have proceeded to collect statistics at the beginning of the diffusion process. Third, 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. In sum, because broadband has been deployed in such a short time span and it is an enabler of remote information technology access, it has represented a substantial research challenge. The primary challenge, though, remains the lack of disaggregated datasets that allow to quantitatively establish the conditions under which broadband has an economic effect.

These methodological challenges rendered the broadband policy making process quite complex. It is difficult to ascertain precisely if broadband contributes to economic growth or it is deployed as a result of growing development. This problem risks repeating the debate started when economists started looking at the impact of computing. As expected, the original results were not conclusive. Robert Solow, the Nobel Economics laureate from MIT, concluded at the time "you can see the computer age everywhere

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

2 Source: Internet World Statistics (September 2009). In June 2010, the number of Internet users had reached 1.96 million.

3 See Atkinson and Schultz (2010).

4 Source: Sinopac (2009). Taiwan Research.

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

6 See Jipp (1963).

7 In addition, in the last five years, the combination of wireless technology and broadband service is taking service adoption from the household to the individual user.

but in the production statistics"[8]. His conclusion kicked off a sceptical body of research and theory. In particular, Paul Krugman, another Nobel laurate, stated in the early 1990s that "either the technology isn't all it's cracked up to be, or we haven't yet seen the impact of the new technology on the economy"[9], while Robert Gordon concluded that computers made only a small contribution to productivity because "there is something wrong with computers"[10].

Luckily enough, the availability of larger data sets at the beginning of the 21st century allowed researchers to more precisely estimate the effects of computing. This led to the development of a new theory based on growth accounting economics that could not only pinpoint the economic impact of information technology, but also identify differential effects by region of the world[11]. For example, a study relating labour productivity growth on ICT investments on an industry level concluded that the faster productivity growth in the US compared to EU countries can be attributed to a larger employment share in the ICT producing sectors and a faster growth in industries that intensively use ICT[12]. No one doubts today that computing in particular and ICT in general have significantly contributed to economic growth in the industrialized world during the 1990s and 2000s.

The evidence on broadband is not quite conclusive, however. As detailed above, the study of the economic effects of broadband presents several methodological challenges. Research has confronted these challenges by proceeding along three avenues. In the first place, macro-economic research grounded on the Harvard economist Robert Barro's endogenous technical change model[13] has analysed the aggregate impact of broadband on economic development. In this case the guiding question is what is the contribution of broadband to GDP growth, productivity and employment? The second avenue has researched the impact of broadband from the microeconomic perspective. It is conducted at the firm level and emphasizes the contribution of broadband to business process efficiency and sales growth. The key issue here is to understand the return on broadband and IT investment at the firm and sector level. The third school of thought tackles this last question from a qualitative perspective, choosing the case study as its primary analytical tool.

Nevertheless, the evidence accrued by these three bodies of research is beginning to support the hypothesis that broadband has an important economic impact. However, when comparing findings across research, a number of caveats need to be raised. First, broadband exhibits a higher contribution to economic growth in countries that have a higher adoption of the technology (this could be labelled the "critical mass" or "return to scale" theory"[14]). 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 labelled the "productivity shock theory"). Fourth, the impact of broadband on small and medium enterprises takes longer to materialize due to the need to restructure the firms' processes and labour organization in order to gain from adopting the technology (this is called "accumulation of intangible capital"). Finally, the economic impact of broadband 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

[8] See Solow, 1987.

[9] See Krugman, 1993.

[10] See Gordon, 1998.

[11] See Jorgenson et al., 2006a, and van der Ark et al., 2002.

[12] See van der Ark et al., 2003.

[13] See Barro, 1991.

[14] According to this theory, driven by network effects, the economic impact of broadband increases exponentially with the penetration of the technology. See further references in Sections 2.2 and 8.1.

emphasizes 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.

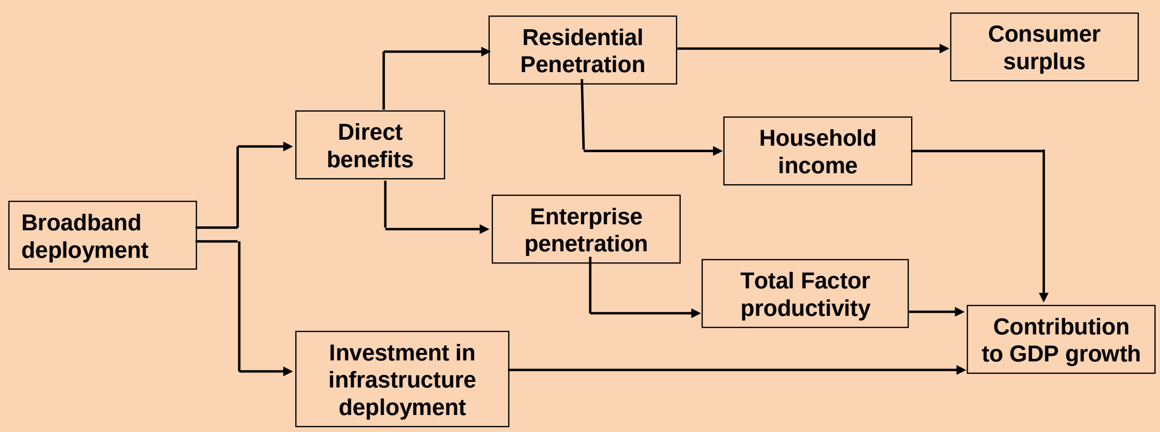
The purpose of this study is threefold. On one hand, it presents the evidence generated by the different bodies of theory regarding the economic impact of broadband. The purpose is not only to summarize but also to present the complexities and conditions under which broadband has an impact. On the other hand, it reviews the results of research the author has conducted across the world measuring the impact of broadband on economic growth and employment creation. In this context, it presents a methodology for calculating the investment necessary to implement national broadband plans. Finally, it outlines the public policy implications, which can stimulate deployment and maximize the impact of the technology.

2 Economic Impact of Broadband: A Review of the Literature

The economic impact of broadband manifests itself through four types of effects (see Figure 1).

The first effect results from the construction of broadband networks. In a way similar to any infrastructure project, the deployment of broadband networks creates jobs and acts over the economy by means of multipliers. The second effect results from the "spill-over" externalities, which impact both enterprises and consumers. The adoption of broadband within firms leads to a multifactor productivity gain, which in turn contributes to growth of GDP. On the other hand, residential adoption drives an increase in household real income as a function of a multiplier. Beyond these direct benefits, which contribute to GDP growth, residential users receive a benefit in terms of consumer surplus, defined as the difference between what they would be willing to pay for broadband service and its price. This last parameter, while not being captured in the GDP statistics, can be significant, insofar that it represents benefits in terms of enhanced access to information, entertainment and public services.

Figure 1: Broadband economic impact



Source: Author

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 five areas:

1. Contribution to economic growth ("positive externalities").
2. Contribution to productivity gains.
3. Contribution to employment and output of broadband deployment ("countercyclical effect").
4. Creation of consumer surplus.
5. Improvement of firm efficiencies.

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 assess broadband's economic contribution. Each methodology that has been utilized so far (input / output analysis, econometric modelling, 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.

2.1 Contribution to economic growth

Broadband technology is a contributor to economic growth at several levels. First, the deployment of broadband technology across business enterprises improves productivity by facilitating the adoption of more efficient business processes (e.g., marketing, inventory optimization, and streamlining of supply chains). Second, extensive deployment of broadband accelerates innovation by introducing new consumer applications and services (e.g., new forms of commerce and financial intermediation). Third, broadband leads to a more efficient functional deployment of enterprises by maximizing their reach to labour pools, access to raw materials, and consumers, (e.g., outsourcing of services, virtual call centres.)

Research aimed at generating hard evidence regarding the economic impact of broadband is fairly recent. The review of the research indicates that there are multiple approaches to estimate the economic impact of broadband, ranging from highly sophisticated econometric techniques to qualitative micro-level case studies. Not all approaches are suitable to all situations. The choice of analytical techniques will be driven by the availability of data and type of effect to be analysed.

The study of the impact of broadband on economic growth covers numerous aspects, ranging from its aggregate impact on GDP growth, to the differential impact of broadband by industrial sector, the increase of exports, and changes in intermediate demand and import substitution. 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 Western Europe and North America) and states in the United States (see Table 1).

Table 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	Not 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) – Imperial College	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% increase in 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 % increase in broadband penetration yielded an additional 1.38 in GDP growth

Source: Author

As the data in Table 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[15].

Explanations for this variance are manifold. Clearly, some of the discrepancies come from the usage of different datasets as well as model specifications. However, in some cases differences may be due to methodological shortfalls. For one, at very high levels of data aggregation, such as country data, the econometric models do not account for the wide discrepancy between regions that are caused by fixed effects. For example, a large portion of the variance in the study by Qiang *et al.* (2009) is explained by dummy variables for Africa and Latin America (nearly ten times as much as the estimate given by Barro (1991) in the original formulation of the model). This probably suggests an over-estimation of impact of broadband on GDP growth. It also justifies the need to rely on the differentiation of fixed effects and to conduct the analysis at lower levels of aggregation such as states and, where data is available, even counties or administrative departments.

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. However, despite the degree of discrepancies, the research consistently concludes that broadband has a significant positive effect on GDP growth.

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:

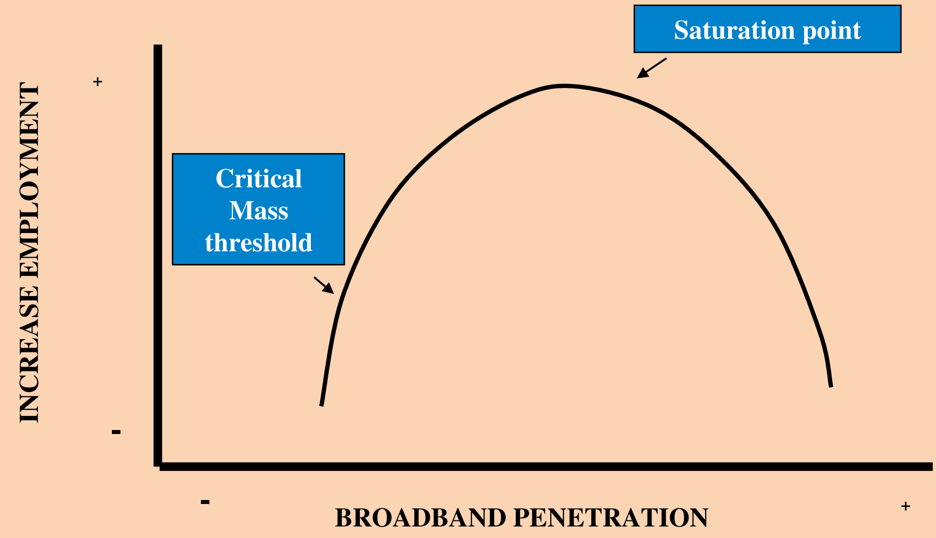
1. Does the economic impact of broadband increase with penetration and can we pinpoint a saturation threshold when decreasing returns to penetration exist?
2. What explains the lagged effect of broadband on the economy?

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 of the impact of telecommunications on the economy, indicates 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) 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” (pp. 10). 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 2).

Theoretically, it appears that there is a non-linear (or inverted U shape) relationship between broadband penetration and output. 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 the “return to scale” theory, the impact of telecommunications infrastructure on the economic output is maximized once the infrastructure reaches a critical mass point, generally associated with levels of penetration of developed countries. As a result, we initially observe increasing returns on growth (see Roeller and Waverman, 2001; Shiu and Lam, 2008). While Roeller and Waverman (2001) associate “critical mass” with near universal voice telephony penetration, we are starting to identify this phenomenon for broadband as well.

[15] Or .36% if we make the standard assumption that 1% increase in productivity or efficiency results in 1% increase in GDP in Thompson and Garbacz (2008).

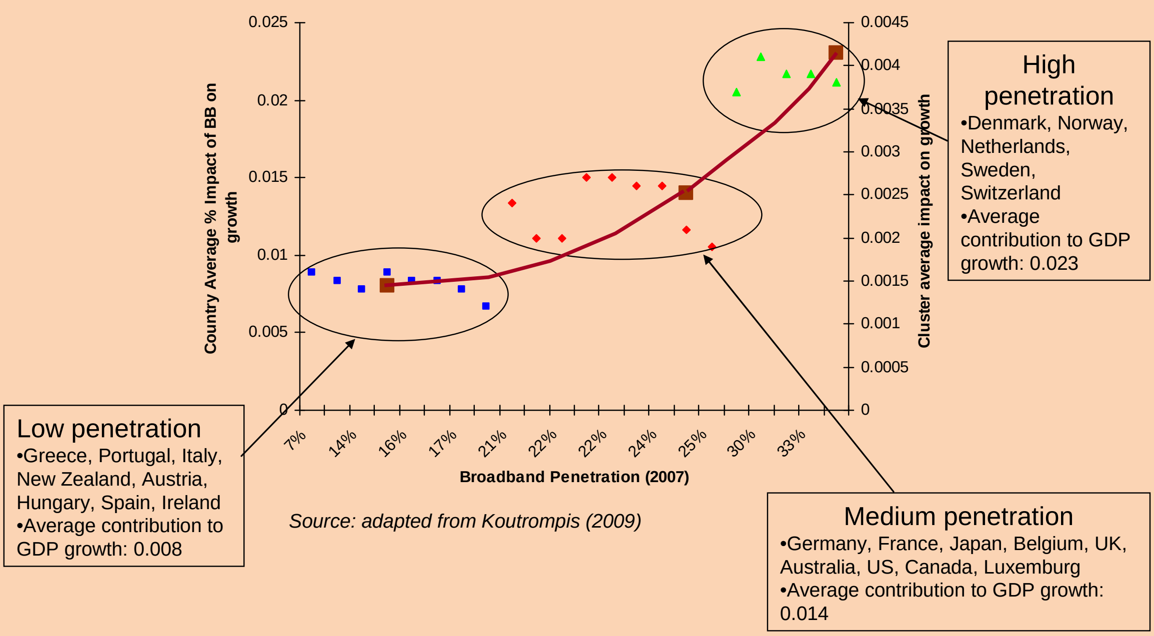
Figure 2: Impact of broadband on output over diffusion process



Source: Adapted from Katz (2008a).

The implication of this finding for developing countries is significant. Research points to the fact that in order to achieve an important level of economic impact, broadband needs to 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 3).

Figure 3: OECD: Percentage of impact of broadband on GDP growth



Source: OECD

As seen above, according to Koutroumpis' research, in countries with low broadband penetration (under 20%), an increase of 1 per cent in broadband adoption contributes to 0.008 per cent of GDP growth, while in countries with medium penetration (between 20% and 30%), the effect is of 0.014 per cent and in countries with penetration higher than 30 per cent, the impact of 1 per cent adoption reaches 0.023. The implication of this finding for developing countries is quite significant. Unless emerging economies do not strive to dramatically increase their penetration of broadband, the economic impact of the technology will be quite limited.

At the other end of the penetration process, some authors have already pointed out a potential "saturation" effect[16].They find that beyond a certain adoption level (not specified, as of yet), the effect of broadband on the economy tends to diminish. For example, Atkinson at al. (2009) point out that network externalities decline with the build out of networks and the maturation of technology over time. There is evidence that supports this argument. It has been demonstrated in diffusion theory that early technology adopters are generally those who can elicit the higher returns of a given innovation. Conversely, network externalities would tend to diminish over time because those effects would not be as strong for late adopters.

To test the saturation hypothesis, Czernich *et al.* (2009)[17] added dummy variables to account for 10 per cent and 20 per cent broadband penetration to their models. They found that 10 per cent broadband penetration has a significant impact on GDP per capita: between 0.9 and 1.5 percentage points. Similarly, in their study of the state of Kentucky, Shideler et al. (2007) estimated that employment growth is highest around the mean level of broadband saturation at the county level, driven by the diminishing returns to scale of the infrastructure. According to this, a critical amount of broadband infrastructure may be needed to sizably increase employment, but once a community is completely built out, additional broadband infrastructure will not further affect employment growth.

The saturation evidence still needs to be carefully tested particularly in terms of what the optimal point is beyond which broadband exhibits decreasing economic returns. For example, in a study conducted in Germany by this author (discussed later), it was not possible to identify a saturation point for broadband penetration[18]. Furthermore, even if that were to be found confirming evidence of saturation with regard to contribution to GDP or employment creation, that would not put into question the need to achieve universal broadband in terms of the social benefits it yields to end users.

Most of the statistical research on the economic impact on GDP growth is performed using regressions of cross-lagged indicators (in other words, an increase in broadband deployment in year one is found to have an impact two or more years later). This approach is common in the assessment of economic impact of infrastructure (given that no deployment has an immediate economic impact.) However, the premise underlying the lagged effects assumption comprises a more complicated process of broadband adoption.

Management science has studied how technology is adopted by individual firms and how it impacts firm productivity. First of all, purchasing ICT is not the only requirement for improving productivity. In fact, both management and economics literature have shown that it is necessary to modify business practices in order for information technology impact firm efficiency. Accordingly, independently from the pace at which ICT is being adopted, the impact on efficiency and productivity is driven by what has been called "accumulation of intangible capital"[19].

This effect that has been studied for ICT exists in the case of broadband as well. Technology adoption is only the first step in the assimilation of business processes that yield improvement in productivity.

To sum up, in order to fully increase efficiency and output, the adoption of information and communication technologies by enterprises requires the introduction of a number of processes and organizational changes. These changes, as well as training and other cultural factors, (such as

16 Gillett et. al, 2006.

17 Op. cit. Above.

18 See Katz *et al*. (2010a).

19 See Basu & Fernald (2006).

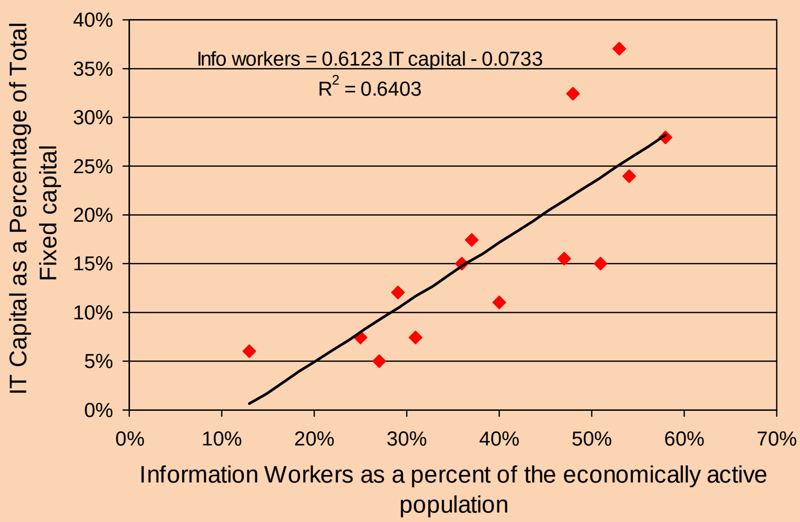
entrepreneurial spirit, willingness to take risks in an organizational transformation), are referred to as the accumulation of intangible capital. Broadband does not in itself have an economic impact. It represents an enabler for the adoption of e-business processes that result in increased efficiency (such as streamlined access to raw materials and management of the supply chain, or better market access). Intangible capital accumulation and the adoption of e-business processes delay the full economic impact of broadband.

Lagged effects are neither uniform nor permanent. They are most marked at the start of broadband deployment. It stands to reason that once firms have undergone the transformation required to enable the full impact of broadband, further deployment of the technology should have an immediate impact. Finally, van der Ark *et al.* (2002) and Gulton *et al.*(2003) note that institutional variables such as labour market regulation could also have a significant impact on models that link broadband and productivity. The public policy implications of this effect cannot be understated. To achieve full economic benefit of broadband deployment, governments need to emphasize the implementation of training programmes and, in the case of SMEs, offer consulting services that help firms capture the full benefit of the technology[20].

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 (administrative employees, managers, teachers, journalists) depends directly on the investment in ICT capital (and particularly broadband). The studies conducted by this author[21] have, in fact, concluded that the larger the per cent of the workforce dedicated to information generation and processing is, the higher the proportion of capital stocks invested in the acquisition of ICT infrastructure (see Figure 4).

Figure 4: Information workers and ICT investment



Note: Data for information workforce was derived from ILO statistics while IT Capital was sourced from Kaplan (2001).
Source: Adapted from Katz (2009b).

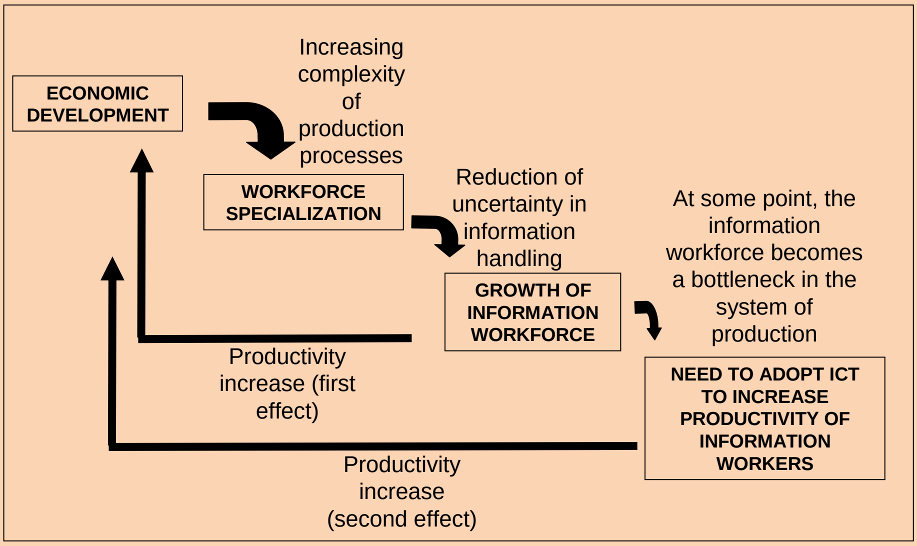
[20] For additional details, see section 7.5.

[21] See Katz, 2009b.

Figure 1 and the corresponding regression coefficient indicate the existence of a direct relationship existing between the amount of information workers and IT capital investment in a given economy: as expected, the larger the proportion of information workers in a given the economy, the more capital is invested in information technology.

How can one theoretically explain the relationship between ICT and productivity? In his economics dissertation at Harvard University (1982), Charles Jonscher raised the hypothesis that if we can measure the micro-economic impact of ICT on firm productivity, then we should also be able to link the growth in informational occupations and the adoption of technology to improve their productivity at the macroeconomic level. This is what is depicted in Figure 5.

Figure 5: Causality model: ICT innovation and diffusion is driven by the growth of information workforce



Source: Adapted from Katz (2009c).

According to this causality framework, economic growth logically leads to increasing complex production processes. In turn, complexity in production processes results in increasing the functional complexity within firms (e.g. more inputs to be combined, more steps to be scheduled in a timely manner, more interactions occurring with suppliers of raw materials and with buyers of the end product). The first response of economic organizations to this effect is the creation of "information workers"—labourers whose primary function is the manipulation of information for purposes of organizing the production of goods. At some point, however, information-processing workers become a bottleneck in the economic system. They cannot grow forever because this process reduces the overall availability of resources in other occupations. Furthermore, when information workers become a large proportion of the workforce, the complexity of information processing becomes a bottleneck itself. In other words, there is a limit to the possibility of manually storing, transferring and processing the growing amounts of information. This is where information and communication technologies come in. Their development and adoption is aimed at increasing the productivity of information workers and addressing this bottleneck. The availability of computing and communications allows firms (and their information workers) to be more productive in their manipulation of information. Broadband is a specific component performing this important productivity enhancement.

For example, research on the impact of broadband on productivity has successfully identified positive effects. For example, Waverman *et al.* (2009) determined the economic effect of broadband on the GDP of 15 OECD nations for the time period of 1980 to 2007. These included 14 European countries and the United States. By relying on an augmented production function derived from Waverman *et al.* (2005), the authors specified two models: a production function and a hedonic function for ICT capital stocks.

Broadband impact on the productivity of the more developed nations in the sample was found to be 0.0013 and was statistically significant at the 5 per cent level[22]. 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 of their sample with relatively low ICT penetration (Greece, Italy, Portugal, Spain and Belgium.). They found that broadband impact on productivity was nil, which indicated the high adoption costs, and critical mass thresholds[23]. In other words, for broadband to have an impact on productivity, the ICT eco-system has to be sufficiently developed[24]. It would appear, therefore, that in developed countries with high broadband penetration, the technology has an impact on aggregate productivity levels.

2.3 Impact on job creation

This section will review the evidence regarding the impact of broadband in terms of job creation. Differences will be made between the research focused on measuring the impact of broadband deployment programmes (e.g. 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 chapter, a section will focus on specific effects, such a differential impact by industrial sector and/or regions.

2.3.1 Broadband construction effects and their counter-cyclical importance

Broadband network construction affects employment in three ways. In the first place, network construction requires the creation of direct jobs (such as telecommunications technicians, construction workers, and manufacturers of the required telecommunications equipment) to build the facility. In addition, the creation of direct jobs has an impact on indirect employment (such as upstream buying and selling between metal and electrical equipment manufacturing sectors). Finally, 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: Crandall *et al.* (2003), Atkinson *et al.* (2009), Liebenau *et al.* (2009), and in prior research carried out by the author (Katz *et al.*, 2008). 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 2).

Since these studies were triggered by the consideration of countercyclical plans devised to face the economic crisis, they tend to focus primarily on gauging the ability of broadband jobs to create jobs. All studies calculate multipliers, which measure the total employment change throughout the economy resulting from the deployment of a broadband network. Multipliers are of two types. Type I multipliers measure the direct and indirect effects (direct plus indirect divided by the direct effect), while Type II multipliers measure Type I effects plus induced effects (direct plus indirect plus induced divided by the direct effect). Cognizant that multipliers from one geographic region cannot be applied to another, it is useful to observe the summary results for the multipliers of the four input-output studies (see Table 3):

[22] 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.

[23] See Waverman, 2009.

[24] For example, Waverman *et al.* 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).

Table 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 140,000 jobs per year over ten years • Total jobs: 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 jobs-year (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 jobs-year (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.

Table 3 – Employment multiplier effects of studies relying on input-output analysis

Country	Studies	Type I	Type II
United States	Crandall *et al.* (2003)	N.A.	2.17
	Atkinson *et al.* (2009)	N.A.	3.60
	Katz *et al.* (2009)	1.83	3.42
Switzerland	Katz *et al.* (2008)	1.38	N.A.
United Kingdom	Liebenau *et al.* (2009)	N.A.	2.76
Germany	Katz *et al.* (2010)	1.45	1.92

Note: Crandall *et al.* (2003) and Atkinson *et al.*(2009) do not differentiate between indirect and induced effects, therefore we cannot calculate Type I multipliers; Katz el (2008) did not calculate Type II multiplier because induced effects were not estimated.
Source: Compiled by the author.

According to the sector interrelationships depicted above, a European economy appears to have lower indirect effects than the US. Furthermore, the decomposition also indicates that a relatively important job creation induced effect occurs as a result of household spending based on the income earned from the direct and indirect effects.

While input-output tables are a reliable tool for predicting investment impact, two words of caution need to be given. First, input-output tables 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.

2.3.2 Broadband positive externalities on job creation

Beyond the employment and output impact of network construction, researchers have also studied the impact of network externalities on employment variously categorized as "innovation", or "network effects"[25]. 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[26].
- New forms of commerce and financial intermediation[27].
- Mass customization of products[28].
- Reduction of excess inventories and optimization of supply chains[29].
- Business revenue growth[30].
- Growth in service industries[31]

Most of the research regarding the impact of broadband externalities on employment has been conducted using US data. There are two types of studies of these effects: regression analyses and top down multipliers. The first ones attempt to identify the macro-economic variables that can impact employment[32], while the second ones rely on top-down network effect multipliers.

Among the econometric studies of employment impact, are Gillett *et al.* (2006), Crandall *et al.* (2007), Shideler *et al.* (2007) and Thompson and Garbacz (2008). The evidence regarding broadband employment externalities appears to be quite conclusive (see Table 4).

Again, the impact of broadband on employment creation appears to be positive. However, as the data indicates, 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. As Crandall indicated, the overestimation of employment creation in his study is due to employment and migratory trends, which existed at the time and biased the sample data. In the case of Gillett *et al.* (2006), researchers should be careful about analysing local effects because zip codes are small enough areas that cross-zip code commuting might throw off estimates on the effect of broadband. For example, increased wages from broadband adoption in one zip code would probably raise rent levels in neighbouring zip codes prompting some migration effects. Finally, the wide range of effects in the case of Shideler *et al.* (2007) is explained by the divergent effects among industry sectors.

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[25] See Atkinson *et al.*, 2009.

[26] Op. cit.

[27] Op. cit.

[28] Op. cit.

[29] Op. cit.

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

[31] See Crandall *et al.* (2007).

[32] In general, studies based on regression analysis do not differentiate between construction and spill-over effects.

Table 4 – Research results of broadband impact on employment in the United States

Authors – Institution	Data	Effect
Crandall *et al.* (2007) – Brookings Institution	48 states 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% per year "assuming the economy is not already at 'full employment'"
Thompson and Garbacz (2009) – Ohio University	46 states during the period 2001-2005	Positive employment generation effect varying by industry
Gillett *et al.* (2006) – MIT	Zip codes 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.

Beyond regression studies, "network effect" multipliers have been used to assess the impact of broadband on job creation in a top down fashion. Within this group, key studies are Pociask (2002), Atkinson *et al.* (2009) and Liebenau *et al.* (2009). Pociask (2002) and Atkinson *et al.* (2009) studies relied on an estimated "network effect" multiplier, which is applied to the network construction employment estimates. For example, Pociask relied on two multiplier estimates (an IT multiplier of 1.5 to 2.0 attributed to a think tank and another multiplier of 6.7, attributed to Microsoft) and calculated an average of 4.1. Similarly, Atkinson *et al.* (2009) derived a multiplier of 1.17 from Crandall *et al.* (2003). Though the top-down approach allows estimation of the broadband impact, it does not have a strong theoretical basis. Network effects are not built on interrelationships between sectors. They refer to the impact of the technology on productivity, employment and innovation by industrial sector.

The methodological implications of these studies are 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[33].

Like the relationship between broadband and GDP growth, the contribution of broadband to employment is also conditioned by a number of special effects. Studies have particularly focused on two specific questions:

1. Does the impact on employment differ according to industry sector?
2. Is there a decreasing return in employment generation linked to broadband penetration?

As with GDP, 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 following sectors. The only sector where a negative relationship was found with the deployment of broadband (0.34% – 39.68%) was the accommodations and food services industry. This may result from a particularly strong capital/labour substitution process taking place, whereby productivity gains from broadband adoption yields reduced employment. Similarly, Thompson and Garbacz (2008) conclude that, for certain industries,

[33] See examples in case studies of Germany and Chile included in Sections 3.2 and 4.3.

"there may be a substitution effect between broadband and employment"[34]. 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.

This particular effect has been analysed by this author in the case of rural economies of the United States. In particular, it was found that, within rural counties, broadband penetration contributes to job creation in financial services, wholesale trade, and health sectors. This is the result of enterprise relocation enabled by broadband, which benefits primarily urban communities in the periphery of metropolitan areas (Katz et al. 2010d).

In summary, research is starting to pinpoint different employment effects by industry sector. Broadband may simultaneously cause labour creation triggered by innovation in services and a productivity effect in labour intensive sectors. Nevertheless, we still lack a robust explanation of the precise effects by sector and the specific drivers in each case. However, given that the sectoral composition varies by regional economies, the deployment of broadband should not have a uniform impact across a national territory.

To sum up, some researchers have found a decreasing impact of broadband on employment. While Gillett *et al.* (2006) observed that the magnitude of impact of broadband on employment increases over time, they also found that the positive impact of broadband on employment tends to diminish as penetration increases. This finding may support the existence of a saturation effect. Coincidentally, Shideler *et al.* (2007) also found a negative statistically significant relationship between broadband saturation and employment generation. This would indicate that at a certain point of broadband deployment, the capability of the technology to have a positive contribution to job creation starts to diminish.

2.4 Creation of consumer surplus

There are some specific economic effects of broadband that are not necessarily captured by 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.

To compare the gains in consumer surplus by an investment one has to compare the initial (before the investment) consumer surplus with the consumer surplus at the end of the investment. During an investment period consumer surplus may change because of two reasons. The first one is an outward-shift of the demand curve and the second is a price reduction. The shift of the demand curve can occur because of the broader penetration of high speed broadband. The price reduction is a result of productivity gains and competition. In the case of deployment of high-speed broadband infrastructures, competition becomes effective at the applications layer. This development is responsible for an increase in consumer surplus in future periods compared to former periods.

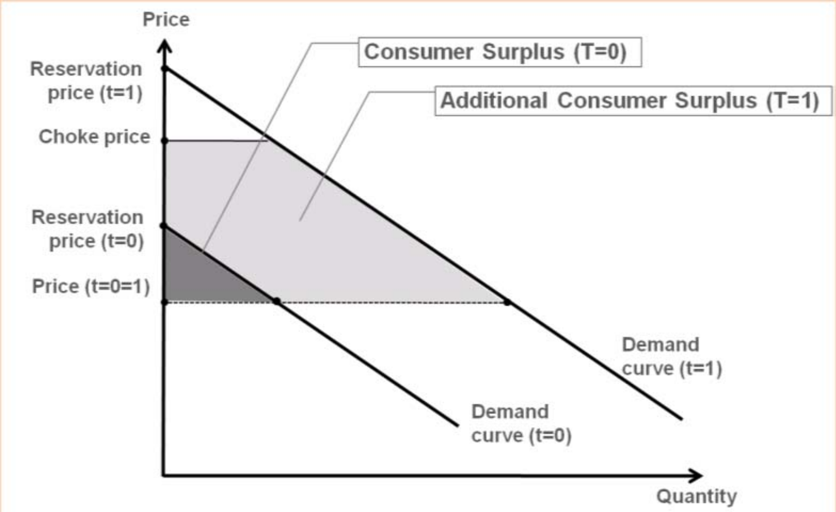
Consumer surplus is the utility gain by consumers due to prices that are lower than their reservation prices. In Figure 6 the consumer surplus is the area between the demand curve and the market price. Consumers gain utility because they can purchase a product at a lower price than they are willing to pay. The larger the area under the curve is, the more utility that consumers derive.

The price reduction may result from productivity gains and competition. More competition and market saturation force producers to reduce prices. These two developments are responsible for increases in consumer surplus. As indicated in Figure 6, the dark grey area represents the initial consumer surplus at t = 0. The shift of the demand curve at t = 1 results in an additional consumer surplus (light grey area). The whole consumer surplus in period 1 is the sum of the dark and light grey areas.

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

The estimation of consumer surplus resulting from broadband penetration is important, but this economic benefit is not captured by GDP. This approach has been utilized by Crandall and Jackson (2003) to estimate the US consumer surplus derived from new services like shopping, entertainment and telemedicine enabled by broadband infrastructure. Similarly, Lee and Lee (2006) relied on regression techniques to estimate the consumer surplus for the Korean telecommunications market.

Figure 6: Consumer surplus



Source: Author

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 billion in broadband surplus). This was calculated on the basis of what users would be willing to pay to adopt broadband and substitute 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.

The authors also recently estimated the surplus generated as a result of broadband adoption in Canada, United Kingdom, Spain, Mexico, Brazil and China (Greenstein & McDevitt, 2010). In this case, due to the data limitations, they restricted their analysis to the benefit derived from price declines, which necessarily underestimates its total impact. Nevertheless, the researchers determined that for 2009, the total Brazilian broadband surplus represented USD 7.03 billion, of which 22 per cent should be considered to be consumer driven. In the case of Mexico, the total surplus is USD 2.30 billion, and the consumer portion was 8 per cent. In general terms, the authors concluded that the total broadband surplus is directly related to broadband penetration.

2.5 Impact on firm efficiency

Converging with the aggregate macro-economic research, the microeconomic analysis of the impact of broadband has helped understand the multiple effects that the technology has on firm performance. Microeconomic research has yielded the following estimates of firm productivity enhancement (see Table 5).

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. In the service sector, broadband enabled firms generate between 7.5 per cent and 10 per cent more sales.

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.

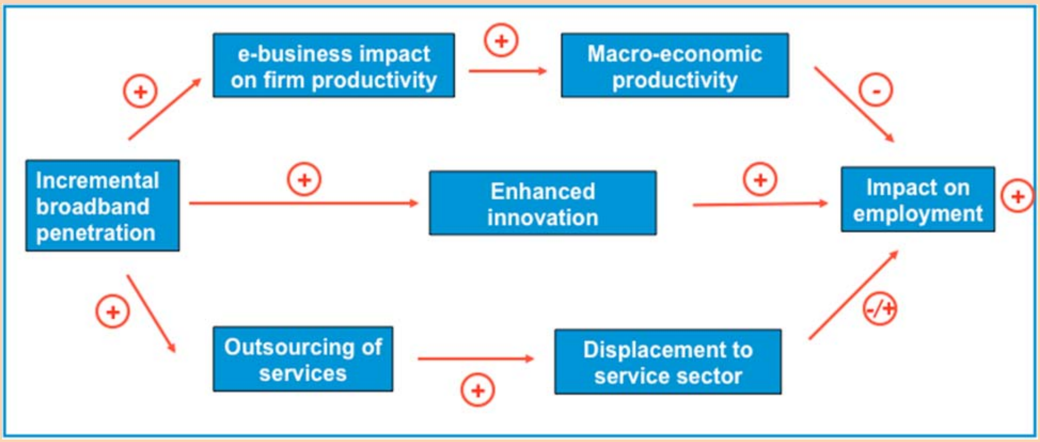
Table 5 – Broadband-induced productivity improvement

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).

The results of the microeconomic research have been utilized to estimate the impact of broadband on job creation. Fornefeld *et al.*, (2008) identified three ways that broadband impacts employment: first, the introduction of new applications and services causes acceleration of innovation; second, the adoption of more efficient business processes enabled by broadband increases productivity; and third, the ability to process information and provide services remotely makes it possible to attract employment from other regions through outsourcing. These three effects act simultaneously, whereby the productivity effect and potential loss of jobs due to outsourcing are neutralized by the innovation effect and gain of outsourced jobs from other regions.

Figure 7: Network effects of broadband on employment



Source: Adapted from a model originally developed by MICUS in a report for the European Commission (see Fornefeld et al., 2008)

According to Fornefeld *et al.* (2008), the negative effect of broadband productivity is compensated by the increase in the rate of innovation and services, thereby resulting in the creation of new jobs. The third effect may induce 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 relocate functions 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. 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.

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 contribution of broadband to GDP growth. While the amount of this contribution varies, the discrepancies can be related to different datasets as well as model specifications. Secondly, broadband has been found to have an 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 the existence of increasing economic returns of broadband penetration. On the other hand, consistent with the research at the ICT level, broadband economic impact could be mediated by a lag effect, indicating that adoption does not automatically translate into growth but that it would require the accumulation of intangible capital, defined as the changes in business processes and firm culture that lead to assimilation of improved business processes.

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

Finally, beyond economic growth and job creation, broadband has a positive effect in consumer surplus in terms of benefits to the end user that is not captured in the GDP statistics. These include efficient access to information, savings in transportation and benefits in health and entertainment, and 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 such an impact. Input-output analysis has proven to be highly reliable tool to estimate the counter-cyclical impact of broadband construction programmes. 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 concluded outlining the impact of broadband in fostering efficiencies and value added opportunities at the firm level.

As the review indicates, most of the research has so far been conducted in developed nations, either the United States or Western Europe. The challenge going forward is to search for similar effects in developing countries, where data availability remains an even larger challenge. In particular, this issue is quite relevant for African countries. In the search for available information to conduct the quantitative case studies presented below, this author encountered a lot of obstacles in identifying adequate datasets for nations in Africa.

3 Economic Impact of Broadband in Developed Countries: Case Studies

The following section presents research conducted by the author primarily at the aggregate macro-economic level. It aims to validate the existence of economic impact of broadband on GDP growth and job creation. It also includes the following case studies:

- United States: employment creation triggered by the Broadband Technology Opportunities Program[35].
- Germany: impact of the National Broadband Plan on economic growth and job creation[36].

The methodologies[37] utilized in these two cases are the following:

- Input/output analysis was utilized for estimating the employment and GDP impact of broadband construction (in the United States and Germany).
- Micro-economic estimates, as utilized in the study commissioned to Fornefeld et al (2008) by the European Commission, was relied upon for estimating the contribution to employment resulting from broadband externalities.
- Econometric modelling, as utilized in several studies (including those conducted by authors affiliated by the World Bank, the Brookings Institution, and MIT) was relied upon in the case of broadband externalities impact on GDP and employment in Germany.

3.1 United States: employment creation as a result of the economic stimulus programme

In the last few years, spurred by the economic crisis, many governments around the world have implemented programmes aimed at deploying broadband in order to stimulate employment (see Table 6).

In 2009, this author attempted to estimate the jobs that could be generated as a result of the grants to be disbursed by the broadband provisions of the conference report on the American Recovery and Reinvestment Act, published February 13, 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 by the deployment of such an infrastructure.

The study found that approximately 127,000 jobs could be created over a four year period from network construction. According to the analysis, the investment of USD 6.390 billion[38] will generate 37,283 direct jobs over the course of the stimulus programme (estimated to be four years). In addition, based on a Type I employment multiplier of 1.83, the bill could indirectly generate 31,046 jobs[39]. The split across sectors is presented in Table 7.

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35 This analysis is based on prior research contained in Katz, R., and Suter, S. (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 February 19, 2009.

36 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 June 17, 2009.

37 See review of methodologies utilized in Appendix A.

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

39 For methodology, see Katz et al (2009a).

Table 6 – Counter-cyclical government programmes

Country	Broadband Focus
United States	Launched the USD 7.2 billion broadband stimulus programme focused on providing service to unserved and underserved areas
Australia	Government plans to spend AUD 11 billion of total AUD 43 billion required for construction of the National Broadband Network
Germany	Government has announced a National Broadband Strategy with the objective to have nationwide capable broadband access (1 Mbps) no later than the end of 2010 and provide 75 per cent of German households access to a broadband connection of at least 50 Mbps by 2014 (estimated investment: EUR36 billion)
Sweden	Broadband government promotion provides financial incentives to municipalities to fund 2/3 of total NGN investment (EUR864 million)
Portugal	Government announced a EUR 800million credit line for the roll-out of NGAN. This is part of an the first step in a EUR 2.18billion 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 programmes to promote broadband development resulting in an overall investment of CAD 300 million
Finland	Government funds one-third of the NGN project cost (USD 130.73 million)
New Zealand	Government funds USD 458,12 million investment to boost fibre over the next five years

Source: Author.

Table 7 – United States: Type I employment effects of Broadband Stimulus Bill

	Sectors	Jobs created
Direct Employment	Electronic equipment	4,242
	Construction	26,218
	Communications	6,823
	Subtotal	**37,283**
Indirect Employment	Distribution	9,167
	Other market/non-market services	8,841
	Transportation	1,536
	Electronic engineering	959
	Metal products	1,839
	Other	8,704
	Subtotal	**31,046**
Total Type I Employment		**68,329**
Type I multiplier (Direct+Indirect)/direct employment		1.87

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

The combination of direct (37,283), indirect (31,046) and induced jobs (59,500) yielded a total employment impact of 127,800 jobs over a four-year period. The average annual employment generation effect is 31,950 jobs per year.

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 per cent of residential households which have access to at least one broadband supplier (that is to say telco or cable, primarily) is 93 per cent or less.[40] There are 18 states that lag the national average broadband penetration significantly: 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 utilized to estimate the employment network effects of the stimulus programme was that it would deploy enough lines to allow these eighteen states to reach the national average, meaning that 3,928,000 subscribers would be added to the existing base[41].

As reviewed above, the estimation of network effects needs to be done stepwise by accounting for jobs that will be gained as well as those that could be lost. Network effects 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.[42] Then this effect is applied to the economy of the targeted states as a whole. As a result, the following effect is predicted (see Table 8).

Table 8 – United States: Jobs gained due to the innovation effect resulting from increased broadband penetration

	2008	2009	2010	2011	2012	Total
Total employment	30,123,300					
Employment likely to be affected by outsourcing trend	25,165,000					
Growth rate in broadband penetration		9%	8%	7%	6%	
Jobs gained by creation of new business services		55,000	47,000	40,000	33,000	175,000
Jobs gained as a result of new economic activity		64,000	55,000	46,000	38,000	203,000
Total jobs gained		**119,000**	**102,000**	**86,000**	**71,000**	**378,000**

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

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 in regions other than the one being targeted. Assuming the same rate of broadband penetration as utilized in the calculation of the innovation effect, the gains and losses due to enhanced outsourcing can be estimated (see Table 9).

[40] 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.

[41] 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.

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

Table 9 – United States: Jobs gained and lost due to accelerated outsourcing resulting from increased broadband penetration

	2008	2009	2010	2011	2012	Total
Total employment	30,123,300					
Employment likely to be affected by outsourcing trend	25,165,000					
Growth rate in broadband penetration		9%	8%	7%	6%	
Jobs gained		49,000	44,000	38,000	33,000	164,000
Jobs lost		82,000	73,000	64,000	55,000	274,000
Net		(33,000)	(29,000)	(26,000)	(22,000)	(110,000)

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

The resulting net number of jobs lost due to outsourcing (110,000) overestimates the economic disadvantage of the targeted 18 states. Their position in a ranking of salary differentials and cost of living indicates that they tend to be in the bottom quartile of the distribution. This would lessen the impact of a negative outsourcing trend. However, it is important to consider the impact that broadband may have in the potential displacement of jobs. Furthermore, given the fact that broadband may also cause job growth in the targeted area, one might assume that pro-active employment relocation policies could increase the number of jobs created. It should be noted that job outsourcing could take place within national markets, such as the entire US territory, in which case jobs lost in one state will be gained in another one. Additionally, outsourcing gains could occur internationally. By tapping into new labour pools and lowering labour costs, broadband could help the United States regain some of the jobs originally lost.

As a result of the uncertainty regarding the amount of jobs that be gained or lost, it is prudent to build two additional scenarios (an optimistic and a mid-course one) to be considered with the one derived above, which is considered to be pessimistic (see Table 10).

Table 10 – United States: Alternative scenarios regarding outsourcing impact

	2009	2010	2011	2012	Total
Pessimistic Scenario	(33,000)	(29,000)	(26,000)	(22,000)	(110,000)
Mid-course scenario	8,000	7,500	6,000	5,500	27,000
Optimistic scenario	49,000	44,000	38,000	33,000	164,000

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

The optimistic scenario assumes that the eighteen states' comparative advantage regarding factor costing, combined with labour retention policies, are sufficient to cancel out the trend toward job displacement. The mid-course scenario represents the mid-point between the pessimistic and optimistic.

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. By differentiating the productivity impact in manufacturing (5%), professional and information services (20%), and the rest of the service sector (10%)

and applying these ratios to sectoral employment, the jobs that could be lost as a result of broadband diffusion was calculated[43].

Assuming that the stimulus programme causes the same rate of broadband penetration in the targeted areas, we were able to calculate the jobs lost due to the increased adoption of more efficient processes, enabled by broadband (see Table 11).

As Table 10 indicates, the productivity effect resulting from increased broadband penetration could result in 266,000 jobs lost over four years.

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

Table 11 – United States: Jobs lost due to productivity improvement resulting from increased broadband penetration

	2008	2009	2010	2011	2012	Total
Manufacturing and Services Employment	25,661,000					
Professional and Information Services	3,860,000					
Growth Rate in BB penetration		9%	8%	7%	6%	
Broadband penetration	48%	52%	56%	59%	62%	
Jobs lost in professional and information services		19,000	17,000	15,000	13,000	64,000
Jobs Lost in other sectors		61,000	54,000	47,000	40,000	202,000
Total jobs lost		80,000	71,000	62,000	53,000	266,000

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

Table 12 – 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).

[43] See methodology in Appendix B.2 of Katz *et al.* (2009a).

These estimates allow drawing the following conclusions for the network construction job creation:

- The deployment of broadband accesses resulting from the stimulus programme 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.
- While, on aggregate, the estimate of Type II multipliers is close to Atkinson *et al.* (2009), the calculation of indirect effects (impact in other sectors of the economy based on interrelationships) is more conservative, and the induced effects (derived from household spending) appear to be a bit more optimistic. This is because the estimation of induced effects is based on sector-specific multipliers rather than aggregates.
- The great part of the difference between the projections for the number of total network construction jobs and those of Atkinson *et al.* (2009), (229,475 versus 127,800), is due to the difference in the absolute size of the stimulus initially assumed (USD 10 billion versus USD6.4 billion).
- Therefore, it is considered that the estimates for jobs created as a result of network construction are quite robust.

When moving to the estimation of network externalities, one should observe the wide range of network effects in this study. The estimates of network effects range from close to nil to a much more optimistic scenario than Atkinson *et al.* (2009). As a result, the broadband stimulus could either lead to no externalities or the creation of up to 273,000 jobs in four years. This number exceeds Atkinson *et al.* (2009) estimates for a USD 10 billion programme (268,480 jobs).

In summary, by ranging the potential success in attracting jobs as a result of outsourcing, a high level of uncertainty is introduced in the final estimate. Since increased broadband penetration has an impact on productivity and outsourcing (which can result in job destruction), unless the innovation and in-sourcing programmes are effective in promoting growth and job creation, any network effects can be significantly eroded. As a result, in order to be successful the broadband stimulus programme needs to be coordinated with other employment generation initiatives.

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 and output of Germany's economy. Two sequential investment scenarios are analysed: the first is based on the national broadband strategy announced by the German Government in 2009. It aims to provide 75 per cent of German households with access to a broadband connection of at least 50Mbps by 2014. The second scenario (labelled "ultra-broadband" and covering 2015-2020) defines the investment required to provide to 50 per cent of households with at least 100 Mbps, and another 30 per cent with 50 Mbps by 2020.

In order to estimate the impact resulting from the construction of broadband infrastructure required to meet the strategy targets, the investment is broken down in three primary sectors of the economy that receive the lion's share of benefits: manufacturing of electronic equipment, construction and telecommunications.

Fulfilling the 2014 objectives of the national broadband strategy is estimated to generate 304,000 jobs over five years (between 2010 and 2014).[44] Following the breakdown of the construction effects, 158,000 jobs will be created in equipment manufacturing, construction and telecommunications. We estimate that

[44] 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.

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 are 71,000. The key sectors benefited from the indirect effects 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 is distributed similarly to the one above: 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. Table 13 presents all the employment effects reviewed above:

The sector impact of direct and indirect effects is included in Table 14.

As Table 14 indicates, the labour intensive nature of broadband deployment causes significant creation of construction jobs. Despite the high-technology nature of the ultimate product, broadband is to be seen as economically meaningful as conventional infrastructure investment such as roads and bridges.

Table 13 – Germany: Total employment impact of broadband network construction

Type of Impact	2014 National broadband strategy	2020 Ultra-broadband evolution	Total
Direct effect	158,000	123,000	281,000
Indirect effect	71,000	55,000	126,000
Induced effect	75,000	59,000	134,000
Total	304,000	237,000	541,000
Type I multiplier	1.45	1.45	
Type II multiplier	1.92	1.93	

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

Table 14 – Germany: Sector impact of direct and indirect job creation

	2014 National broadband strategy	2020 Ultra-broadband evolution	Total
Construction	125,000	99,000	224,000
Telecommunications	28,400	21,000	49,400
Other services	17,000	13,000	30,000
Distribution	10,700	8,400	19,100
Metal products	4,800	3,700	8,500
Electronics equipment	4,700	3,400	8,100
Electrical equipment	3,200	2,500	5,700
Financial services	3,000	2,000	5,000
Other	32,200	25,000	57,200
Total	**229,000**	**178,000**	**407,000**

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

In addition to estimating employment effects, industrial output and GDP impact were also calculated. The investment required to meet the targets of the 2014 Broadband strategy, (EUR 20,243 million), will generate additional production totalling EUR 52,324 million. This means that for each Euro invested in broadband deployment, EUR 2.58 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 would be additional GDP (+0.15%). Again, each Euro invested in broadband deployment will trigger 0.93 per cent in additional value added, or incremental GDP. Table 15 compiles the economic impact of the 2014 and 2020 targets:

Table 15 – Germany: Industrial output of broadband construction (in EUR millions)

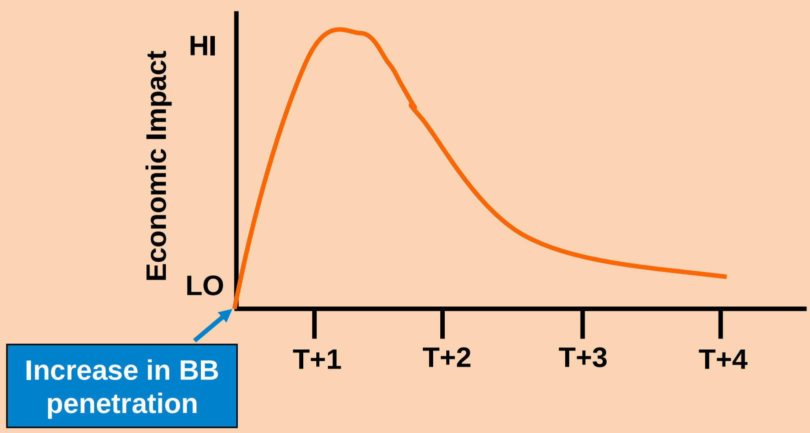
	2014 National broadband strategy	2020 Ultra-broadband evolution	Total
Investment	20,243	15,690	35,933
Total additional production	52,324	40,749	93,073
• Domestic	48,178	37,609	85,787
Additional Value added	*18,733*	*14,631*	*33,364*
Intermediate outputs	*29,466*	*22,978*	*52,444*
• Imported	4,146	3,148	7,294

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

To sum up, the incremental GDP growth achieved by investing in broadband deployment would amount to EUR 33,364 million (which represents +0.12 per cent of the German GDP). This amount does not include the additional impact to 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 relation between broadband penetration and economic growth and job creation. It has found that the economic stimulus impact of broadband is highest in the first year after deployment and tends to diminish over time (see Figure 8).

Figure 8: Conceptual depiction of broadband externalities



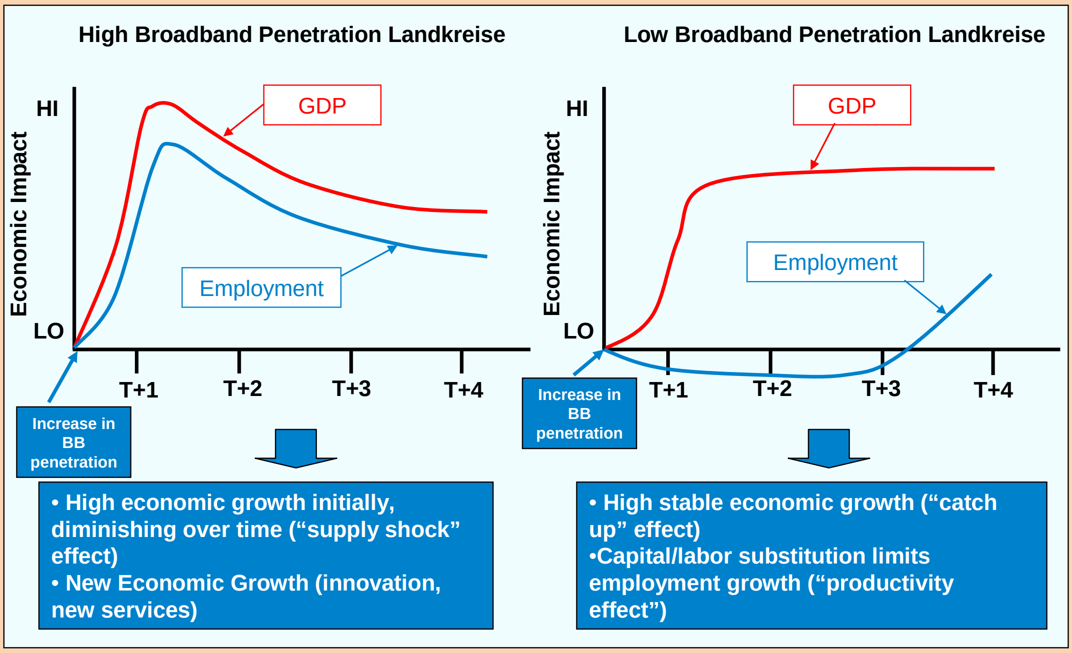
Source: Author

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 regarding 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, by splitting the national territory into two groups, counties with 2008 average broadband penetration of 31 per cent of population and counties with average broadband penetration of 24.8 per cent, the analysis determined that the type of network effects of broadband varies by region. In high broadband penetrated counties 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 new 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 on GDP of broadband penetration is lower than in high 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 low penetration areas is more complex than in the high penetration areas. The increase in broadband penetration in low penetrated areas takes longer to materialize economic growth because these economies require a longer period of time to develop and fully utilize the technology. However, after three years the level of impact of broadband in low penetrated regions is as high as in the more developed areas. Negative initial employment growth appears to indicate that the productivity increase resulting from the introduction of new technology is the most important network effect to begin with. 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[45]. Therefore broadband deployment in low penetrated areas will likely generate high stable economic growth (“catch up” effect) combined capital/labour substitution, which initially limits employment growth (“productivity” effect). Figure 9 presents in conceptual fashion a comparison of impact in both regions.

Figure 9: Conceptual view of comparative broadband regional effects[46]



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

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

[46] Only effects up to t + 3 are estimated.

These differentiated effects were used to estimate the impact of broadband on economic growth and employment are estimated. It was stipulated that broadband penetration in advanced areas would increase from 31 per cent in 2008 to 45.9 per cent in 2014, while the low penetration areas 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"[47]. Together, these improvements amount to an incremental increase in penetration of approximately 25 per cent in both regions between 2008 and 2011.[48].

The per cent increase was inputted in the regression models specified for the time series 2000-2006.[49] The regression models estimate an incremental annual GDP growth rate of 0.61 percentage points for low penetrated counties and 0.64 percentage points for high-penetrated counties, which over three years amounts to 1.93 per cent and 1.82 per cent respectively. These incremental percentage point increases were applied to the GDP of both regions (estimated to be EUR 1,698 billion for high penetrated counties and EUR 791 billion for low penetrated counties). This represents an incremental GDP of EUR 32,809 million for high-penetrated counties and EUR 14,375 million for low penetrated counties. In sum, the total incremental GDP is EUR 47,184 million (+0.62%) in three years.

Following the same methodology, it is estimated that 162,000 jobs will be created. More developed broadband areas are expected to gain 132,000 and the low penetrated regions 30,000.[50] The differentials across regions are driven by the divergent effects discussed above.

As discussed throughout the review of the study projections, the estimates were generated for several years and dependent on stages of network deployment. For example, the projected 541,000 jobs due to network construction do not occur all in one year but over a ten-year period. To understand the yearly impact of the estimates, a table that displays the yearly impact over time is included (see Table 16).

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

48 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.

49 $g\_gdp\_03\_06 = \beta1*gdp\_pc\_2000 + \beta2*g\_pop\_00\_06 + \beta3*g\_bbpen\_02\_03$
$g\_emp\_03\_06 = \beta1*gdp\_pc\_2000 + \beta2*g\_pop\_00\_06 + \beta3*g\_bbpen\_02\_03$

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

Table 16 – 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).

Based on these figures, the net employment effects over two time periods were calculated (see Table 17).

Table 17 – Germany: Employment effect over time (in thousands)

	Network Construction				Network externalities	Total
	Direct	Indirect	Induced	Total		
2010-14	158	71	75	304	103	407
2015-20	123	55	59	237	324	561
Total	281	126	134	541	427	968

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

Between 2010 and 2014 407,000 jobs will be created and between 2015 and 2020 561,000 jobs will be created[51]. The growth in impact over time is due to the fact that between 2015 and 2020, additional ultra-broadband lines are deployed as part of the second phase of the national strategy.

To sum up, the national broadband strategy and the expected evolution of ultra-broadband through 2020 will have a significant impact on jobs and 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, of which 541,000 will be derived from the network construction required to meet the stipulated targets. An additional 427,000 will be generated 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.

[51] Three remarks are noteworthy: 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 suite.

4 Economic Impact in Developing Countries: Case Studies

The following section compiles research conducted by the author primarily at the aggregate macro-economic level. It aims to validate the existence of 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[52].
- Brazil: the impact of broadband on employment and economic growth[53].
- Chile: the impact of broadband on employment and economic growth[54].
- Dominican Republic: the contribution of broadband to employment growth.
- Arab States: impact of broadband on economic growth.
- Saudi Arabia: the impact of broadband on employment.
- India: the impact of broadband on employment and economic growth.
- Malaysia: the impact of broadband on economic growth.
- China: the relationship between broadband deployment and economic growth.
- Indonesia: the contribution of broadband to employment growth.

As it can be seen, in the case of Latin America, first a regional model was constructed to identify broadband contribution to the sub-continent. This was followed for specific modelling exercises for Brazil, Chile and the Dominican Republic. In the case of the Arab States, a general model was developed, followed by a quantitative case study on Saudi Arabia, and qualitative studies based on descriptive statistics on Jordan, United Arab Emirates and Qatar. In the case of Asia, only case studies were developed for a selected set of countries.

In all of the case studies mentioned in the list above, the analysis was conducted based on econometric modelling 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 is confronted with major methodological problems due to the lack of sufficiently large time series and sample sizes and sufficiently disaggregated indicators. For example, in the case of developed countries, Katz *et al.* (2010a) were able to rely on over 424 observations regarding economic, control and broadband variables for German counties. This situation is rarely the case in the emerging world. This is why the results that will be presented in the next section need to be prefaced with a word of caution. Sample sizes lower than 30 observations limit the robustness of estimates. In five of the twelve models presented below (economic growth for Latin America, economic growth and employment creation models for Chile, employment creation model for the Dominican Republic, and economic growth for the Arab States), the number of observations exceeded this threshold.

Secondly, the lack of time series does not allow 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

52 This analysis was originally published in Katz, R.L. "The contribution of broadband to economic development", in Jordan, V., Galperin, H. and Peres, W. (2010). *Fast-tracking the digital revolution: Broadband for Latin America and the Caribbean*, published by the Economic Commission for Latin America and the Caribbean (ECLAC) and DIRSI.

53 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.

54 This analysis was originally published in Katz, R.L. "The contribution of broadband to economic development", in Jordan, V., Galperin, H. and Peres, W. (2010). *Fast-tracking the digital revolution: Broadband for Latin America and the Caribbean*, published by the Economic Commission for Latin America and the Caribbean (ECLAC) and DIRSI.

endogeneity. The only approach that could be relied upon for this issue was a cross-lagged regression[55]. The authors recognize that this methodology has some limitations regarding endogeneity control.

Thirdly, recognizing that the contribution of broadband to GDP growth increases with penetration, it is pertinent to assert that at adoption levels as low as the ones pervading the emerging world up to 2008 the economic effects could be quite limited[56].

4.1 Latin America: Contribution to regional economic growth

In a prior paper, this author presented a simple regression model linking Latin American broadband penetration and economic development[57]. In this case, this author attempted to advance the research by developing a multi-variate equation based on the endogenous growth model[58]. This model has been used by several authors to assess the impact of broadband and other telecommunications technologies on a country's economic growth[59].

4.1.1 Multivariate Regression Analysis:

Given the lack of available time series data regarding broadband penetration in Latin American countries[60], the author chose to conduct a cross-sectional analysis with pooled data for the period 2004-2009, relying on ordinary least squares with robust errors. Two problems needed to be addressed with this type of analysis. The first problem is that the constant term in a linear regression does not capture the potential differences among countries. One possible solution is to rely on panel data, which allows control for the country idiosyncratic factors. However, the limited availability of data prevented the author from relying on this approach. Yet, by including variables such as technology (e.g. broadband) and the level of openness of the economy, it is expected that problems linked to the omitted variables be mitigated.

The second problem has to do with the endogeneity between GDP per capita and broadband penetration. Ideally, the author would have liked to tackle this problem by relying on an approach similar to Koutroumpis (2009), who implemented a simultaneous equations model that endogeneizes the decision to deploy broadband as a function of GDP per capita, pricing, competition and regulation. However, given the lack of time series data on pricing and competition for Latin American countries, it was impossible to use this approach. Therefore, to control for this problem the analysis was based on the lag of the broadband penetration variable.

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55 See definition of cross-lagged regression methodologies in Appendix A, Section A.2.

56 In that 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 (Jorgenson *et al.*, 2007).

57 See Katz, 2009d.

58 See Barro, 1991.

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

60 Broadband penetration data for the majority of Latin American and Caribbean countries after 2003 is available (25 countries included in the sample).

The following variables were used (see Table 18):

Table 18 – 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
Level of economic development	GDP per capita for 2003 and 2006	World Bank	Control measure for starting point of growth
Control for Investment	Average Investment / GDP for (2001-3) and (2004-6)	World Bank	Control measure for differences in investment levels
Population growth	Population growth for (2004-6) and (2007-9)	World Bank	Control measure for differences in population size
Human Capital	Tertiary education (2002)	Unesco, Earthtrends, University of West Indies, Euromonitor, Government of the Commonwealth of Dominica	Control measure for differences in human capital
Globalization	Average globalization index for (2001-3) and (2004-6)	Dreher *et al.* (2008). *Measuring globalization.* NY: Springer.	Control measure for differences in level of openness (economic, social and political)
Broadband penetration growth	Fixed Broadband penetration growth (2003-4) and (2005-6)	ITU and National Regulatory Agencies	Independent variable

Source: Author.

The dataset relied upon is included in Appendix C. The model results are as follows:

Table 19 - Latin America: Broadband impact on economic growth

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
Human capital	.2139614	.1108325	1.93	0.060	–.0097076	.4376304
Level of development	–.0006957	.0001806	–3.85	0.000	–.0010602	–.0003313
Globalization	–.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
R2	0.3814
Root MSE	7.024

Source: Author.

The coefficient of broadband penetration was positive and significant. According to this, an increment of 1 per cent on the penetration of broadband services could generate an additional 0.0158 to the GDP growth of the region[61]. This econometric 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 USD 3,925 billion. The model specified above indicates that the elasticity of broadband with regard to GDP growth is 0.0158per cent [62]. 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 span from the estimate derived in this study to that derived by Koutroumpis (2009) for OECD 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 between 2007 and 2009), we conclude that the technology contributed between USD 6.7 billion and 14.3 billion. This impact includes direct effects from the telecommunications industry and indirect spill-overs.

4.1.2 Case studies

In addition to the cross-sectional analysis presented above which proves in the aggregate that broadband has a contribution to economic growth, research also should focus on the specific effects by country. It is expected that, given the particularities of each nation, the economic impact of broadband might be of a different nature. The following set of case studies provides a first view of broadband's impact at the country level.

4.1.2.1 Brazil: The impact of broadband on economic growth and employment

To estimate the economic impact of broadband in Brazil, it was attempted to replicate the analysis conducted at the country level for Germany to an emerging country. However, the lack of disaggregated data prevented the specification of a model with robust estimates due to the limited number of observations. As a result, the model built to estimate the impact of broadband on the Brazilian GDP growth relied on a database for the 27 states of Brazil. It contained the following information (see Table 20):

Table 20 – 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[63]	Dependent variable
Level of economic development	GDP per capita (2002)	IBGE	Control variable used to determine the starting point of development
Human capital	Illiteracy rate 2002	IBGE	Control variable to determine differences in human capital
Interstate trade costs	Cost index for inter-state trade costs	Newton de Castro (2004)	Control variable to determine differences in cost of transportation of goods
Business creation	Costs to create a new business	Lima Chagas (2009)	Control variable to determine environmental differences in the creation of new businesses

[61] Alternative specifications were used including primary and secondary education enrollment rates as proxy for human capital, but only the model including tertiary education resulted significant.

[62] This is indicative for a period without major economic crises, since the model was run for the period 2004-9.

[63] Instituto Brasileiro de Geografia e Estadistica.

Variable	Series	Source	Observations
Change in economic inequality	Average of Gini coefficient (2004-5)	IBGE	Control variable to determine differences in income distribution
Growth of household broad.penetration	Fixed Broadband penetration Δ (2005-6)	Household Survey (IBGE)	Independent variable

Source: Adapted from Katz (2010b).

The methodology used to calculate the penetration of broadband by state follows the methodology proposed by IPEA (*Instituto de Pesquisa Economica Aplicada*) (2010)[64]. The state-wise penetration was calculated using data from the National Survey of Households administered by the IBGE (*Instituto Brasileiro de Geografia e Estatística*) for the years 2005 and 2008[65]. Each response in the survey was linked to only one household, thus eliminating the possibility of over-estimation. Finally, the compound annual growth rate was calculated to construct the broadband penetration growth variable.

The results are as follows:

Table 21 – Brazil: Impact of broadband on GDP growth

GDP Growth (2006-7)	Coefficient	Standard error	T-statistic	P>[t]
Economic development	–0.0007415	0.0002883	–2.57	0.018**
Human capital	–0.4950848	0.2323575	–2.13	0.046**
Interstate trade costs	–0.0004711	0.0009957	–0.47	0.641
New business creation	–0.0009246	0.0072004	–0.13	0.899
Change in economic inequality	32.67246	46.25561	0.71	0.488
Broadband penetration Δ (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

Source: Adapted from Katz (2010b).

As the results indicate, the statistically significant variables with appropriate signs are the 2002 State GDP and illiteracy rate. In accordance with Barro's economic growth theory, the 2002 State GDP is negative,

64 The 2005 and 2008 National Household Survey *"Pesquisa Nacional por Amostra de Domicilios"* contains a question regarding access to broadband in households. The survey has two sections, individuals and households, the "Broadband Access" question is included in the latter. Because identification variables are included in the first section of the survey, individuals, this question and the identification variables could be matched quantitatively. Finally, using the factors of expansion located on the first section of the survey, broadband penetration was calculated for each state. This is the same methodology used by the IPEA in its research study "Análise e recomendações para as políticas públicas de massificação de acesso à internet em banda larga", published on April 26 2010.

65 The survey relies on a national sample; to expand the survey the coefficients provided by the IBGE were used. The question used to determine the existence of a broadband connection in a household is: "Have you accessed to the internet using a broadband connection in your household during the last three months?".

which would indicate a conditional convergence toward a single growth path. The illiteracy rate is also negative, which confirms the importance of human capital in economic development. 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, we assume our estimation is valid because it is consistent with the results of similar studies (e.g. Koutroumpis, 2009). Thus, while recognizing the model limitations, we expect that when controlling for education level and departing point of economic development in the case of Brazil, an increase of 1 per cent in the rate of penetration of broadband could contribute 0.008 percentage points to GDP growth.

In addition to estimating the broadband impact on GDP growth, we studied the impact of the technology 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.

The following information was compiled for the 27 Brazilian states:

Table 22 – 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
Level of development	GDP per capita (2003)	IBGE	Control variable to determine the point of departure of state economic growth
Growth in household broadband penetration	Fixed Broadband penetration Δ (2005-6)	Household survey (IBGE)	Independent variable
Human capital	Years of schooling	IBGE	Control variable to differentiate the level of human capital by state
Population growth	Population growth (2006-7)	IBGE	Control variable to differentiate the level of population growth by state

Source: Adapted from Katz (2010b).

The results of the model are as follows (see Table 23).

Table 23 – Brazil: Impact of broadband on Job creation

Unemployment Rate	Coefficient	Standard error	T-statistic	P>[t]
Level of state economic development	–0.0449243	0.0259892	–1.73	0.098
Growth in household broadband penetration	–0.0069189	0.003575	–1.94	0.066
Human capital	0.1095254	0.0940011	1.17	0.256
Population growth	0.2009585	0.1213108	1.66	0.112
Constant	–0.1925308	.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

Source: Adapted from Katz (2010b).

It is counterintuitive that the difference in schooling years and population growth is not statistically significant in explaining the differences in the level of unemployment across regions. However, the relationship between the rate of change of unemployment rate and the rate of change in broadband penetration is significant and with the expected negative sign. According to the model results, a change of 10 per cent in broadband penetration could reduce the unemployment rate by 0.06 percentage points. Brazilian unemployment in 2009 was 7.7 per cent and that by 2010 it would fall to 7.4 per cent[66], which would imply a reduction of 3.89 per cent. According to our 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. Thus we would expect such a deployment of broadband to result in a reduction of unemployment from the original 3.89 per cent to 4.03 per cent.

4.1.2.2 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. This data base was constructed by compiling data for each of Chile's regions (except for the metropolitan areas due to the lack of quarterly data) from 2001 until the fourth quarter of 2009. The dataset contains the following information:

Table 24 – 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
Level of economic activity by region	Quarterly index of economic activity (2001-9)	Regional Institutes of Statistics	Control variable of economic development
Growth in broadband penetration	Quarterly Δ in fixed broadband penetration (2002-9)	Subtel	Independent variable
Human capital	Schooling years (population 15 years old and older)	Employment Survey, INE	Control variable to determine differences in human capital
Dominant industrial 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

Source: Author

A model including level of economic activity and broadband penetration was specified. In addition, an alternative model was proposed aimed to study possible effects of human capital and specialization on the level of employment. According to 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. Thus, the model results are as follows (see Table 25).

[66] According to a consensus forecast compiled by EMIS.

The economic activity variable remained unaltered between models 1 and 2; in both cases it was significant and positive. The coefficient of broadband penetration is significant[67] and positive in both specifications. The small variation between the coefficients of broadband impact in both specifications suggests the robustness of the following conclusion: an increase in 1 percentage point in broadband penetration would contribute nearly 0.18 percentage points to the employment rate.

Table 25 – 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
R2	0.2820	R2	0.2863
F(11,310)	33.89	F(11,259)	24.41
Prob>F	0.0000	Prob >F	0.0000

Source: Author.

An interesting result on the second specification was the coefficient of human capital, which resulted significant at the 10 per cent level and with a negative sign. Contreras at al (2008) argues that this result is mostly explained by the impressive increment in the years of schooling of the population in one generation and the entrance of women to the labour force.[68]

Today, the Chilean workforce comprises 6,500,000 individuals, which result in 93 per cent employment rate. Of those, it is estimated that broadband deployment, which reached a penetration of 9.78 per cent, contributed in 1.76 percentage points to the employment rate, which amounts to the creation of 114,426 direct and indirect jobs.

In addition to estimating the impact of broadband on job creation in Chile, we attempted to estimate its contribution to the country's GDP growth. For this purpose, a database for the 13 regions of Chile was built, which contained the following information (see Table 26):

[67] It was significant at the 1 per cent level on the first specification and at the 5 per cent level on the second one.

[68] According to Contreras, et al (2008), women were educated but were not part of the labor force. As more women entered the labor force the average schooling years of the population increased but also increased the number of women unemployed looking for jobs.

Table 26 – 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
Level of development	Regional GDP (2000;2001;2002)	Central Bank of Chile	Variable to control for point of departure in economic development
Human capital	Percentage of population with some level of tertiary education (2003-2006)	Casen Survey	Variable to control for the level of human capital
Population size	Region population as a per cent of country population (2002)	National Institutes of Statistics – Chile	Variable to control for level of density
Population growth	Regional population growth (2002-2008)	National Institutes of Statistics – Chile	Variable to control for differences in rate of population growth
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
Urban density	Percentage of people living in urban centres by region (2002)	National Institutes of Statistics – Chile	Variable to control for level of urbanization
Growth of broadband penetration	Δ in fixed broadband penetration (2002-3: 2004-05; 2006-07)	Under-Secretariat of Telecommunications (Subtel)	Independent variable

Source: Author.

The results are as follows:

Table 27 – Chile: Contribution of broadband to GDP growth

Dependent variable: GDP Growth (2006-7)	Coefficient	Standard error	T-statistic	P>[t]
Level of development	–1.35E–06	7.67E–07	–1.76	0.088
Human capital	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
Economic dynamics	–0.00809	0.080571	–0.1	0.921
Urban density	–0.05128	0.080926	–0.63	0.531
Broadband penetration 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

Source: Author.

Broadband penetration was found to be statistically significant and with the expected sign in terms of contributing to GDP growth in Chile. According to the coefficient of this variable, a 10 per cent increase in penetration will result in an increase of 0.09 percentage points in regional GDP of Chile's regions. The initial regional GDP variable was included to control for the starting point of development. The coefficient sign is consistent with the conditional convergence theory. According to the model, human capital measured as the percentage of people with tertiary education is extremely important, once again corroborating the results obtained for Latin America.

In addition, two variables were included to determine the effect that population growth could have on broadband penetration. The population size variable controls for the density effect. According to this, population size in a certain region could result in attractive markets, which would attract firms to the given region, therefore driving economic growth. The coefficient in this case was statistically significant containing the right sign. On the other hand, according to the traditional development theory, the population growth variable was included. In this case, once again, the coefficient was positive and statistically significant.

4.1.2.3 Dominican Republic: The contribution of broadband to employment growth

To study the contribution of broadband to employment in the Dominican Republic, a database for 32 provinces was constructed (see Table 28).

Table 28 – Dominican Republic: Variables used to estimate the broadband impact on employment growth

Type of Variable	Data Set	Source	Rationale
Change in unemployment	Difference in unemployment rate between 2009 and 2008	National Statistical Office	Dependent variable
Population growth	Population growth rate 2009-2008	National Statistical Office	Control unemployment by population growth
Broadband penetration	Average fixed broadband penetration 2008-2009	Indotel	Effect of broadband penetration
Change in number of establishments	Change in number of establishments 2008-9	National Statistical Office	Control of sources of new jobs
Construction value	Share of private investment in construction sector of Province. 2008-2009	National Statistical Office	Relationship between Investment and unemployment
Construction area	Share of square metres of private constructions of province 2008-2009	National Statistical Office	Relationship between Investment and unemployment

Source: Author

The model results are as follows (see Table 29).

Table 29 – Dominican Republic: Broadband impact on job creation

Growth in unemployment	Coef.	Std. Err.	t	P>t	95% Conf.Interval	
Population growth	0.72442	0.24939	2.90	0.0070	0.21180	1.23704
Change in broadband penetration	–0.29529	0.13290	–2.22	0.0350	–0.56846	–0.02211
Change in number of establishments	–0.14959	0.04728	–3.16	0.0040	–0.24678	–0.05241
Value of construction 2009	0.69456	0.14588	4.76	0.0000	0.39469	0.99443
Change in construction 2008-9	–0.64299	0.12787	–5.03	0.0000	–0.90583	–0.38015
Constant	0.74317	0.37360	1.99	0.0570	–0.02477	1.51111

Number of Obs	32
F(5,26)	12.70
Prob>F	0.0000
R2	0.4175

Source: Author

The results show an extremely high impact of broadband on unemployment. According to Table 40, an increase in broadband penetration of 1 per cent would diminish unemployment in 0.29 percentage points. For example, if the unemployment rate were to be 14 per cent, an increase of 1 per cent in broadband penetration would contribute to a reduction of unemployment to 13.71 per cent.

The other variables that indirectly affect unemployment are, as expected, number of establishments between 2008 and 2009, and the intensity of the construction sector in a specific area in 2009. Therefore, a combination of increase in the number of establishment, investment in construction and broadband yields a positive effect in terms of job creation.

It is considered that the contribution of broadband relative to the other two variables is too high. Part of this is due to the fact that the largest increase in broadband has taken place in Santo Domingo, the capital, and Altagracia, a tourism hub. Ideally, to refine the impact of broadband it would be necessary to include in the model specification a variable related to the intensity of the tourism sector. However, while data exists for three regions, Altagracia, Puerto Plata and Cibao Norte, data for the rest of the country is not captured. Therefore, it is impossible to introduce a variable measuring the intensity of tourism. As a result, the case confirms the contribution of broadband to job creation, although the range of impact might be overestimated.

4.2 Assessment of Broadband Economic Impact in Arab States

The purpose of this section is to estimate the economic impact of broadband on a selected group of Arab States. The universe of analysis comprises the following countries:

- Algeria
- Bahrain
- Djibouti
- Egypt
- Iraq
- Jordan
- Kuwait
- Lebanon
- Libya
- Morocco
- Oman
- Qatar
- Saudi Arabia
- Syria
- Tunisia
- United Arab Emirates
- Yemen

Two methodologies were utilized. In the first place, a multivariate regression model was built to determine the impact of broadband adoption on the GDP growth of a cross-section of Arab countries. Secondly, case studies supported by descriptive statistics were developed for Jordan, Qatar, the United Arab Emirates and Saudi Arabia.

4.2.1 Multivariate Regression Analysis:

This analysis is based on assessing the impact of broadband penetration[69] growth between 2004 and 2010 on growth of the GDP, measured in constant 2005 prices. For that purpose, a model based on a classical

[69] In this analysis, given that the dataset extended through 2010, it was considered necessary to include mobile broadband connections.

production function, complemented with control variables to account for country specific factors, was specified. The following variables were utilized (see Table 30):

Table 30 – Variables used to measure the economic impact of broadband in Arab States

Variable	Series	Sources	Observations
Economic growth	Per capita GDP (in constant 2005 prices) growth between 2004-10	World Bank and IMF	Dependent variable
Broadband penetration growth	Broadband penetration growth 2004-10 (including fixed wired and fixed wireless broadband connections)	ITU	Independent variable
Control for population growth	Population growth 2004-10	World Bank	Measure to determine size of population
Control for human capital	Secondary school enrollment rate 2000	World Bank	Measure to determine the importance of human capital
Control for level of development	GDP per capita in year 2000	World Bank	Measure to determine point of departure in economic growth
Control for changes in oil prices	Annual change in price of oil barrel as a per cent of annual oil exports 2004-10	World Bank and US Department of Energy	Measure to control for the impact of changes in oil prices in the gross product of Arab States
Capital	Gross capital formation (as per cent of GDP) 2004-10	World Bank	Measure to determine the importance of fixed capital investment
Control for level of globalization	Average globalization index 2004-8 (estimated 2009-10)	Dreher et al. (2008)	Measure to determine the different level of economic, social and political integration
Control for bank credit	Annual domestic credit provided by the banking sector (as per cent of GDP) 2004-10	World Bank	Measure to determine the importance of financial markets

Source: Author.

The regression model was built on time series from 2004 (which includes the observations corresponding to the growth of variables between 2003 and 2004) to 2010. For this purpose, the model considers only those annual observations for countries where broadband penetration was higher than 1 per cent[70]. As a result, the sample considered in the regression model included the following years and countries (see Table 31).

Table 31 – Arab States: Observations with a Broadband Penetration Rate Higher than 1 per cent

	2004	2005	2006	2007	2008	2009	2010
Algeria	0.11 %	0.41 %	0.51 %	0.85 %	1.41 %	2.34 %	2.54 %
Bahrain	1.50 %	2.23 %	2.96 %	4.76 %	7.35 %	8.87 %	12.27 %
Djibouti	0.00 %	0.01 %	0.02 %	0.13 %	0.29 %	0.61 %	0.91 %
Egypt	0.11 %	0.19 %	0.34 %	0.62 %	0.98 %	1.35 %	1.79 %

70 In the case penetration is lower than 1 percent, changes in growth rate of penetration are not significant given the low variance in the number of total connections.

	2004	2005	2006	2007	2008	2009	2010
Iraq	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
Jordan	0.20 %	0.44 %	0.88 %	1.57 %	2.49 %	3.95 %	4.73 %
Kuwait	0.91 %	1.10 %	1.28 %	1.43 %	1.57 %	1.70 %	1.68 %
Lebanon	2.00 %	3.21 %	4.64 %	4.64 %	4.68 %	4.69 %	4.73 %
Libya	0.00 %	0.00 %	0.16 %	0.16 %	0.75 %	1.01 %	1.15 %
Morocco	0.21 %	0.82 %	1.28 %	1.54 %	1.57 %	1.54 %	1.62 %
Oman	0.03 %	0.54 %	0.81 %	0.79 %	1.23 %	1.52 %	1.63 %
Qatar	1.53 %	3.12 %	4.78 %	7.44 %	7.61 %	9.05 %	8.38 %
S. Arabia	0.30 %	0.28 %	0.88 %	2.44 %	4.01 %	5.36 %	6.23 %
Syria	0.00 %	0.01 %	0.03 %	0.04 %	0.06 %	0.17 %	0.33 %
Tunisia	0.03 %	0.18 %	0.44 %	0.95 %	2.22 %	3.60 %	4.60 %
UAE	1.53 %	3.18 %	5.16 %	7.03 %	8.98 %	9.95 %	10.51 %
Yemen	0.00 %	0.01 %	0.01 %	0.05 %	0.11 %	0.23 %	0.35 %

Source: ITU World Telecommunications/ICT Indicators Database, www.itu.int/icteye

Based on the 60 observations (highlighted in Table 31 above), the regression coefficients were calculated as follows (see Table 32):

Table 32 – Assessing the Broadband Economic Impact in the Arab States using a Linear Multivariate Regression Model

Growth in per capita GDP	Coefficient	Standard error	T-Stat	P>[t]	Confidence Interval at 95%[71]	
Broadband penetration growth	0.0207588	0.0109596	1.89	0.064	–0.0012435	0.0427612
Control for population growth	–0.5742083	0.1529595	–3.75	0.000	–0.8812873	–0.2671294
Control for human capital	0.0291687	0.0301354	0.97	0.338	–0.0313306	0.0896679
Control for level of development	–0.0113077	0.0098631	–1.15	0.257	–0.0311088	0.0084933
Control for changes in oil prices	0.1917185	0.0475012	4.04	0.000	0.096356	0.2870811
Control for Gross Capital Formation	0.2810046	0.0982635	2.86	0.006	0.0837325	0.4782767
Control for level of globalization	–0.0140371	0.1700399	–0.08	0.935	–0.3554065	0.3273322
Control for bank credit	0.0227318	0.0135549	1.68	0.100	–0.0044809	0.0499445
Constant	–7.846972	12.02959	–0.65	0.517	–31.99738	16.30343

Number of observations	60
F (8,51)	8.73
Prob>F	0.0000
R^2	0.5209
Root MSE	3.7653

Source: Analysis by the author.

[71] The two values in the confidence interval represent one for the low interval and the other for the upper interval at the 95% confidence interval.

According to the model, an increase in broadband penetration of 10 per cent results in an average increase of 0.208 per cent in per capita GDP (measured in real terms).

All variables in the model have the correct signs in the sense that they are directly or inversely related to the penetration of broadband:

- Population growth is indirectly related to GDP per capita, indicating that the growth in population reduces the product to be shared by all the inhabitants; this result is consistent with that of the Latin American broadband impact model (coefficient: -0.4469177);
- There is a positive relation between human capital (as indicated by educational level) and GDP; however, the coefficient is not statistically significant, probably due to the unreliability of available data;
- The more developed countries exhibit lower GDP per capita growth rates (which is consistent with Solow's hypothesis);
- An increase in oil prices has an important and statistically significant impact on GDP, given that the value of exports tends to increase accordingly; the coefficient for this variable is, as expected, holding the highest significance;
- Gross Capital Formation is, consistent with the production function, positively and significantly related to GDP;
- Similarly to the results in Katz (2010), the globalization index appears to have a negligible impact in the countries being studied;
- A more developed credit market has a positive effect on GDP growth.

In order to conduct a robustness test of the previous linear multivariate regression model, another model using fixed effects by year and country also using robust standard errors was developed. In the new approach, the fixed controls capture the variables that change for all the countries by year (per example the price of the oil), and the specific characteristics of the countries analyzed (education, Level of development, etc.). As a result of this approach, the only control variable utilized is the growth of the population (with the same dataset that in the previous model).

Table 33 – Assessing Broadband Economic Impact in the Arab States using a Fixed Effects by Year and Country Model

Growth in per capita GDP	Coefficient	Standard error	T-Stat	P>[t]	Confidence Interval at 95%	
Broadband penetration growth	0.0184833	0.0124923	1.48	0.165	-0.008735	0.0457016
Control for population growth	-0.4901746	0. 1463068	-3.35	0.006	-0.8089498	-0.1713994
Constant	2.676135	1.031105	2.60	0.023	0.4295504	4.922719

Number of observations	**60**
F (2,12)	7.62
Prob>F	0.0073
R^2	0.2279

Source: Analysis by the author.

The result of the regression model with fixed effects shows a coefficient similar to the one yielded in the first approach (a 10% of difference). As a result, an increase in 10 per cent in the penetration of broadband, we should have a 0.185 per cent increase in the per capita GDP.

In summary, according to the results of both models for Arab States, the impact of broadband penetration growth of 10 per cent, in the growth of the per capita GDP is between 0.18 per cent and 0.21 per cent.

4.2.2 General Impact Model

Based on the general impact model presented in Table 32, the contribution of broadband to GDP growth for each Arab country was calculated as follows:

- Count the number of years that broadband penetration is >1%[72] (column 1)
- Calculate the total growth between the first year of broadband >1% and 2010 (column 2)
- Calculate CAGR between the first year of broadband >1% and 2010 (column 3)
- Multiply CAGR by broadband contribution coefficient to GDP per capita growth per the general model (0.0207588) (column 4)
- Multiply results of column 4 by the number of years that broadband penetration level is >1% (column 5)

The results are included in Table 34.

Table 34 – Arab States: Contribution of broadband penetration growth rate to GDP per capita

Country	Years of penetration >1%	Growth of Broadband Penetration	CAGR	Annual Impact to GDP per capita	Total Impact on GDP per capita for the period
Bahrain	7	695%	41%	0.86%	6.00%
UAE	7	587%	38%	0.79%	5.50%
Qatar	7	448%	33%	0.68%	4.76%
Jordan	4	201%	44%	0.92%	3.69%
S. Arabia	4	155%	37%	0.76%	3.05%
Tunisia	3	107%	44%	0.91%	2.74%
Lebanon	7	137%	15%	0.32%	2.24%
Algeria	3	80%	34%	0.71%	2.13%
Egypt	2	33%	33%	0.68%	1.35%
Kuwait	6	53%	9%	0.18%	1.10%
Oman	3	33%	15%	0.31%	0.94%
Morocco	5	27%	6%	0.13%	0.64%
Libya	2	14%	14%	0.29%	0.58%

Note: It should be noted that some countries, such as Djibouti, Iraq, Syria and Yemen never reached 1 per cent penetration and therefore, the broadband economic impact is 0 per cent.

Source: ITU, analysis by the author

As Table 34 indicates, broadband has had a substantial contribution to GDP growth in the Arab region, ranging from 6 per cent of total GDP growth for Bahrain between 2003 and 2010 to 0.58 per cent between 2005 and 2010 for Libya. This finding confirms the rule of "return to scale" where the contribution of broadband to GDP per capita growth increases with penetration. From a policy

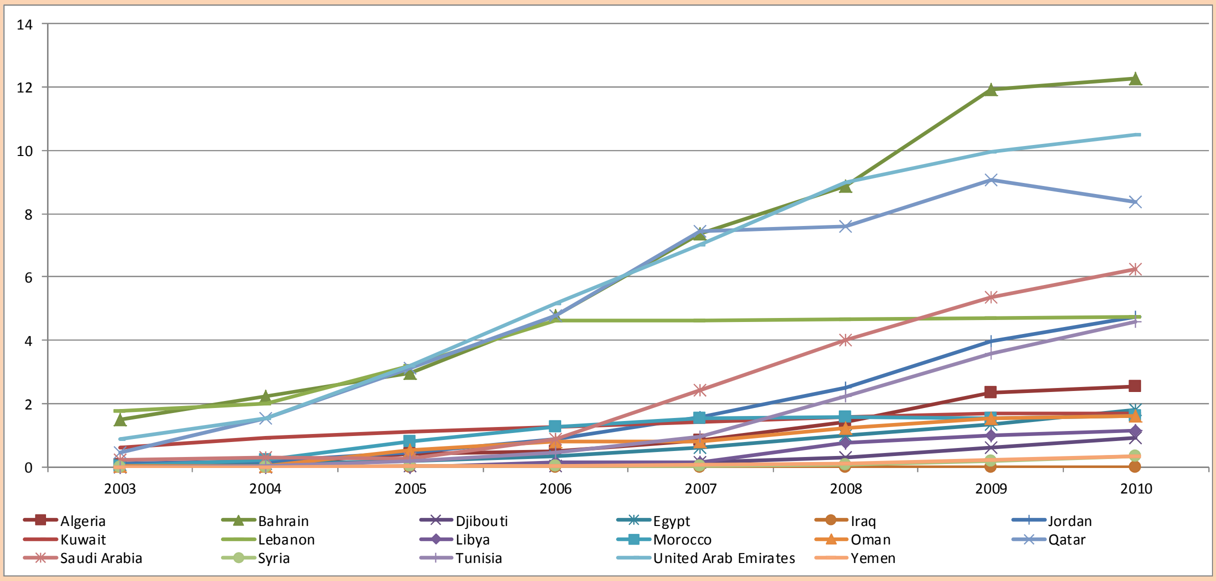
[72] See comment in footnote 69.

standpoint, governments need to fast-forward the deployment of broadband if they want to maximize its economic impact.

4.2.3 Case Studies

In the following section, three Arab countries have been analysed in further detail in an attempt to ascertain the specific economic impact of broadband on those countries. Three of them, United Arab Emirates, Bahrain and Qatar, exhibit the highest level of broadband adoption among Arab countries. The other one, Jordan, is a country that exhibits a very low adoption level until 2003 but has been growing at a fast rate since then (see Figure 10).

Figure 10. Arab States: Fixed Broadband Penetration (2002-10), in per cent



Source: ITU; analysis by the author

As indicated in Figure 10, Qatar and UAE are in top three Arab countries that exhibit the highest rate of penetration growth, while Jordan achieved an adoption of higher than 3 per cent in four years. Table 35 presents a comparison of penetration rates and CAGR in two different periods[73].

As Table 34 indicates, both Qatar and the UAE succeeded in maintaining a high CAGR throughout the whole period under study (51% and 42% respectively), while Jordan placed itself in a good relative position when considering fixed wireless connections. The impact of broadband on selected economic descriptive statistics will be analysed in turn.

[73] In addition, 2003 represents a key year in the development of broadband in the Arab states as it embodies the combination of multiple trends, ranging from industry liberalization and competition to economic development resulting in added purchasing power to Internet adoption.

Table 35 – Arab States: Comparative Broadband Penetration Growth, CAGR and increase of penetration rate

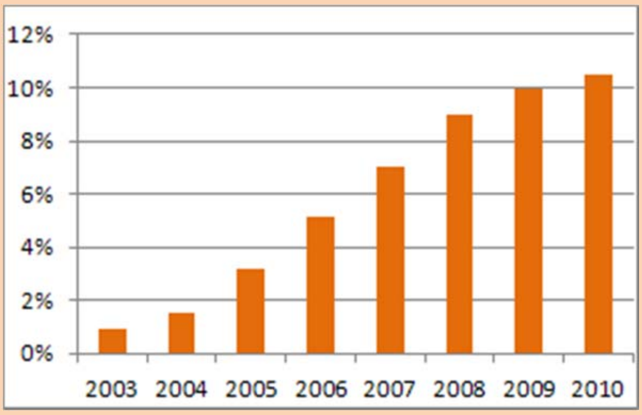
Country	Increase in Penetration Rate 2003-2010 (in %)	CAGR 2003-2010	CAGR 2006-2010
Algeria	2.4800	71%	49%
Bahrain	10.77753	35%	27%
Egypt	1.7100	56%	51%
Jordan	4.6335	74%	52%
Kuwait	1.0700	16%	7%
Lebanon	2.9500	15%	0%
Morocco	1.6136	107%	6%
Oman	1.6200	107%	19%
Qatar	7.9234	51%	15%
Saudi Arabia	6.0229	62%	63%
Tunisia	4.5973	189%	80%
United Arab Emirates	9.6161	42%	19%

Source: ITU; analysis by the author

4.2.3.1. United Arab Emirates:

The United Arab Emirates exhibits a CAGR of 42 per cent in broadband penetration between 2003 and 2010. However, this rate masks an expected gradual decline in the broadband penetration growth rate (see Figures 11 and 12).

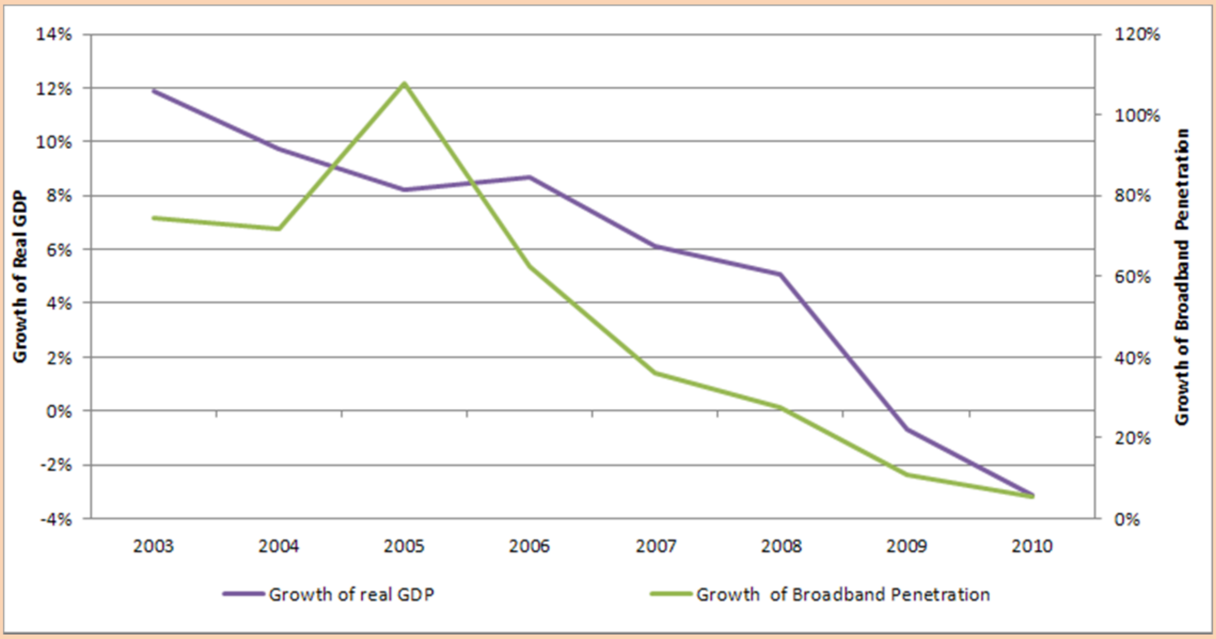
Figure 11. U.A.E. Broadband Penetration (2003-10)



Source: ITU; analysis by the author

Despite the gradual decrease in the broadband growth rate, a comparison with the GDP growth rate indicates a high level of correlation: 84 per cent. The parallel evolution of growth rate in both variables can be clearly seen in Figure 12. This relationship points to a probable dual causation, whereby broadband has an impact on the economy, while economic growth contributes to the adoption of broadband as well.

Figure 12. UAE: Growth rate of broadband penetration and GDP per capita



Source: World Bank; IMF; ITU; analysis by the author

While the number of observations for the specific case study is not sufficient to ascertain the causality between both variables, we can apply the coefficient of the general model for Arab States to estimate the economic contribution of broadband in the UAE[74]. By relying on the model specified for all Arab States, we can estimate that the average annual contribution of broadband to per capita GDP growth between 2004 and 2010 is 0.79 per cent[75].

4.2.3.2. Jordan:

Jordan's broadband penetration in 2003 was only 0.10 per cent. However, after growing its broadband deployment at an annual rate of 100 per cent between 2003 and 2007, the country reached a penetration of 1.57 per cent. While the growth rate declined after that year, the country doubled its penetration by 2009 if we only count fixed connections. When wireless connections are considered, Jordan's broadband penetration in 2010 is approximately 5 per cent (the fifth higher in the region).

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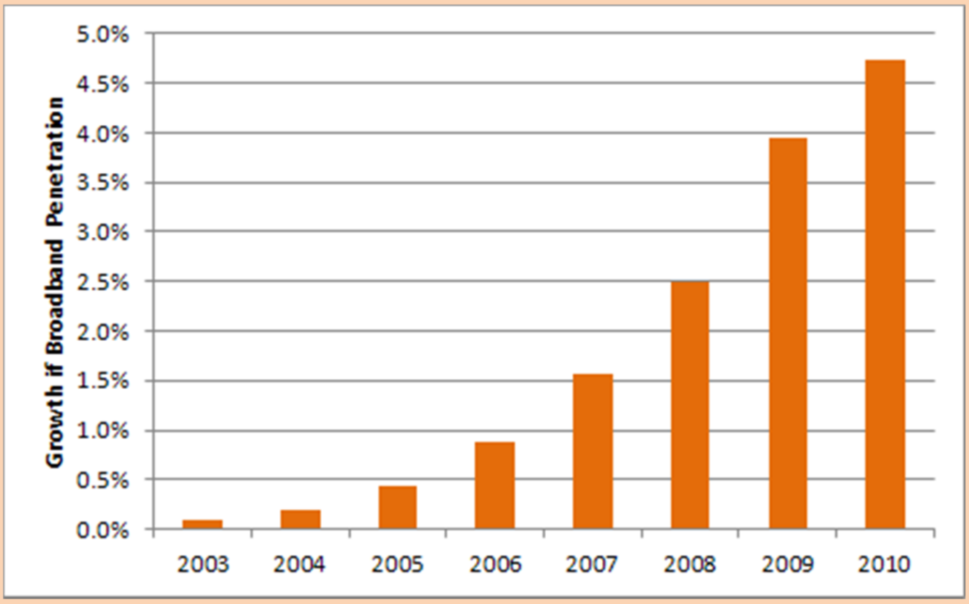
[74] The general model remains statistically significant because the analysis of multiple countries generates a sufficient number of observations.

[75] This estimate considers the CAGR of broadband penetration between 2004 and 2010, because in 2004 the UAE surpasses the barrier of 1% penetration. The average CAGR for that period is 38%, which is then multiplied by the coefficient of GDP impact of broadband penetration growth estimated in the model of figure D-3 (0.0207588)

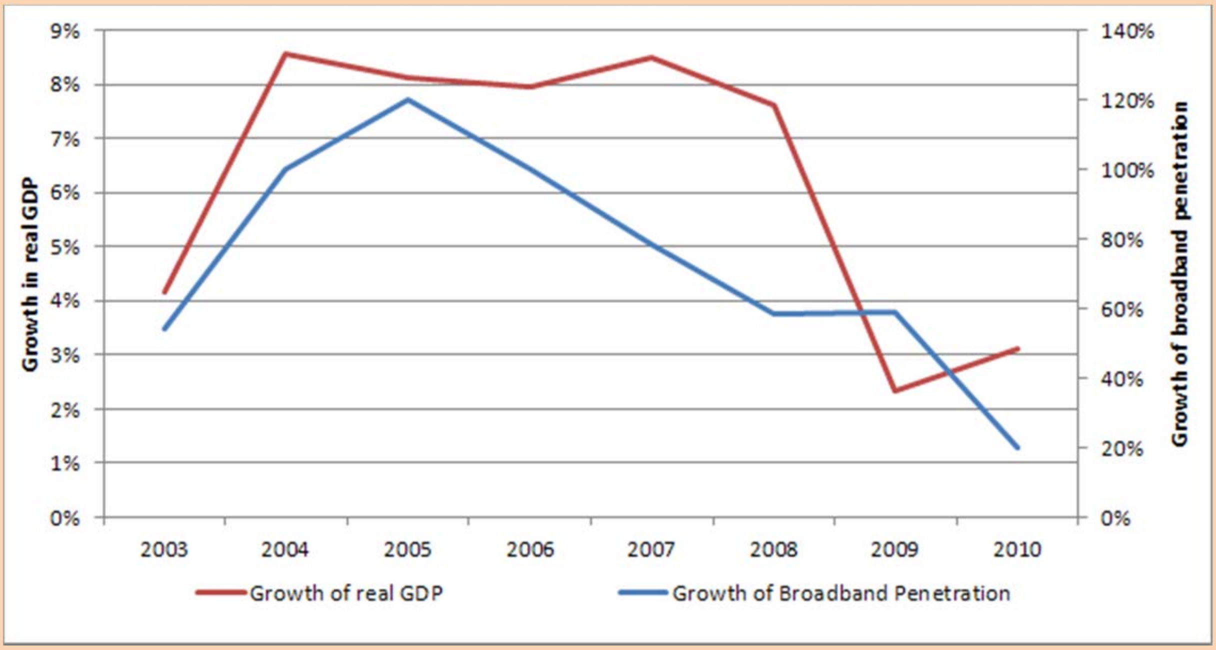
Figure 13. Jordan. Broadband Penetration (2003-10)



Source: ITU; analysis by the author

The growth in broadband penetration and GDP per capita are fairly correlated: 76 per cent. This is clearly depicted in Figure 14.

Figure 14. Jordan: Growth rate of broadband penetration and GDP per capita



Source: World Bank; IMF; ITU; analysis by the author

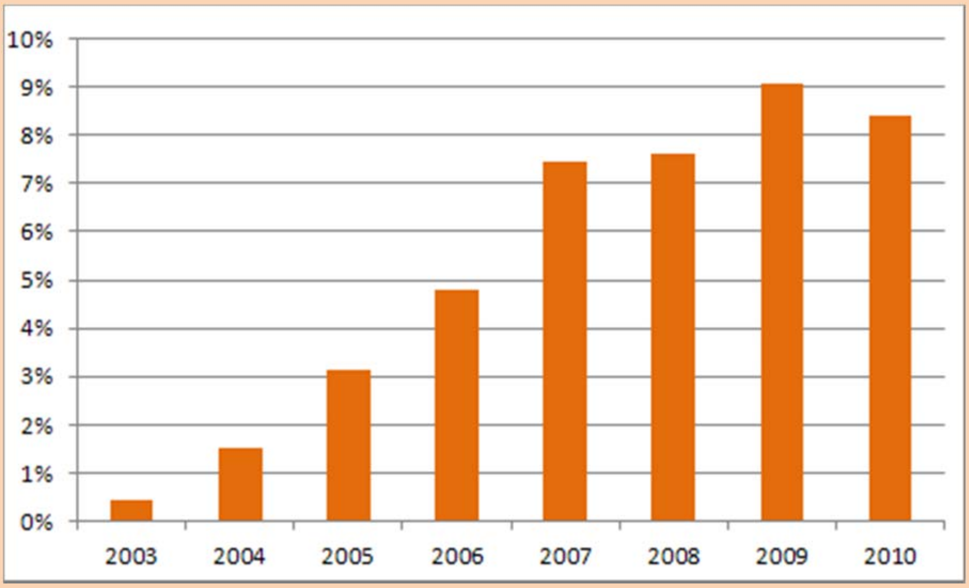
As shown in Figure 14, broadband growth rate is related to GDP, in some cases with a two-year lag. This lag can be, in some cases, explained by the complex set of causal links existing between the two variables. For example, when assessing the economic impact of broadband, the effect emerges only after broadband has resulted in changes in the adoption of e-business processes in enterprises (a process that requires more than one year to occur after broadband is deployed).

In order to estimate the contribution of broadband to economic growth, only the years when penetration exceeded the floor of 1 per cent were considered (2007 to 2010). The CAGR for that period was 44 per cent, which, when multiplied by the broadband penetration growth coefficient of the model included in Figure 14, yields an average annual increase of GDP per capita of 0.92 per cent.

4.2.3.3. Qatar:

Qatar is the Arab country with third highest broadband penetration growth rate by 2010 (behind Bahrain and the UAE). It was one of the first countries in the Arab region that surpassed the barrier of 1 per cent penetration, having continued its growth trend until reaching almost 10 per cent by 2010. Between 2003 and 2007, Qatar has been doubling the number of broadband lines year over year. After 2007, although the growth rate declined significantly, the penetration continued to grow steadily. Thus, between 2003 and 2010, the penetration rate CAGR was 51 per cent and the penetration reached over 8 per cent (see Figure 15).

Figure 15. Qatar: Broadband Penetration (2003-10)



Source: ITU; analysis by the author

Contrary to the other two case studies, the GDP per capita and broadband penetration growth rates are not significantly correlated, since oil prices are a significant driver of GDP growth. In the case of Qatar, oil prices are, as expected, the primary and most significant driver of GDP growth. This raises the relevance of having introduced oil prices in the broadband impact general model for Arab States.

Considering that Qatar surpassed the broadband penetration floor of 1 per cent in 2004, the CAGR of broadband penetration between that year and 2010 was 35 per cent. By multiplying that number by the broadband coefficient in the Arab States general model (0.0185964), it is estimated that broadband contributed an average 0.65 per cent to the annual GDP growth.

4.2.3.4 Saudi Arabia: The impact of broadband on employment

To estimate the impact of broadband on Saudi employment database containing information for its 13 provinces was compiled. It was composed of the following variables:

Table 36 – 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 Monetary Agency	Dependent variable
Broadband penetration	Broadband penetration per population Δ (2007-8)	Communications and Information Technology Commission	Independent variable
Infrastructure development I	Facilities authorized to provide health services (2008)	Annual Report – Saudi Arabia Monetary Agency	Variable to control for differences in level infrastructure
Tourism development	Change in the number of domestic tourism trips (2007-2008)	Annual Report – Saudi Arabia Monetary Agency	Independent variable
Infrastructure development II	Percentage of households with access to potable water	Annual Report – Saudi Arabia Monetary Agency	Variable to control for differences in level infrastructure
Government spending I	Change in the number of projects funded by the government (2007-2008)	Annual Report – Saudi Arabia Monetary Agency	Independent variable
Government spending II	Change in the value of projects funded by the government (2007-2008)	Annual Report – Saudi Arabia Monetary Agency	Independent variable

Source: Author

The model results are as follows (see Table 37):

Table 37 – 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

Source: Author

The independent variables (the change in broadband penetration, change in the number of domestic tourism trips, change in the number of publicly-funded projects 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. It should also be noted that because of lack of reliable data, a human capital variable could not be included. In consequence, the broadband variable could be capturing the effect of the missing human capital variable.

The control variables (the amount of facilities authorized to provide health services and percentage of households with public provisioning of potable water) had statistically significant coefficients with positive signs. As expected, two of the other variables considered (variation of the number of and value of projects funded by the government) had a negative impact on unemployment. However, we found an unexpected sign on the tourism coefficient: the increase in the number of domestic tourism trips increased the gap in unemployment.

4.3 Asia Pacific

In the case of Asia-Pacific, the analysis of the economic impact of broadband was only conducted on a country basis, given the difficulty in capturing general effects in a cross-sectional model.

4.3.1 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 aggregated level, which impacted the robustness of estimates.

The information regarding broadband penetration is reported according to the telecommunications circles in which the Indian territory was divided during the privatization process. Each circle may represent only one province, (e.g., the Assam Telecom circle only includes the Assam province), or may include more than one province, (e.g., the Maharashtra Telecom circle includes the Maharashtra and the Goa provinces)[76]. The definition of circles has changed on several occasions, but in this study the definition of 2006 has been used[77].

In order to estimate the impact of broadband on Indian employment, a database containing information for India's 20 circles was compiled[78]. It contained the following dataset:

Table 38 – India: Variables used to estimate the broadband impact on job creation

Variable	Series	Source	Observations
Broadband penetration	Broadband penetration Δ (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

76 Bihar includes Jharkhand, Delhi includes Noida, Gugaon, Ghaziabad and Faridabad, Maharashtra includes Goa, Madhya Pradesh includes Chhattisgarh and Uttar Pradesh includes Uttaranchal.

77 Andaman and Nicobar Islands, Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Mahrashtra, New Delhi, North East, Orissa, Punjab, Rajasthan, Tamil Nadu, UP East, UP West, West Bengal.

78 While there were 20 telecom circles defined by the government for 2006, lack of information made it necessary to consolidate two circles into one.

Variable	Series	Source	Observations
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
Financial development I	Number of banking offices per Lakh (100,000 of Population) 2002	Indiastat	Variable to control for differences in the level of banking infrastructure
Financial development II	Bank credit per capita by region 2002	Indiastat	Variable to control for differences in financial access
Infrastructure development	Total road length per hundred sq. Km by area (km.) 2001	Indiastat	Variable to control for differences in level of infrastructure
Population growth	Average population growth by province 2001-11	Indiastat	Variable to control for differences in population growth

Source: Author.

The model results are as follows (Table 39).

Table 39 –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

Source: Author.

Four variables exhibited significant coefficients: growth of broadband penetration between 2007 and 2008, the number of small and medium enterprises in 2006, GDP per capita 2005, (although the negative sign lends itself to different interpretations), and population growth. According to the model, an increase in 1 percentage point in broadband penetration growth results in 0.028 percentage points increase in the employment rate.

According to ITU, India reached a broadband penetration level of 0.64 percentage points in 2009. Considering that India's labour force has already passed the 500 million people frontier, this model suggests that broadband has generated nearly 9 million jobs in direct and indirect ways. This result becomes more important taking into consideration the latest estimates provided by the Reserve Bank of India forecasting an increment of 220 million to India's workforce by 2030.

In addition to estimating the impact of broadband on job creation in India, its contribution to the country's GDP growth was estimated. For this purpose, a dataset for India's 20 circles was built (see Table 40):

Table 40 – 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
Infrastructure development	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	Broadband penetration Δ (2007-8)	Indiastat	Independent variable
Human capital	Participation rate in secondary schooling 2001	Indiastat	Variable to control for contribution of human capital to economic growth
Population growth	Average population growth by province 2001-2006	Indiastat	Variable to control for differences in population growth
Point of departure of economic growth	GDP per capita by region 2000	Indiastat	Variable to control pre-existent level of economic development

Source: Author.

The results are as follows:

Table 41 – India: Contribution of broadband to GDP growth

GDP Growth (2007-8)	Coefficient	Standard error	T-statistic	P>[t]
Infrastructure development	.00300	.0006727	4.46	0.001
Growth of broadband penetration 2007-2008	.031284	.0158414	1.97	0.070
Human capital	.0133936	.0803297	0.17	0.870
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

Source: Author.

Broadband penetration was found to be statistically significant and exhibited the expected positive sign. According to the coefficient of this variable, a 10 per cent increase in penetration will result in an increase of 0.3128 percentage points in regional GDP. The GDP 2003 variable was included to control for the starting point of development. Its coefficient sign is positive and not significant, which according to the conditional convergence theory could be interpreted as a sign of divergence among the regions (circles) of India.

The results of this model should be carefully interpreted because of the potential bias. It is possible that the casual relationship between dependent variable, (GDP growth 2007-2008) and the independent variable, (broadband penetration growth 2007-2008)[79] 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 broadband impact 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.

4.3.2 Malaysia: The contribution of broadband to economic growth

This case study estimates the contribution of broadband to GDP growth in Malaysia. For this purpose, the following data was collected (see Table 42):

Table 42 – 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	Broadband household penetration Δ 2006-7	Under Secretariat ICT Policy Division	Independent variable
Health infrastructure I	Hospitals per million population 2005	Ninth Malaysia Plan (2006-2010)	Variable to control for physical capital
Health infrastructure II	Beds in hospitals per million population 2005	Ninth Malaysia Plan (2006-2010)	Variable to control for physical capital
Infrastructure development	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
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

Source: Author.

[79] 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.

The results are as follows:

Table 43 – 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

Source: Author.

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 will contribute to 0.7 percentage points to regional GDP growth. This result has to be put in a context of an economy that has a service sector contributing more than 55 per cent of the GDP. It should be noted that this estimation, based on penetration per household, is lower than the 0.4 per cent impact on GDP per 10 per cent of broadband penetration per inhabitant estimated for Malaysia by McKinsey and Co Inc (2009)[80].

On the other hand, the control variables (hospitals per million populations, construction projects funded by the government, and road development index) had statistically significant coefficients and with negative signs. These indicate convergence between highly developed and lesser developed regions of the country.

4.3.3 China: The relation between broadband and economic growth

To estimate the impact of broadband on China's economic growth a database containing information for its thirty provinces was compiled. It was composed of the following variables:

80 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.

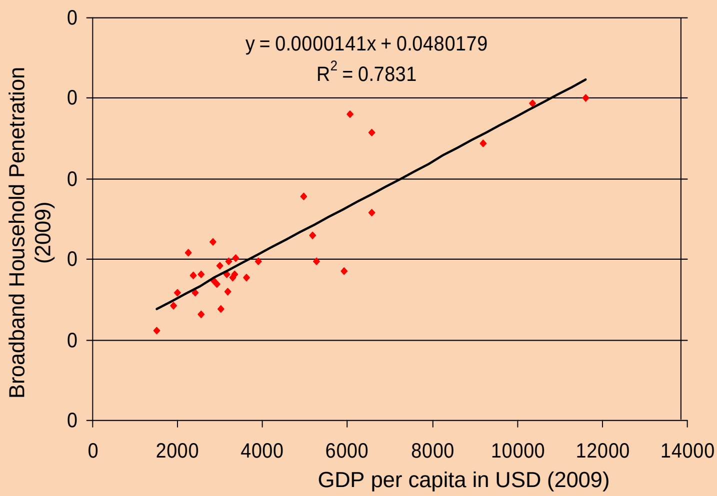
Table 44 – China: Variables used to estimate the broadband impact on economic growth

Variable	Series	Source	Observations
Economic growth	Regional economic growth between 2008-2009	All China Marketing Research (ACMR)	Dependent variable
Importance of tertiary sector	GDP tertiary sector / Regional GDP (2009)	ACMR	Importance of a less agricultural economy
Deposits	Deposit in financial institutions divided by regional GDP (2009)	ACMR	Importance of relationship of financial services and growth
Loans	Loans in financial institutions divided by regional GDP (2009)	ACMR	Variable to control for impact of financial access on the economy
Education	Secondary institutions (10,000 pop) 2000	ACMR	Relationship between growth and education
Investment	Local and foreign investment divided by GDP (2009)	ACMR	Relationship between Investment and growth
Gross capital	Gross capital/GDP (2009)	ACMR	Relationship between acquisition of assets and growth
Fixed capital	Fixed Capital/GDP (2009)	ACMR	Variable to control for impact of investment on the economy
Broadband penetration growth	Difference between broadband penetration in 2009 and 2008	Euromonitor	Relationship between Growth and Broadband

Source: Author.

Unfortunately, the regressions run against this data set did not yield statistically significant results. The author suspects that part of the reason could lie in some limitations encountered in measuring broadband penetration. Figure 16 clearly indicates that a correlation exists between broadband and economic growth for China's 30 provinces.

Figure 16: China: Correlation between economic growth and broadband deployment



Source: Author

Without pre-supposing a causal link, data in Figure 16 indicates some sort of relationship. The only further analysis that could be conducted allowed us to estimate the importance that broadband penetration in driving the variance of the level of economic development of a Chinese province. The correlation model results are as follows (see Table 45).

Table 45 – China: Correlation between broadband deployment and economic growth

Dependent variable: GDPPP09	Coefficient	Standard error	T-statistic	P>[t]	[95% Conf. Interval]	
Broadband penetration 2008-09	1.867034	1.081138	1.73	0.099	–0.38132	4.115384
Importance of tertiary sector	0.644611	0.091923	7.01	0	0.453447	0.835776
Deposits/GDP	–8.71734	1.404212	–6.21	0	–11.6376	–5.79712
Loans/GDP	3.361515	1.515494	2.22	0.038	0.209873	6.513158
Secondary institutions (10,000 pop) 2000	0.149747	0.055293	2.71	0.013	0.03476	0.264734
Investment/GDP	0.256488	0.047665	5.38	0	0.157363	0.355613
Gross capital/GDP	0.376151	0.18138	2.07	0.051	–0.00105	0.753351
Fixed capital/GDP	–0.42741	0.182476	–2.34	0.029	–0.80688	–0.04793
Constant	–30.3521	5.867167	–5.17	0	–42.5535	–18.1506

Number of Observations	30
F (8,21)=	10.45
Prob>=	0.0000
R2=	0.7180
Root MSE=	2.2161

Source: Author.

According to the results of Table 37, broadband penetration appears to be related to economic development in a significant way. Without assuming a causal relationship, it is reasonable to conclude that broadband has some level of contribution to economic growth in China. It should be noted that this analysis only yields a correlation result between the broadband and the economic variable. Further analytical work is necessary to deepen our understanding of the relationship between the two variables in the Chinese context.

4.3.4 Indonesia: The contribution of broadband to employment growth

To study the contribution of broadband to employment in Indonesia, a data panel analysis was implemented. The model was constructed using the unemployment growth rate as the dependent variable. The independent variables used in the model included the unemployment rate lagged one period, the average of the broadband penetration per household, the years of education of the labour force and the difference between the years of education between male and female economic active population (see Table 46).

Table 46 – Indonesia: Variables used to estimate the broadband impact on employment growth

Type of Variable	Data Set	Source	Rationale
Unemployment growth rate	Annual change on the open unemployment rate – per province (2006,2007,2008,2009)	PerkembanganBeberapaIndikator UtamaSosialEkonomi Indonesia – (2005, 2006, 2007, 2008, 2009, 2010)	Dependent variable
Unemployment rate	Annual open unemployment rate per province (2005, 2006, 2007, 2008)	PerkembanganBeberapaIndikator UtamaSosialEkonomi Indonesia – (2005, 2006, 2007, 2008, 2009, 2010)	Importance of relationship of unemployment rate of previous year and current change in unemployment
Broadband penetration	Average broadband penetration per household (2005, 2006, 2007, 2008, 2009)	Euromonitor	Importance of relationship of broadband and unemployment
Human capital I	Years of education of the male economic active population (2006, 2007, 2008, 2009)	PerkembanganBeberapaIndikator UtamaSosialEkonomi Indonesia – (2005, 2006, 2007, 2008, 2009)	Importance of relationship of education and unemployment
Human capital II	Difference in years of education between male and female economic active population (2006, 2007, 2008, 2009)	PerkembanganBeberapaIndikator UtamaSosialEkonomi Indonesia – (2005,2006,2007, 2008,2009)	The impact of the difference in education between male and female economic active population on unemployment

The model results are as follows (see Table 47).

Table 47 – Indonesia: Broadband impact on job creation

Dependent variable: unemployment growth	Coefficient	Standard Error	T-Statistic	P>[t]	95% Confidence Interval	
Lag unemployment growth rate	–23.8118	3.148876	–7.56	0.0000	–30.1063	–17.5173
Broadband penetration	–8.61628	3.335997	–2.58	0.0120	–15.2848	–1.94772
Years education male	–3.77658	1.659112	–2.28	0.0260	–7.09309	–0.46006
Differences years education male/female	3.895974	1.669609	2.33	0.0230	0.558474	7.233474
Constant	203.2246	27.90692	7.28	0.0000	147.4395	259.0097

Number of observations	99
Number of groups	33
F (4,62)	15.35
Prob > F	0.0000

Source: Author.

As expected, the results show a strong relationship between the lagged employment rate and the growth in unemployment. Another variable important in the model is the number of years of education between the male and female population. Finally, the contribution of the broadband variable appears to be an extremely contributor to the reduction of unemployment, with a negative effect of -8.61 per cent. This means that for each 1 per cent increase in the penetration rate of the service among the Indonesian households, the unemployment growth would be reduced it by 8.61 percentage points. It is important to note that the entire effect of broadband on unemployment is a combination of new jobs and existing jobs saved that otherwise would have contributed to the unemployment rate.

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 analysed, one can safely confirm that broadband has a directionally positive economic impact. The following chart compiles the results of the existing literature as well as this study's (see Table 48).

While it is not optimal to compare model results across geographic units, the following conclusions can be drawn. The case studies of Latin America and the Caribbean, the Arab States, Chile, India and Malaysia yielded statistically significant coefficients. However, due to data limitations, some of the country cases are handicapped by the low number of observations, which may jeopardize the consistency of estimators (Chile and Malaysia). However, Koutroumpis (2009), Katz *et al.* (2010a), the cross-sectional Latin American model , the cross-sectional Arab states models exhibit a higher level of reliability.

Table 48 – Comparative estimate of broadband impact on GDP growth

Study	Region/Country	Impact on GDP growth for each 1% in Δ of broadband penetration	Observations
Koutroumpis (2009)	5 OECD countries with penetration higher than 30%[81]	0.023	• Statistically significant coefficient at 1% level • 132 Observations
	8 OECD countries with penetration between 20% and 30%	0.014	Statistically significant coefficient at 1% level • 132 Observations
	8 OECD countries with penetration under 17%	0.008	• Statistically significant coefficient at 5% level • 132 Observations
Katz *et al.* (2010a)	High Developed Counties in Germany	0.0256	• Statistically significant coefficient at 1% level • 214 observations
	Less Developed Counties in Germany	0.0238	• Statistically significant coefficient at 1% level • 210 observations
Qiang *et al.* (2009)	Countries of medium and low economic development	0.138	• Statistically significant coefficient at the 10% level • Human capital carries insignificant explanatory power, which indicates that most variation in her dataset is explained by the dummies and the constant
Present study	Latin America and the Caribbean	0.0158	• Statistically significant coefficient (t-statistic = 1.98) • 49 observations
	Arab States[82]	0.02076	• Statistically significant coefficient (t-statistic = 1.62) • 60 observations

[81] Denmark, Norway, Netherlands, Sweden, Switzerland.

[82] See Appendix D

Study	Region/Country	Impact on GDP growth for each 1% in Δ of broadband penetration	Observations
	Brazil	0.008	• Statistically not significant coefficient (t-statistic = 0.16) • 27 observations
	Chile	0.009	• Statistically significant coefficient (t-statistic = 2.04) • 13 observations
	India	0.031	• Statistically significant coefficient (t-statistic = 1.97) • 19 observations • Potential endogeneity
	Malaysia	0.077	• Statistically significant • coefficient (t-statistic = 5.81) • 15 observations
	China		• Statistically not significant coefficients • 30 observations
	Indonesia		• Statistically not significant coefficients • 93 observations

Source: Author.

As pertains to the results, Qiang *et al.* (2009) and the Malaysia case study appear to over-estimate the amount of impact of broadband on GDP growth. In the case of Qiang, the overestimation could be the result of a number of factors. First, it is likely that there is a two sided relationship between the dependent and independent variables. In this study the dependent variable is the average growth rate for 1980 to 2006 while the independent variable is the average broadband penetration for 1998 to 2006. The authors rely on the initial level of penetration as instruments, but as the literature on the diffusion of broadband shows both variables, broadband penetration and initial level of penetration, tend to be determined by income[83]. Second, the authors presented several specifications each of them including one type of communications technology (e.g. One model only included fixed telephony, another one only included mobile telephony). In all of these models the variables, fixed telephony, mobile telephony and Internet penetration were significant and positive. Thus, it would be probable that the variable broadband penetration 1998-2006 would be functioning as a technological index capturing the effect of technologies that contributed to the growth between 1980 and 2006 but were not included in the model that measures the impact of broadband.

In the Malaysian case study, part of the overestimation could result from the fact that broadband penetration data is calculated on a per household basis, rather than per population. Given that the ratio of population to household is roughly 1:3, the appropriate coefficient for Malaysia could be 0.026, which is closer to the range of case study results.

All in all, it is fair to conclude and reaffirm the positive contribution of broadband to economic growth with a clear "return to scale" effect. Thus, in countries with higher broadband penetration, 1 per cent growth in broadband penetration results between 0.023 per cent (Koutroumpis, 2009) and 0.026 % (Katz et al., 2010a) to GDP growth. On the other hand, in the countries with low broadband penetration, the

[83] See Sangwon L and Brown J. (2009) and Garcia-Murillo (2005).

contribution to GDP growth ranges between 0.008 per cent (Koutroumpis) and 0.0158 per cent to 0.02076 of the current study.

The results of the analyses tend to be more conclusive when it comes to the positive contribution of broadband to employment creation for less developed countries and regions. The following chart compiles the results of the existing literature and this study's (see Table 49).

In this case, all prior research, as well as the results of this study, coincide and indicate that broadband has a positive impact on job creation. In particular, the German study and the Indonesian and Chilean cases, 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, i.e. positive when the independent variable is employment and negative when it is unemployment. However, the reduced number of observations (particularly for India and Saudi Arabia) significantly reduces the models' robustness.

Table 49 – Comparative estimate of broadband impact on employment growth

Study	Region/Country	Impact on job creation for each 1% increase in rate of growth of broadband penetration		Observations
		Employment	Unemployment	
Katz *et al.* (2010a)	High developed counties in Germany	0.0061		• Statistically significant level at 1% • 214 observations
Shideler *et al.* (2007)	Kentucky, USA	0.14-5.32		• Statistically significant level at 1% (total employment) • Significance level varies depending on the industry analysed- from not significant to significant • 114 observations (total). Range varies according the industry analysed (from 20 to 120)
Present study	Brazil		-0.0449	• Statistically significant coefficient (t-statistic=1.73) • 27 observations
	Chile	0.181		• Statistically significant coefficient (t-statistic = -8.29) • 13 observations
	India	0.02825		• Statistically significant coefficient (t-statistic = 1.86) • 19 observations
	Saudi Arabia		-0.2434	• Statistically significant • coefficient (t-statistic = -8.29) • 13 observations
	Indonesia		-8.6163	• Statistically significant coefficient (t-statistic = -2.58) • 99 observations
	Dominican Republic		-0.2952	• Statistically significant coefficient (t-statistic = -2.22) • 32 observations

Source: Author.

6 Estimation of Broadband Gaps and Investment Requirement

The chapter above 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. Understanding the cost of broadband deployment is critical to develop public policies that provide for realistic targets based on economic considerations.

Policy makers have taken three approaches to the issue of investment costs calculation. The first is the conventional engineering one, which is based on estimating the coverage requirements, and then using those estimates to project the necessary investment to fulfil them. This is the methodology followed for the investment estimation of Australia's National Broadband Plan. The second approach, labelled “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 Opportunities Program. Since this was part of the stimulus package passed by the US Congress, the funds would be assigned through grants with the specific construction plans defined as they are given out. The third approach does not estimate an investment amount. Labelled the “public policy” framework, it defines targets, (such as coverage and speeds), but leaves the amount of investment required unaddressed. This is the approach followed in Germany's and Brazil's national broadband plans, and, to some degree, in the United States.

The following section presents a methodology that determines investment requirements. The objective is not to provide extremely precise estimates but to gauge the investment in broadband required in order to have a sense of the resultant social and economic returns.

6.1 Methodology

The methodology used to estimate broadband investment is based on the assumption that policy makers have defined targets in their national broadband plan. As mentioned above, these targets generally refer to metrics such as coverage, adoption, and speed. In other words, the plan defines the percentage of the population that needs to be served by broadband, and the specific service level at which it needs to reached, (typically in terms of download speeds.)

Once defined, the targets have to be compared against the current situation of broadband deployment. Data on current coverage at a disaggregated enough level (municipalities, counties, administrative departments) is in many cases not available either because the government does not keep accurate records of coverage and service level or because the private sector considers this information to be proprietary for competitive reasons. Some countries, however, have public records with excellent quality of information[84]. The comparison between the current situation and the targets allows estimation of the deployment objectives. Using these figures it is possible to calculate the number of broadband access lines to: 1) cover the “white” spots (unserved areas), 2) upgrade the “grey” spots (areas with inferior service measured by low access speeds), and 3) deploy high speed lines in priority areas. Once the number of lines per service target is estimated, they are multiplied by the costs per broadband line. This last step should take into account the type of platform.

In order to determine the costs per line, the estimates from deployment experience in Europe and the United States can be utilized[85]. These costs need to be adjusted by factors such as urban density, economies of scale, and experience curve[86]. This calculation yields the total investment required for wireless and wireline technologies. The total investment is then split according to three cost categories: 1)

[84] For example, Germany’s Federal Ministry of Economics and Technology publishes the Broadband Atlas (BMWi 2009b).

[85] It is important to realize that these figures may not translate exactly in cross country comparisons due to difference in labor markets, in particular construction wages.

[86] See, in particular, Elixman et al. (2008).

construction labour, 2) electronic equipment, and 3) telecommunications labour. These splits are based on cost allocations based on "real life" deployment data for NGAN (furnished by a European operator), and for 3G and WiMAX for a US operator.

The next two sections will review examples of investment requirement calculation. The case studies to be analysed include Germany's National Broadband Plan[87] and Brazil's Broadband Plan.

6.2 The National Broadband Plan in Germany

According to estimates based on publicly available data published in the national broadband strategy, of all German households[88], 39 million have access to some type of broadband technology. Of these, 36.7 million have DSL capability, 22.0 million are passed by cable TV networks (and, therefore 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 via VDSL, while only 240,000 could be based on fibre to the home (FTTH). These estimates are based upon announcements of fibre optics technology being deployed by telecommunications operators and municipal networks.

In addition to improving coverage[89], Germany plans to raise the access speed of residential broadband users. As of 2009, the national broadband strategy reports that 98 per cent of all German households have access to broadband Internet with transmission rates of at a minimum 384 Kbps and 92 per cent of households are served by lines with at least 1 Mbps. About 2.8 million households are in "grey spots", meaning that they have broadband access between 384 Kbps and 1 Mbps. The remaining "white spots", which comprise 2 per cent of households (or 730,000), are located in areas with low population densities or near the outer boundaries of already connected areas.

Furthermore, Germany is undergoing three levels of fibre deployment: 1) Fibre to the Main Distribution Frame for ADSL 2+ services for selected cities, 2) Fibre to the street cabinet for VDSL services, and 3) Fibre to the home (DTAG, NetCologne, M'net, and Stadtwerke Schwerte). In the case of VDSL, Deutsche Telekom has announced that 90 per cent of households located in top 50 cities (which are estimated to be 10.9 million) can have access to VDSL. Simultaneously, the municipal networks have launched or are planning to deploy FTTB networks. Deployment is focused on densely populated areas of their home markets. Total coverage, based on these targets under construction, is of 240,000 homes.

The major cable players have all upgraded networks to two way Hybrid Fibre Coax, generally relying on DTAG ducts. Kabel Deutschland's acquisition of Orion in the first quarter of 2008 resulted in 7.6 million upgraded households passed (71 per cent of homes passed). Unitymedia has 6.3 million upgraded households passed (72 per cent of homes passed). Kabel BW has upgraded 91 per cent of its network, which 3.3 million homes. All players are offering DOCSIS 2.0 and plan to roll out DOCSIS 3.0 by the end of 2010.

Turning to the demand side, as of the end of 2008, there were 22.6 million broadband lines in Germany (Source: Bundesnetzagentur Jahresbericht 2008, 2009). Based on this statistic, Germany has reached 58 per cent household penetration, or 27 per cent of its population. In light of the supply perspective we see that 58 per cent of households actually served by any combination of broadband technologies purchase service (see Table 50):

[87] This calculation 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 June 17, 2009.

[88] Total households: 39.7 million, Federal Statistical Office, Germany, 2006.

[89] Coverage is defined as the ability of the technology to serve a given population. It is different from penetration, which means actual adoption.

Table 50 – Households passed by broadband

Technology	Coverage (million)	Subscribers (million)	Connected/ passed in %
DSL	36.7	20.9	57
Cable modem	22.0	1.6	7
Fixed wireless, satellite	0.730	0.092	13
FTTB	0.240	0.043	18
Total (assuming overbuilds)	39.0	22.6	58

Sources: DT; Kabel Deutschland; Unitymedia; M-net; Bundesnetzagentur.

The Federal Government of Germany has agreed on the following two broadband strategy targets[90]:

1. Nationwide capable broadband access (1 Mbps) no later than the end of 2010.
2. Provide 75 per cent of German households with access to a broadband connection of at least 50Mbps by 2014, specifically with the goal that such access lines should be available as soon as possible throughout the country.

The deployment actions required to meet these targets are three-fold. First, the 730,000 unserved households (white spots) will be covered by a mix of wireless and wireline technology. It is assumed, following Deutsche Telekom's recent announcement that 250,000 unserved households will be covered by DSL technology, while the remainder will be covered by wireless technologies. The second action will be to upgrade the 2.8 million "grey spot" households to 1 Mbps connection.

The third target of the National Broadband Strategy is that 75 per cent of households will have to be served by at least 50 Mbps by 2014 with higher bandwidths to follow. This was structured in two stages:

- Upgrade to FTTH: Given that VDSL technology deployed in dense cities limited to 50 Mbps, it is assumed that 9.92 million households (representing 25 per cent of the German households) will be upgraded to FTTH. Since the current number of households served by VDSL is 10.9 million they 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: Here it is assumed that the remaining 50 per cent of households will be upgraded from DSL to VDSL. The number of lines to be upgraded is calculated by subtracting from the target, the coverage that is already provided:

$$\textit{Lines to be upgraded to VDSL} = \textit{29,791,000 households (2014 coverage target)} - \textit{9,920,000 households (FTTH covered)} - \left(\textit{10,900,000 households (current VDSL coverage)} - \textit{9,920,000 households (moved to FTTH)}\right)$$

According to this calculation, it is estimated the broadband lines that will be connected as a result of this effort are approximately 18.9 million.

To sum up, the broadband strategy will require the following investments to be completed by 2014:

- Unserved households (730,000) covered by a mix of wireless (480,000 lines) and wireline technologies (250,000 lines).
- "Grey zone" households (2.8 million) upgraded to 1 Mbps.
- 9,930,500 households (or 25%) upgraded to FTTH: these will come from the 240,000 where FTTH has already been deployed (municipalities) and by upgrading the rest from the existing VDSL lines.

[90] Federal Government of Germany (2009) "Breitbandstrategie der Bundesregierung", 3.

- 18.9 million households (or 50%) upgraded to VDSL: this will be reached by the remaining existing VDSL lines (980,000) and by upgrading 17.9 million currently DSL lines.

Longer-term aspirations, as mentioned in other government reports (BMWi, 2009c, *38*), foresee the completion of a national ultra-broadband infrastructure by 2020. While this aim has not been underlined by clear policy objectives in the National Broadband Strategy, one can assume a set of “aspirational” targets for 2020:

- Deploy FTTH to 50 per cent of households.
- Deploy VDSL to the next 30 per cent of households.
- Offer broadband services under 50 Mbps to the remaining population (20%).

The action implied from these targets is to upgrade an additional 25 per cent of households to FTTH, (which when added to the 25 per cent upgraded by 2014 would reach a total 50 per cent by 2020).The calculation of total investment required has been conducted for each provision by relying on costs per line. The combined wireline and wireless costs required to cover the unserved households will total EUR 924 million, which are broken down in Table 51:

Table 51 – Investment required to cover unserved households

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

Source: Katz et al. (2010a).

The calculation of VDSL and FTTH deployment relies on cost per line gathered by a number of sources (see Table 52):

Table 52 – Cost per line estimates for VDSL and FTTH upgrade

Source	Cases	VDSL (EUR)	FTTH (EUR)
Analysis (2006)		300-400	1,000
Analysis (2008)	Netherlands		1,566
ADL (2009)	Generic	300-450	1,150-1,700
AT Kearney (2008)	Greece		1,206-1,525
WIK (2008)		475	
JP Morgan (2006)	Iliad (France)		1,000-1,500
	Net Cologne (Germany)		1,000
	Fastweb (Italy)		1,200
	Hillegon (NL)		1,200

Source: Katz et al. (2010a).

The cost calculation relies on the ADL figures with increasing cost per household as deployment of the technology network increases. For example, in the case of FTTH the initial 10 per cent of households (3,972,000) will cost EUR 1,150 per household to deploy, the next 10 per cent will require EUR 1,287, and the next 10 per cent, EUR 1,425. In the case of VDSL the first 10 per cent will cost EUR 300 per line, while deploying beyond 50 per cent will require EUR 450. Based on these figures and the number of lines to be deployed, calculated in 5.2, 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. To sum up, the total investment required to fulfil the 2014 National Broadband Strategy will be EUR 20,243 million (see Table 53).

Table 53 – Total investment required to achieve objectives for 2014

Target	Amount (EUR 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

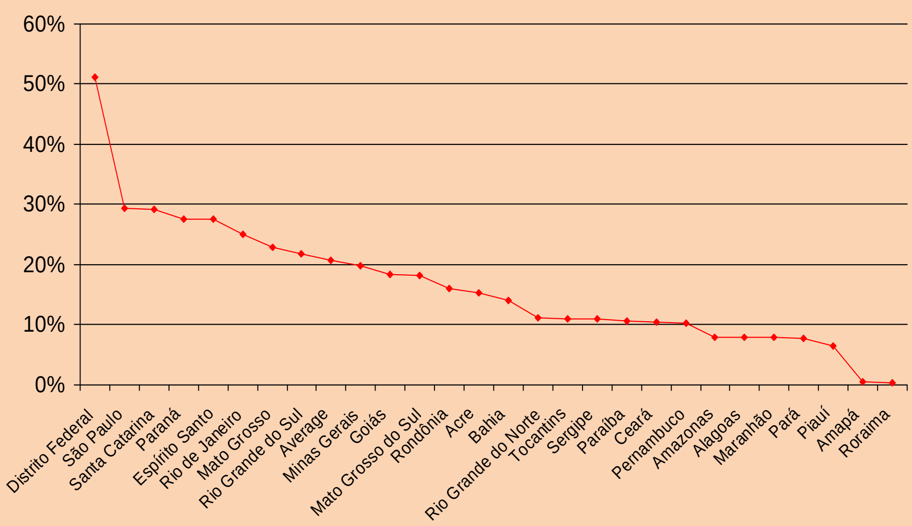
Source: Katz et al. (2010a).

As a result, the incremental investment required to meet the FTTH target of 50 per cent households served by 2020 will be EUR 15,690 million.[91]

6.3 The National Broadband Plan in Brazil

Broadband infrastructure in Brazil is still underdeveloped. In 2008, there were 11,489,000 fixed broadband lines in the country, which represent 7.1 per cent penetration per person (or 18.88% per household). Broadband deployment is uneven, ranging from states like the Federal District with 52 per cent of households, to Roraima with 0.30 per cent of households (see Figure 17).

Figure 17: Brazil: Broadband household penetration



Source: IBGE Pesquisa Nacional de Amostra de Domicilios 2008; IPEA; analysis by the author.

[91] The difference between the first 25 per cent achieved in 2014 (EUR 12,236 million) and the second 25 per cent 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.

In addition, download speeds exhibit significant shortfalls (see Table 54).

Table 54 – Brazil: Breakdown of download speeds (2009)

Speed	Per cent of lines
128 kbps-255 kbps	9.5%
256 kbps – 511 kbps	21.2%
512 kbps – 0.99 kbps	26.6%
1 Mbps – 1.99 Mbps	24.3%
> 2 Mbps	18.5%

Source: Cisco/IDC (2010).

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, which means that in addition to the population that currently subscribes to broadband, and additional 20 per cent of households can purchase service but do not due to either economic, educational or device accessibility reasons. Under this assumption, and considering the 40 per cent growth in broadband penetration that has taken place since 2008, the last year that household penetration was collected, the author estimates that broadband coverage amounts to approximately 49 per cent of households (see Table 49).

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 Mbps. With this in mind, it is necessary to estimate how many existing lines to be upgraded to 1 Mbps and how many lines need to be deployed to achieve universal coverage.

Assuming that current coverage is 49 per cent of households and that 57 per cent of total lines are under 1 Mbps, 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. To sum up, the fulfilment of the stipulated target will require upgrading 16,260,000 lines and deploying 29,470,000 additional lines.

The calculation of total investment required has been conducted for each programme (upgrades and new deployment) by relying on costs per line. It is estimated that the cost per upgraded line is USD300, while the cost to deploy a new broadband line would average USD450[92] As such, the combined wireline and wireless costs required to cover the unserved households are depicted in Table 55:

[92] The deployment cost is an approximate estimate that averages the deployment of ADSL in relatively dense areas (USD300) and the construction of broadband wireless infrastructure in rural areas. (In the US the estimate approximates USD 1,800/line). The USD 450 per line value was reported by Giusti, M. (2010). Ier Foro Iberoamericano para impulse de la banda ancha. June 21, Sao Paulo, Brazil.

Table 55 – Broadband penetration and estimated coverage (2009)

UF	Federative Unit	Total Households (2008)	Broadband Households (2008)	% of Broadband Households (2008)	Total Households (2009)	Broadband Households (2009)	% of broadband households (2009)	Penetration + demand gap
12	Acre	186,748	28,600	15.31%	187,175	40,057	21.40%	41.40%
27	Alagoas	884,165	70,646	7.99%	886,184	98,947	11.17%	31.17%
16	Amapá	165,097	1,044	0.63%	165,474	1,462	0.88%	20.88%
13	Amazonas	797,134	63,826	8.01%	798,955	89,395	11.19%	31.19%
29	Bahia	4,232,440	595,190	14.06%	4,242,106	833,622	19.65%	39.65%
23	Ceará	2,377,863	247,918	10.43%	2,383,294	347,234	14.57%	34.57%
53	Distrito Federal	755,130	386,779	51.22%	756,855	541,722	71.58%	91.58%
32	Espírito Santo	1,064,608	294,160	27.63%	1,067,039	412,000	38.61%	58.61%
52	Goiás	1,860,237	342,817	18.43%	1,864,486	480,149	25.75%	45.75%
21	Maranhão	1,621,311	129,109	7.96%	1,625,014	180,830	11.13%	31.13%
51	Mato Grosso	928,017	213,169	22.97%	930,136	298,564	32.10%	52.10%
50	Mato Grosso do Sul	734,761	133,255	18.14%	736,439	186,637	25.34%	45.34%
31	Minas Gerais	6,126,839	1,210,850	19.76%	6,140,832	1,695,915	27.62%	47.62%
15	Pará	1,941,274	150,302	7.74%	1,945,708	210,513	10.82%	30.82%
25	Paraíba	1,086,860	114,679	10.55%	1,089,342	160,619	14.74%	34.74%
41	Paraná	3,392,013	937,449	27.64%	3,399,760	1,312,990	38.62%	58.62%
26	Pernambuco	2,481,854	256,223	10.32%	2,487,522	358,866	14.43%	34.43%
22	Piauí	875,939	56,531	6.45%	877,940	79,177	9.02%	29.02%
33	Rio de Janeiro	5,258,154	1,317,226	25.05%	5,270,163	1,844,905	35.01%	55.01%
24	Rio Grande do Norte	888,764	99,484	11.19%	890,794	139,337	15.64%	35.64%
43	Rio Grande do Sul	3,662,250	798,518	21.80%	3,670,614	1,118,403	30.47%	50.47%
11	Rondônia	452,541	72,886	16.11%	453,575	102,084	22.51%	42.51%
14	Roraima	117,126	347	0.30%	117,394	486	0.41%	20.41%
42	Santa Catarina	1,960,334	573,559	29.26%	1,964,811	803,326	40.89%	60.89%
35	São Paulo	12,916,358	3,800,540	29.42%	12,945,858	5,323,031	41.12%	61.12%
28	Sergipe	567,747	62,859	11.07%	569,044	88,040	15.47%	35.47%
17	Tocantins	378,961	41,980	11.08%	379,827	58,797	15.48%	35.48%
	Total	**57,714,525**	**11,999,946**	**20.79%**	**57,846,339**	**16,807,106**	**29.05%**	**49.05%**

Sources: IBGE Pesquisa Nacional de Amostra de Domicilios 2008; IPEA; Cisco/IDC (2010); analysis by the author.

Table 56 – Investment required to fulfil targets

Programme	Number of households	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 coverage and upgrade of under 1 Mbps lines to 1 Mbps, Brazil will require an investment of USD 18 billion.

6.4 Conclusion

This section presented a methodology on how to estimate investment requirements to meet deployment targets as stipulated in national broadband programmes. 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 to be relied upon to stimulate the funding of future deployment.

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).

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 "freed" 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 programmes:** primarily oriented at addressing demand gaps, these programmes focus on: universal service policies; the stimulation of the adoption of broadband through digital literacy; economic subsidies; deployment of public access centres; and the development 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 57).

Table 57 – Coverage and speed targets of selected national broadband plans

Country	Coverage Targets (as per cent of households)	Speed Targets for per cent 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.

As Table 56 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.

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.
- They help build accountability for plan fulfilment at the highest levels of government, particularly the executive branch.

Each of these four areas will be further discussed in sections 7.1.1, 7.1.2, 7.1.3, and 7.1.4.

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 targets should be defined based on rigorous analysis of investment and social and economic returns, as well as policy tools. The targets provide the context for the development of specific projects and programmes. 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 Korea Government sponsored ICT planning process remains its holistic character[93]. 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

[93] Kim et al., 2010.

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 spill-overs 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 labelled 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 programmes 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 Programme (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, the integration of broadband goals with the fulfilment of objectives in other areas of the ICT eco-system (applications and services), and a follow-up and continuity built around the on-going formulation of plans and programmes.

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), "grey" 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 "grey" 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 in section 7.1.3.

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 and technology (for deployment of broadband in support of research programmes), education (for promoting digital literacy), health (to foster adoption of eHealth programmes), 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 Defence.

7.1.3 Developing state policies that go beyond electoral cycles

In addition to plan formulation and programme 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 on-going 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.

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 fulfilment 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 Colombia, the recently announced digital plan was presented to the nation by the President, in conjunction with all members of his cabinet.

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"[94] 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[95]. Similarly, the government fostered the consolidation of alternative broadband service providers at times of financial crisis.

This required the modification of the original *Telecommunications Law*. The Japanese experience 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 Japan Government has constantly adapted the regulatory framework to facilitate the moderate consolidation of the broadband sector in order to build a competitively sustainable regime.

7.2 Competition policies to stimulate infrastructure investment

Recognizing that the private sector has primary responsibility[96] 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. While endorsing this model, it is agreed that some situations might prompt governments to define alternative competition policies, around service-based models.

The development of facilities-based competition, also labelled 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[97]. The benefits of this model include the possibility of multidimensional competitive dynamics (prices, services, and 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

[94] Kim et al., 2010.

[95] For example, in the last tranche of privatization of Korea Telecom, the government agreed with SK Telecom the acquisition of 11.3per cent of shares, while LG acquired 2.3 per cent.

[96] 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 many developing countries.

[97] 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.

infrastructure at a regulated wholesale price or through sharing agreements, 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 behaviour 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[98], 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 of providing wholesale access reach beyond an 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. Because of the enormous economies of scale resident in broadband access, a service-based policy might lead to the emergence of a single transport player that can achieve national coverage. In other words, whether the chosen broadband competition model is infrastructure-based or service-based, the economics of the technology will result in a single operator (either supported by the state or a nationally deployed transport player) serving the rural and isolated regions of a country.

Infrastructure-based competition requires the existence of two or more nationally-deployed players. Ideally, such a model should comprise a national telecommunications carrier, a single (or regionally focused) cable TV operator, and a stand-alone "pure play" wireless carrier. Table 58 presents information from five countries around the world that have implemented such a model based on such an industry structure.

[98] See Aghion et al., 2005.

Table 58 – 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

The industry structure in the countries depicted in Table 50 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 such a 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 these countries 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). 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[99]. 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.

[99] See Katz, 2008.

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 natural "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 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. Table 59 indicates that in the transition towards the inter-platform competition models, the end user interest in innovation and low prices has been preserved.

Table 59 – 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 (USD PPP)	USD 19.99	USD 20.83	USD 27.48	USD 30.47	USD 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

Table 59 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 position 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 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.

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 fibre 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[100].

The successful experience of infrastructure-based competition models needs to be considered as a model in the context of country specific circumstances. For example, it is very likely that in countries where the industry structure comprises a single full service-based provider and a stand-alone wireless player, an infrastructure-based model could likely result in market failures (e.g. large broadband unserved areas). In this situation, regulators need to pragmatically recognize that wholesale obligations of access on the telecommunications operator could be the more appropriate approach to stimulate entry of new players and boost a competitive regime. Alternatively, if the presence of a cable TV operator is limited to certain regions of the country (as it is so often the case), a hybrid model that combines infrastructure-based competition in selected geographies with service-based competition in others might be the most appropriate approach. In fact, the latter approach, labelled “geographic segmentation” has been implemented in many developed countries around the world.

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 to address this potential market failure, the question remains as to what is the best way for the state to intervene. It is initially assumed that private sector investment tends to gravitate to areas where demand and demographic density guarantee an appropriate rate of return (see Table 60).

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 on-going funding.

There are two potential routes that governments 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[101], etc.). Some of these risks will be addressed below.

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[100] 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 neighbourhoods in Quebec City will get FTTH with 100 Mbps capability.

[101] 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.

Table 60 – 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			
	Medium		Urban areas/towns with primarily residential density		
	Low			Rural areas with sparse residential density	
	Very low				Rural areas with very low density

Source: Author.

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.[102]

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 potential adopters, 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.

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

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 pro-actively 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. The Netherlands has developed a number of good practices in this regard.

Subscriber subsidies

Subscriber subsidies should be used sparingly because of their distortion potential. 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 subscription costs are deductible up to a maximum of SEK 5000 (or roughly USD740).[103]

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. National 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,

[103] This represented a key stimulus in a country where the average taxpayer has a marginal tax rate 20 per cent.

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). However, it is important to mention here that 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 fibre or access to their infrastructure to competitors[104].
- 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 and Canada with some of the municipal fibre networks[105].

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

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

[105] See Mitchell, Christopher (2008) "Municipal Broadband: Demystifying wireless and fiber optic options", *Broadband properties*, February, p. 42, and Curri, Michael. The South-Dundas "Municipally owned network: from fiber optic pioneer to cautionary tale". Strategic Networks Group.

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[106].

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 pre-empt private investment is not likely to prove sustainable (see Table 61).

Table 61 – Options for government intervention in broadband provisioning

		Is project sustainable and profitable?	
		Yes	**No**
Is government intervening?	Yes	• Pre-emption ("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.

According to Table 55, 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.

In sum, government should intervene in broadband and wireless deployment, but only by facilitating market forces, not by pre-empting 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.

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,

[106] 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.

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 labelled*u-Japan*, which was guided by three targets:

1. 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.
2. 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.
3. 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 development and adoption of its products in the domestic market. A key policy objective of all Korea master plans has been the articulation of industrial policies such as research and development promotion (R&D), 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. This 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 a USD 8.3 billion online gaming industry, a USD 3.4 billion domestic content industry, as a well as a home-grown Internet search sector.[107]

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 programme 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. Similarly, several Latin American countries, such as Panama and Brazil, link broadband development goals with objectives to expand their presence in international software markets and/or creating a local call centre industry.

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 expansion 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.

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[108] 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. In the National Broadband Plan released in 2010[109], the number of unserved or underserved housing units amounted to 7,000,000. 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 acquiring 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 satellite or other fixed wireless services. Table 56 estimates the demand gap for a number of countries.

107 See Kim et al. (2010).

108 See Katz et al, 2009.

109 www.broadband.gov/download-plan/

Table 62 – 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.

As Table 62 indicates, the broadband demand gap in the developed world ranges from 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[110]

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 adoption.

In a study on ICT adoption inhibitors in Spain,[111] 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 it. Within those that adopt the technology, another subgroup exists – the “sporadic users”.[112] 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

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

[111] See Red.es, 2007.

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

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 States and the United Kingdom place the reasons into four categories (see Table 63).

Table 63 – 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 – person with disability)	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 United States and the United Kingdom cases illustrate the reasons for non-adoption in developed economies. In developing countries, however, availability and affordability of services 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 2.7.3), 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[113]. However, education merits further analysis because it can be influenced by public policy. According to OECD statistics, at 93 per cent, the Republic of 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 Japan or United States population. The average number of years of education completed in the Republic of Korea is 15, one more than the Japan average. Moreover, this figure is 50 per cent higher than the average for US households.[114] 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

[113] 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.

[114] See Kalba (2006).

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.[115]

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

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

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 portals that allow the interaction between the government and enterprises for e-business transactions.

This initiative is generally complemented by the implementation of digital literacy programmes that include subsidies for acquiring PCs and online education programmes targeted at the elderly and disabled, such as the programmes implemented in the Republic of Korea. In the case of small businesses, the Japan 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[116], 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.

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

[116] See Katz, 2009b.

In addition, many of the entrepreneurs that run SMEs (which are primarily 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 training 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 SME 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 uneven telecommunications network deployment, 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 programmes, 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 programmes is recommended. These programmes can teach SMEs how to take advantage of new technologies, for example, web sites can be used to market products worldwide. Another measure to be considered is the development of participatory applications and social networks (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 use 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, a vast number of measures that will contribute to ICT adoption can be implemented.

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 programmes 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 they have on the adoption of ICT and thus on enhancements to productivity. In the same vein, to speed the rates of acquisition and modernization of equipment, the use of accelerated depreciation accounting schedules should be considered. Finally, the establishment of discounts or rewards for enterprises that use ICT for their transactions with the government could become an additional incentive. 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, the extension of opening hours of telecentres in order to serve schools, communities, and businesses throughout the day and evening should be considered.

What can we expect if a region is not successful in promoting ICT adoption by SMEs? Given the importance of SMEs in the economies of developing countries, a policy failure in this domain could 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 Forum 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 Republic of Korea 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 programme 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 analyse the experience of Asian countries where SMEs represent the centre of gravity of the economy. 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 2.1. 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 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 countries such as India and Malaysia.

7.6 Addressing taxation as a barrier to broadband adoption

The developing world lags significantly when it comes to broadband penetration (see Table 64).

Table 64 – 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.

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[117]. Wireless broadband is the technology of choice to achieve this target. For this purpose, the government has issued new spectrum licences to four companies that will roll-out new wireless broadband services based on WiMAX platforms.

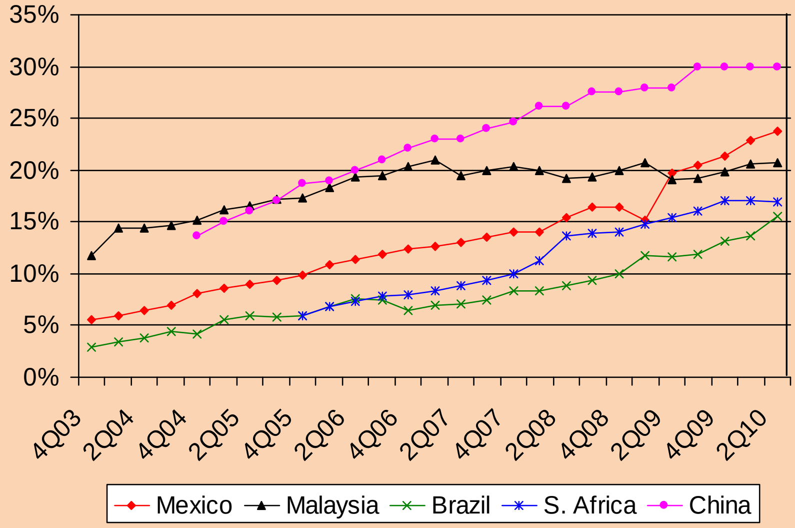
Furthermore, to rationalize capital investment, the government has imposed sharing requirements for towers among high-speed downlink packet access (HSDPA) and WiMAX operators. Finally, as an incentive for operators to roll-out their broadband networks, the government also approved tax allowances on expenditures 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 licences have not yet been

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

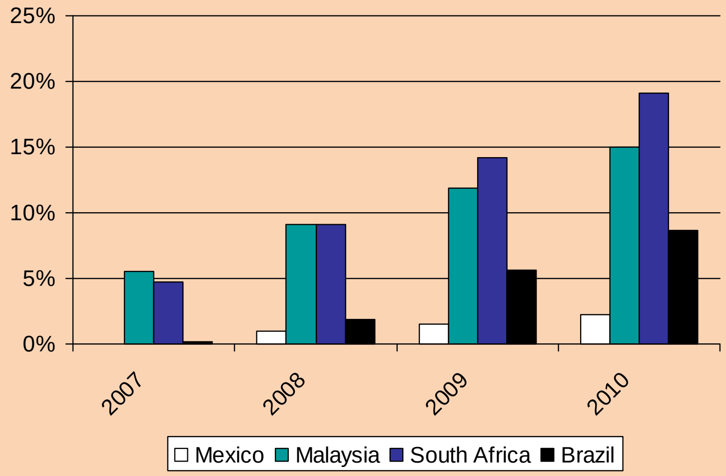
auctioned, all countries register a continuous increase in wireless broadband services combined with the deployment of 3G-enabled handsets and devices (see Figures 18 and 19).

Figure 18: Mobile data as a percentage of service revenues (2003-10)



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

Figure 19: 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 countries like Malaysia, which has implemented a benign taxation system based on extremely low value-added tax, many developing countries have introduced taxes that could negatively affect service diffusion (see Table 65).

Table 65 – Mobile taxation approaches in selected economies

Country	Services			Handset			
	VAT	Other Taxes	Fixed Taxes (USD)	VAT	Customs Duty	Other Taxes	Fixed Taxes (USD)
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%					33%	
Tunisia	18%	5%		10%		8%	
Venezuela	14%		1.56-6.25	14%	14%		

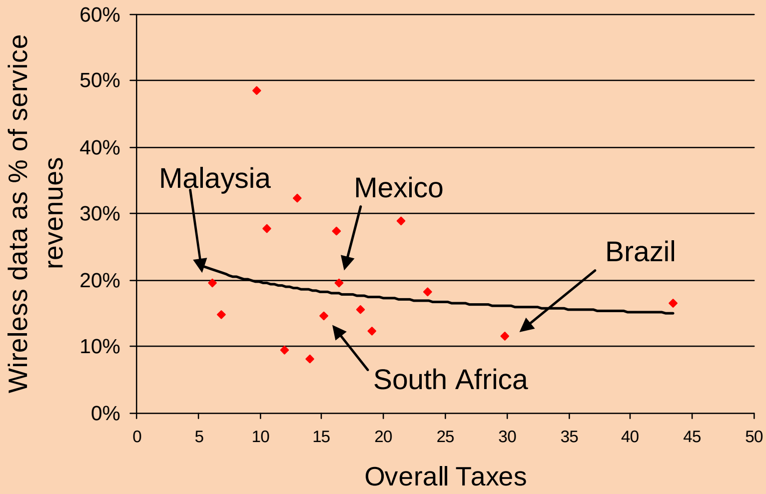
Source: Adapted from Katz et al. (2010c).

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 per cent of service revenues (see Figure 20).

If taxes limit adoption of wireless broadband, it is relevant to ask what the ultimate impact of reduced penetration might have 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 spill overeffects of broadband diffusion (Katz *et al.*, 2010). To conclude, it is safe to assume that a reduction in adoption as a result of incremental taxation could yield a negative impact on GDP growth.

Figure 20. Taxation vs. adoption of data services



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

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 the still evolving analytical tools. In spite of this situation, the research, and this study, has already generated a considerable amount of proof that broadband has considerable positive spill-over effects on the economy, both in terms of fostering growth and creating employment. The study conclusions are structured in three areas. First, the evidence of both the existing research literature and this study will be summarized. Second, based on the experience gathered in the course of this study, recommendations will be made in terms of data that needs to be collected by public administrations going forward in order to further refine the study of economic of broadband. Finally, a number of policy implications will be highlighted.

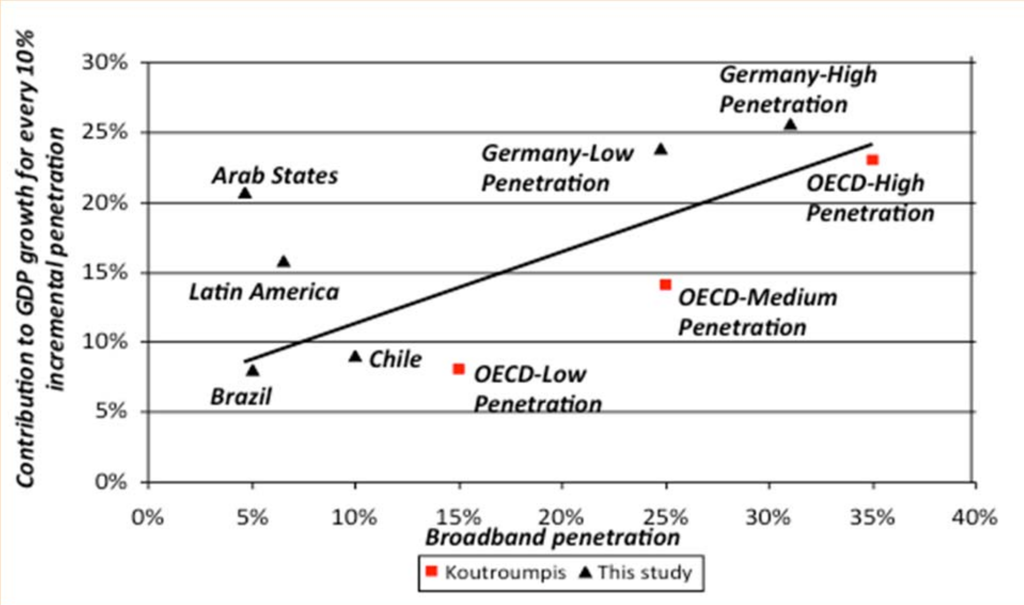
8.1 The nature of the evidence of broadband economic impact

The evidence generated for this study as well as the results of prior research validate the positive contribution of broadband to GDP growth both for developed and developing countries and regions. While limited in the number of countries studied, these analyses 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.

First, the quantitative case studies of Germany, Latin America and the Caribbean, Chile, Malaysia and India yielded statistically significant coefficients, indicating a positive effect on GDP growth. These results add to the evidence generated by the studies conducted in the developed world by other researchers. However, due to data limitations, the Chile, Malaysia and India cases are based on a low number of observations, which may jeopardize the consistency of estimators. The ability to generate a larger set of observations for these last studies would allow us to safely conclude on the positive effect that broadband has on economic growth of developing nations. Nevertheless, Koutroumpis (2009), Katz *et al.* (2010a), and the cross-sectional Latin America and Arab States models exhibit higher levels of reliability.

Second, an aggregated interpretation of the evidence would appear to point out to the validation of a critical mass hypothesis: the higher penetration of broadband, the more important is its contribution to economic growth (see Figure 21).

Figure 21: Relationship between broadband penetration and importance of contribution to GDP growth



Source: Author's analysis.

As Figure 21 demonstrates, it would appear to be a direct relationship between broadband penetration and strength of economic effect.

The results of the analyses also consistently validate the positive contribution of broadband to job creation in developed and developing countries. In particular, the Germany, Indonesia, Brazil and Chile cases yield statistically significant positive coefficients. The other cases (e.g. India, 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. However, the reduced number of observations limits the robustness of estimates of the models.

8.2 The need to emphasize data gathering to refine impact measurement

The assessment of economic impact of broadband technology should be considered an emerging area of research, which is critical in providing evidence in defining policies. The broadband policy arena has been advancing very rapidly since the inception of the technology prompted by the shift of information flows to data communications from voice, and the consequent growing amount of investment from the private sector. Unfortunately, it would be fair to say that economic impact studies have not developed at a step commensurate to that of the policy development domain. Yet, triggered by the growing availability of data series, new studies have been completed recently, shedding some light on under which conditions, and to what extent, can broadband contribute to economic growth and job creation. At the same time, the studies have allowed to identify the gaps in data availability. Governments, especially regulatory authorities, should emphasize the gathering of data in order to facilitate the analysis of economic impact, a key cornerstone of policy making.

As a primary take-away of this study, a set of indicators for measuring the economic impact of broadband is proposed and included in Appendix B. Data requirements range from the aggregate macro-indicators to the micro-data that provide an indication of consumption patterns and user needs.

8.2.1 Disaggregated data for ICT, broadband and economic indicators

The foremost need is for data on all indicators to be disaggregated at the regional level within a country (county, canton, department, even postal code). The lower the level of aggregation is, the more data points there are and, with more data points, the effects of broadband can be estimated more precisely. In addition, the more variables that are used, the more points are needed to obtain an adequate level of precision. Since growth models rely on at least five or six variables, it is necessary to have a large number of observations (at least 30-40) to estimate the effects of broadband.

The second reason for disaggregated data needs is that it allows research to deal with local fixed effects. Even with a rich set of controls, it is hard to measure the effects of broadband using large levels of aggregation. All sorts of questions arise as to how comparable the data are. For example, it is difficult to compare penetration rates or education (which are two variables used in growth models), across countries, or even between cities and rural areas. Quality may differ tremendously between countries, therefore two people with the number of years of education or both with broadband Internet may be getting very different services if one is in a developed and another is in a developing country. Therefore, the lower the level of aggregation is, the more accurate results will be.

8.2.2 Quarterly data

Quarterly data is another way to increase the number of observations and thus the accuracy of estimations of broadband effects. In many countries employment is reported on a quarterly basis. Therefore, if broadband subscriptions are also reported quarterly, it will be possible to estimate the relationship between broadband and employment more accurately.

For one, the amount of time required for broadband to impact employment will be known with greater specificity. At the moment, research indicates that there is a lag period between network construction and the moment where indirect employment effects kick in. However, whether this lag is one quarter or two years long is currently unknown. Quarterly data is the only way to observe this phenomenon. More accurate estimations of the effect of broadband on employment are also needed because the relationship is complex and also subtler than that of broadband on GDP. While employment is clearly raised by network construction, the long-term effects on employment are less clear. For example, broadband may enable outsourcing or online shopping could hurt employment at local commercial businesses.

From an economic point of view, in the short-run, increases in labour productivity may lead businesses to substitute capital for labour. While there are also many positive effects of broadband on employment, the relationship is very subtle and more precise estimates are needed to quantify it; as of now the results of research vary, some papers find no relationship, (the negative and positive effects are balanced), while others find a positive effect. Quarterly data will allow for more precision, which will go a long way towards solving this problem.

Finally, growth models necessitate data from at least two points in time per country, state or other unit of observation. Therefore, if data is collected quarterly, research may be conducted as soon as one year after regulators begin releasing new time series. However, with annual data, two years is the absolute minimum needed for researchers to use new data.

8.2.3 Range of broadband download speed

Policy makers and researchers agree that the speed of Internet access matters. So far, research has proven that the move from dial-up to broadband (be it DSL or cable modem) has a positive impact on productivity. However, it is yet unclear whether there is a linear relationship between speeds and economic impact. The question is: at what speed should broadband be offered in order to maximize economic impact?

In order to answer this question, regulators need to keep data on the number of subscriptions by speed. For one, this would greatly facilitate cross-country comparisons. It is unrealistic to assume that the average broadband customer in a developed country has the same service quality as his counterpart in a developing nation. Yet, because these data are not available economic studies are forced to make this assumption. This may have created a large range of problems. For example, studies disagree whether broadband is more useful to urban areas and developed countries. However, more developed countries often offer faster broadband services, so it is difficult to tell whether the effects increase because the impact of increasing access speeds is very large or developed countries can more successfully use broadband services. Data compiled on the number of subscriptions by range of speed will help researchers quantify the marginal returns on speed. In turn, this will help countries optimize their broadband plans. For example, it will become clear whether policy should focus on the development of new technologies (such as fibre to the home deployment) or increasing coverage of basic technologies. There is no point in investing in 100 Mbit/s services if they don't offer any socio-economic gains relative to 10 Mbit/s services.

8.2.4 Data on wireless broadband Internet

Wireless Internet represents the platform of choice for meeting the demand for broadband in developing countries. It is also increasingly important for developed countries in terms of the shift to wireless of a great deal broadband usage. Wireless data plans are becoming increasingly sophisticated and as a result their speeds and capabilities are comparable to fixed-line broadband plans. In light of the surge in wireless data plans, (which is expected to continue through the next few years), developed countries will experience a substantial increase in broadband subscriptions, even though the fixed line market is in some cases saturated. Without data on wireless data plans, socio-economic benefits will be wrongly accounted for. This problem is only exacerbated in developing countries, where, due to lack of infrastructure, the majority of Internet connections are through wireless networks. Fixed-line broadband and wireless data subscriptions simultaneously increasing and therefore without data on mobile broadband subscriptions the economic benefits will be attributed solely to fixed line broadband. This will severely influence estimations on the importance of broadband, because mobile data plans are just as if not more important than fixed lines.

8.2.5 Data measuring: the demand gap

There is much debate over the short-term and long-term effects of broadband networks. From an econometric point of view homes passed allows us to differentiate between direct effects of roll out and other effects. At the moment econometric models have a great amount of difficulty measuring direct effects because if subscribers rise during one year it is usually as a result of construction in the previous year. However, we tend to measure the effects of subscriber gains on the next year. Because homes passed are a more accurate measure of network construction, the confounding effect would be solved if this data were collected. Differentiating between short-term and long-term effects would be especially useful for understanding the relationship between broadband and employment. As mentioned above, the long term effects of employment are the most controversial. However, when the both short and long term effects are measured at the same time, we risk overlooking the subtleties of the long-term effects.

In addition, homes passed would allow researchers to gauge the demand gap, defined as the population that could subscribe to broadband but do not. This is critical since in many cases, broadband policies are primarily focused on supply stimulation (e.g. how to stimulate further investment in unserved and underserved regions) when the first and easiest problem to be tackled to increase penetration would be the demand side (e.g. what type of education programmes, digital literacy campaigns, and potential subsidies could be implemented to stimulated adoption).

In that sense, it is critical to gather data in terms of coverage, quality and speed by region of a given country. In addition, survey data on household and enterprise broadband utilization should be extremely useful to determine policies tackling the demand gap.

8.2.6 Variables for income endogeneity

There is good reason to believe that, like most other goods, broadband is income elastic. That is to say broadband not only drives income growth, but income also drives broadband demand. This two-way relationship is termed endogeneity and is very difficult for researchers to deal with. It may severely impact estimations of the impact of broadband on GDP. The most convincing econometric tool to deal with this is to rely on a system of equations. However, this process is not feasible for most countries because of data availability. The following variables would greatly enhance researcher's capabilities for using systems of equations. They allow the estimation of broadband supply and demand, which solves the problem of income endogeneity.

In the first place, both supply and demand are functions of price. Therefore, in order to make use of simultaneous equations, it is necessary to have a measure of price (such as average or median price paid), for each geographical unit of observation. Though it is far less desirable, if price is unavailable, competition can be used as a proxy. This can be measured by the number of providers serving a certain area (however this is obviously only useful at small levels of aggregation such as the zip code or county). Competition is also useful because it can be used as a proxy for subscription rates. For example FCC only collects data on the number of firms that offer broadband in a given zip code, not the penetration level.

Secondly, a large amount of broadband ventures are supported by government. This share is so large that is problematic to broadband supply without government incentives. Government surplus is not a good enough proxy – in fact it is misleading. One would think that governments with greater surpluses would be able to offer more incentives, but research such as Koutrompis (2009) has observed the opposite effect in OECD countries. It would seem that large deficits are indicative of big spenders. However, it is very likely that this would not hold up if we analysed developing countries where broadband plans might be the first to be cut in a situation of financial need. Clearly, in order to adequately describe supply, researchers need direct data on government incentives and investment.

8.3 The policy kit for stimulating broadband deployment and adoption

This study also introduced a methodology aimed at calculating the investment required to achieve full broadband penetration in section 6.1. That 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 substantial. Accordingly, the next step should be the development of social and economic "business cases" of such an investment. In other words, what is it going to be the return of a national broadband plan and its associated price tag?

Finally, the study focused on the policies that have proven to be most successful in stimulating not only investment in broadband but also adoption by population and businesses. The tool kit is wide ranging comprising 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.

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Appendix A
Methodologies and Data Utilized in Measuring Broadband Economic Impact

A.1 Input/output analysis to measure multipliers of broadband deployment

This approach focuses on determining how much value added and employment is generated through the national rollout of high speed broadband services in the access network. The importance of a sector can be measured by direct and indirect effects on the whole economy. The direct effects can be expressed in terms of indicators like the sector's contribution to total value added, growth or its importance as an employer. However, these single indicators do not represent the full importance of a stimulus programme. Complex relationships develop between industries because each sector sources goods and services from other sectors. In consequence, investments in one sector trigger demand indirectly in other sectors as well. These networked relationships mean that the effect of investment of a high speed broadband rollout programme is greater than the direct effects would suggest. The indirect effect can be measured using parameters known as multipliers; they estimate the factor by which the direct effect must be multiplied to determine the total impact of investment in a single sector on the national economy. It is important to mention, however, that, in some cases, investment does not fully materialize in job creation. First, a portion of the investment can be "leaked" to other economies due to the fact that some intermediate inputs, such as equipment, are manufactured in other countries. Second, while the models might predict that investment leads to job creation in a fairly deterministic way, a number of institutional factors could stand in the way of this effect to happen. For example, the public funds could be available for investment but bureaucratic impediments act as obstacles for networks to be deployed.

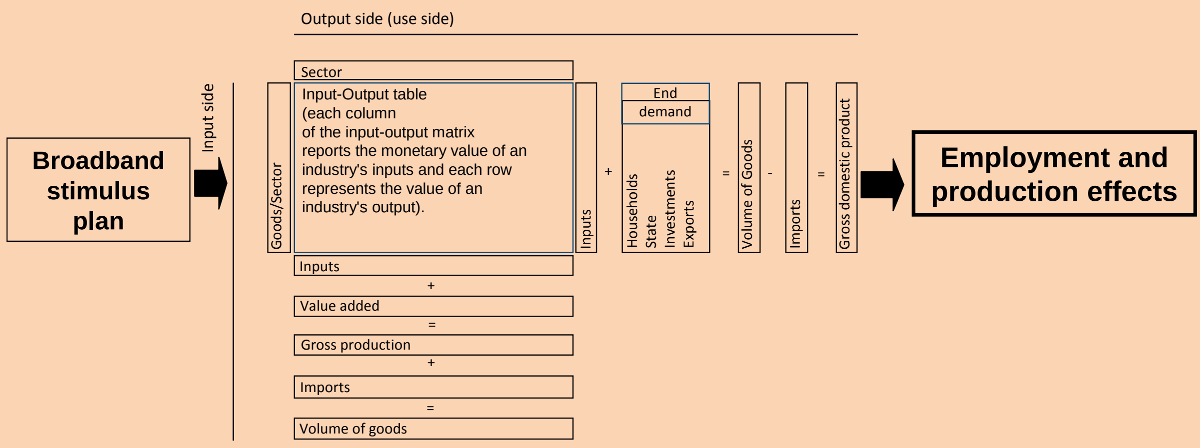
Input-output tables enable the calculation of the impact of additional inputs in specific sectors on the economy as a whole. The relationships between the sectors at the inputs stage trigger additional demand and thus increase production in other sectors. The sum of all these effects is the multiplier for the total volume of goods. Multipliers can be calculated in several ways and also for several economic dimensions. There are, for example, goods-related multipliers for the total volume of goods in an economy, for the value of total production or for the value added. There are also multipliers for labour market parameters such as the size of the workforce or the number of hours worked.

A.1.1 Methodology

The estimation of countercyclical effects comprises two steps: the estimation of investment required to fulfil the targets of the broadband stimulus plan and the calculation of resulting economic effects through input-output analysis (see Figure A.1).

The coverage and service targets established by the broadband stimulus plan are used to estimate the investment required to deploy the broadband infrastructure. These targets were compared against the current situation of broadband deployment. The comparison between the current situation and the targets allows estimating the deployment objectives in terms of number of lines to: 1) cover the "white" spots (unserved areas), 2) upgrade the "grey" spots (areas with inferior service measured by low access speeds), and 3) deploy additional lines for different type of platforms (wireless, DSL, VDSL and FTTH).

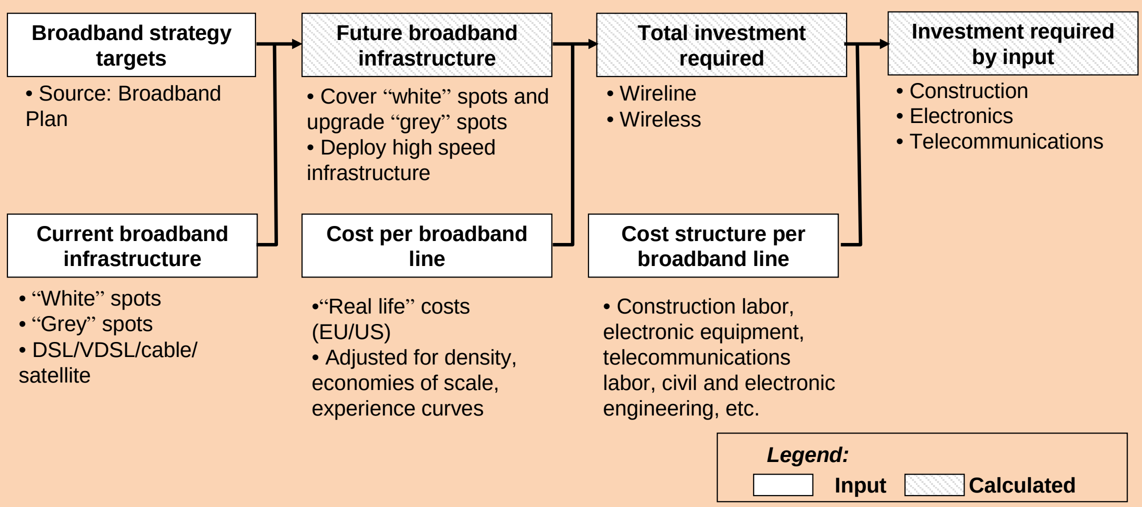
Figure A.1: Structure of input-output table



Source: Based on the Bureau of Economic Analysis (BEA) make- and use-tables

Once the number of lines by service target is estimated, they are multiplied by the costs per broadband line by type of platform. In order to determine the costs per line, the costs from deployment experience in Europe and the United States were relied upon, adjusted for factors such as urban density, economies of scale, and experience curve. This calculation yields the total investment required for wireless and wireline technologies. The total investment is then split according to three cost categories: 1) construction labour, 2) electronic equipment, and 3) telecommunications labour. These splits are based on cost allocations based on "real life" deployment data furnished by operators. The resulting process yielded the amount of total investment by cost category (see Figure A.2):

Figure A.2: Methodology for estimating broadband deployment costs



Source: Author

Once the investment input is calculated, the estimation of employment and output effects can be done. Input-output tables help calculating the direct, indirect, and induced effects of broadband network construction on employment and production. The interrelationship of these three effects can be measured through multipliers, which estimate how one unit change on the input side effects total employment change throughout the economy.

To calculate employment effects resulting broadband deployment, one relies on input-output matrices published by government census and statistics departments (see below). However, in order to be utilized in this analysis, the input-output matrices need to be formatted to calculate the employment multipliers.

Once the table is reformatted, one calculates the multipliers. From the I/O-table it is possible to obtain multipliers for total industry supply and additional variables as value added and employment. The calculation of the multipliers for the total industry supply uses the direct requirement table, which is also called Leontief-Inverse. The direct requirement table (DR) is calculated by the following formula:

DR = (I – A)^-1
with A = I/O-table / total industry supply
(division of each cell of intermediate domestic supply by total industry supply)
I = Identity matrix

The sum of the columns per industry reflects the increase of the total industry supply by one additional unit of demand in this specific sector. A correction for the share of imports on total industry supply results in the total domestic production of the industries. The multiplying of the share of value added of total domestic industry production results in the value added multiplier. Using labour productivities it is possible to calculate the job effects now.

A.1.2 Data utilized for input/output analysis

The following data sets are needed to conduct the input-output analysis (see Table 6).

Table A.1 – Data utilized in input-output studies

Data	Remarks	Availability	Rationale
Investment in broadband programme	Breakdown of investment by sectors (i.e. manufacturing of electronic equipment, construction, telecommunication)	To be calculated based on benchmarks	This is the investment input that will trigger growth in output and/or jobs
Input-output-table		To be supplied by government statistical units and/or central banks	Required to understand inter-sectoral relationships
Number of employed persons	In the same classification as the input-output-table	To be supplied by government statistical units	Required to calculate employment effects

To calculate investment inputs, data on current broadband coverage and service quality is required. Data on current coverage is typically difficult to find from public sources, although it is available through the service providers in each country[118]. In other cases, the regulatory authority might have information regarding broadband coverage.

Once the investment input is calculated based on the methodology described in section A.1.1., one needs to move to measuring the broadband construction effect. The starting point is a make-use table from input-output statistics, from which imports are excluded to reflect domestic production. In addition, as mentioned above, the matrix might need to be consolidated in a more reduced number of industries to

118 Some countries, however, have up to date information on broadband coverage. For example, Germany possesses the Broadband Atlas produced by the Federal Ministry of Economics and Technology (BMWi 2009). As part of its National Broadband Plan, the United States is conducting an effort at developing its broadband map.

reflect sector codes of the country being analysed. For the US study, Katz and Suter (2008) relied on three original matrices and data sources:

1. Bureau of Economic Analysis: Matrix from the 2002 Benchmark Input-Output Accounts
2. Bureau of Labor Statistics: Employment by Industry ("Employment and Earnings Online," January 2008 issue)
3. Oxford Economics: Sector share of employed persons by sector in the USA

The I/O-table (Figure A.1) was built based on the Bureau of Economic Analysis (BEA) make- and use-tables using a methodology from Chamberlain Economics LLC. To obtain an I/O-table that can be used to calculate multipliers that reflect domestic production it is necessary to exclude imports from the make-table. The resulting I/O-table from BEA data has the dimension of 133*133 industries. Due to the fact that the employment data used for further calculations is in a NACE code with 28 industries the I/O-matrix is transformed to a 28*28 industries matrix.

In their study of Germany, the input-output matrix supplied by Eurostat (Eurostat 2009), and originally developed by the Federal Statistical Office (Destatis 2009) was utilized.

Beyond developed countries, input-output matrices might not be available and therefore, the possibility of conducting this kind of analysis might be greatly limited.

A.1.3 Advantages and disadvantages of input/output analysis

Input-output analysis to assess broadband deployment impact has certain advantages. Input-output tables are easy to communicate and are based on proven interlinks between sectors. The results of the analysis are particularly robust in terms of estimating short-term direct and indirect effects of broadband investment on employment and value added.

However, while input-output tables are a reliable tool for predicting investment impact, two words of caution need to be given. First, input-output tables are static models reflecting the interrelationship between economic sectors at a certain point in time. Therefore, they cannot measure dynamic processes of sectoral adjustment in response to changing demand. 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-out 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. Third, induced effects are calculated based on numerous assumptions, which need to be carefully formulated. For example, under close to full employment conditions, induced effects do not materialize.

A.2 Econometric analysis to measure externalities of broadband

This approach for measuring the impact of broadband on economic growth and job creation entails specifying regression models where GDP growth, employment and other output metrics are a function of broadband deployment and broadband penetration. A number of econometric studies have been generated to measure broadband's impact on GDP growth and employment. Because of limited data availability, most studies tend to focus on the developed countries (see Table A.2).

Table A.2 – Econometric studies of broadband externalities

Author	Year	Title	Area	Period	Aggregation
Crandall *et al.*	2007	The Effects of Broadband Deployment on Output and Employment	48 US States	2003-05, 04-05	State
Czernich *et al.*	2009	Broadband Infrastructure and Economic Growth	20 OECD	1996-07	National
Ford & Koutsky	2005	Broadband and Economic Development	Lake County, FL	1999-04	County
Katz *et al.*	2010	The Impact of Broadband on Jobs and the German Economy	Germany	2003-06	County
Kolko	2010	Does Broadband Boost Local Economic Development?	US	1992-06	Zip Code, County, Individual
Koutrompis	2009	The economic impact of broadband on growth: A simultaneous approach	22 OECD	2002-07	National
LECG	2009	Economic Impact of Broadband: An Empirical Study	15 OECD	1980-07	National
Gillett et al	2006	Measuring Broadband's Economic Impact	US States	1999-02	State/Zip
Qiang & Rossotto	2009	Economic Impacts of Broadband	120 Countries	1980-06	Country
Shiedeler, *et al.*	2007	The Economic Impact of Broadband Deployment in Kentucky	Kentucky Zips	2003-05	Zip Code
Thompson & Garbacz	2009	Broadband Impacts on State GDP: Direct and Indirect Impacts.	48 US States	2001-06	State
Waverman *et al.*	2005	The Impact of Telecoms on Economic Growth in Developing Countries	102 Countries	1980-03	Country
Katz	2010	The impact of broadband on the economy	Latin America	2004-09	Country
			Brazil	2006-07	State
			Chile	2003-08	Region
			India	2007-08	Telecom Circles
			Malaysia	2007-08	States
			Saudi Arabia	2007-08	Provinces

Source: Compiled by the author.

A.2.1 Methodology

Econometric studies rely on regressions and therefore necessitate historical datasets to determine the effect of broadband on GDP, employment and other economic indicators. In order for these studies to investigate causal effects (rather than correlations), models are developed that account for factors, other than just broadband, that may influence economic indicators. In slightly more technical language, a regression is informed by the historical levels of an economic indicator and the factors that influence it. Then, given a certain model, it assigns coefficients that maximize the amount of explained variance: that is to say it assigns the set of relationships between factors and the indicator that will cause the projected value of the indicator to most closely mimic what happened historically. For example, level of education in a given country drives GDP growth as well as broadband usage; thus it is important that this variable is present in a regression model, because if it does not, we may attribute the effects of education to broadband. In that vein, economists specify models that account for each of the factors that influence economic indicators. An optimal regression breaks up the variation of an indicator, such as GDP. It assigns a set of coefficients which measure how important each factor is in determining the indicator, or how much a change in each of the factors caused the economic indicator to change. Hence, we are left with the effects of broadband keeping other factors constant. This is why broadband effects are conceptualized in terms of, all other variables (education, fixed capital investment, infrastructure) being constant, and the change in broadband penetration that would explain GDP growth.

There are three types of model estimation procedures used to assess the economic impact of broadband: cross-sectional regression; panel data and simultaneous equations. The cross-sectional procedure relies on one observation per unit (country, county, region, etc.) and in the case of studying change in variables; at least two points in time are needed. It includes independent variables such as broadband penetration, level of tertiary education, fixed capital investment (see below) and the dependent variables (such as GDP growth and employment and unemployment growth). This methodology is the most commonly used because it is rare the case when more than two years worth of data across variables is available. Given the issue of carefully estimating the direction of causality (what drives what), it is advisable to lag the variables collecting data for independent variables in year 1 and regressing them against dependent variables in year 2 or more.

Panel data and simultaneous equations are two techniques that further help econometric analyses study causation rather than correlation. They are among the most successful techniques that have been employed in the papers that analyse broadband economic effects.

Panel data is a time series for multiple geographic areas, (i.e., it is both a time series and a cross-sectional dataset). This allows researchers to account for time fixed effects and geographical fixed effects. For example, if a dataset were confined only to 2008, it would be extremely difficult for researchers to separate the effects of the recession from their growth models. The reliance on the panel data approach is to allow unobserved differences in preferences and technology across regions or countries, differences that if were not taken into account in a cross-sectional regression could cause biased estimators (omitted variable bias).As these differences are not easily measurable, they can be treated as unobserved individual effects in the panel data regression framework. From an econometric point of view, the panel data model will correct the omitted variable bias, where the omitted variable captures the differences across countries. The panel data approach requires the compilation of time series for multiple geographic areas, (i.e., it is therefore, both a time series and a cross-sectional dataset).

The third methodology -simultaneous equations- is used to deal with endogeneity—or a cycle where factors cause the indicators to change and vice versa. This problem is particularly pronounced in the study of broadband's effect on GDP, GDP per capita and income. Research unilaterally agrees that broadband increases GDP and income. However, numerous studies on broadband demand have also shown that broadband is income elastic (or that an increase in income substantially increases broadband demand). Therefore, when we model the effect of broadband on income (or GDP, etc.) we must have a way to account this reverse effect (income elasticity), or our estimate will be biased. Simultaneous equations do just this: regressions are performed that simultaneously estimate broadband demand, supply and impact on income, solving the problem of endogeneity. The key disadvantage of this approach, particularly for developing countries, is the lack of data availability (particularly, prices and supply side variables).

A.2.2 Data utilized for econometric analysis

The econometric methods require the gathering of data for both dependent and independent variables in terms of their rate of change in order to determine to what extent changes in broadband penetration affects the economy. The dependent variables that are required for this analysis are GDP per capita and employment or unemployment rate. In some cases, when it comes to regional studies, analysis has been conducted considering Gross sales (see Table A.3).

Table A.3 – Data utilized in econometric studies

Dependent Variables	Independent Variables	Control Variables
• Annual or quarterly rate of change of GDP • Annual or quarterly rate of change of employment • Annual or quarterly rate of change of unemployment • Annual number of SME's	• Annual or quarterly rate of change of broadband penetration	• GDP at starting time of period • Level of education: Per cent of population with tertiary degrees; Illiteracy rate; Years of schooling; participation rate in secondary school • Regional Investment as percentage of regional GDP • Per cent of households with electricity or running water • Number of projects and added value of construction projects financed by the state • Number of hospitals per inhabitant; number of beds in hospitals per inhabitant • Access to financial services: Number of banking offices and bank credit per capita • Industry concentration: Contribution of financial services, commerce and manufacturing sectors to regional GDP • Importance of tourism in the region (number of domestic tourism trips) • Cost index for interstate trade costs • Cost to create new business • Regional Gini Coefficient • Percentage of people living in urban centres • Total road length per hundred sq. Km by area; Road development index • Population growth rate • Globalization Index; Globalization Index per region

A number of observations need to be made regarding this list:

- Level of education: in countries where the minimum level of education is secondary school, tertiary education is determining variable
- Regional investment as per cent of regional GDP: It is critical to understand if the increase in employment or GDP is driven by investment other than broadband; this is why analyses consider several control variables that measure not only the pre-existing quality of infrastructure, but also the change in infrastructure deployment as a proxy of investment
- Number of projects and added value of construction projects financed by the State: In the case of countries where the economy is run by the government, it is imperative to introduce this variable as a way for not over-estimate the effect of broadband
- Appendix B presents the variables utilized by the most important econometric studies.

A.2.3 Advantages and disadvantages of econometric analysis

The primary advantage of the econometric modelling is its capacity to link projections of broadband penetration, growth and productivity by relying on macro-economic causal models that rely on historical time series and cross-sectional analysis. More specifically, the methodology can provide estimates on employment growth and productivity based broadband network externalities, and generates results and identifies productivity and employment effects at the industry sector level.

On the disadvantage side, since the impact of investment on productivity is generally lagged, time series data sets need to be somewhat long for reliability. Furthermore, the analyses require data at a fairly granular level (e.g. postal code). Finally, it is more difficult to identify effects at the regional level, although this can be addressed with disaggregated data

A.3 Measuring consumer surplus of broadband

The measurement of broadband consumer surplus is not as common as the econometric studies discussed above. Shane Greenstein and Ryan McDevitt, from Northwestern University, pioneered this methodology for the United States broadband sector and have recently replicated this analysis for a number of selected countries: Canada, the UK, Spain, Mexico, Brazil and China. The authors' theoretical framework is based on the notion that a new good (broadband) provides benefits that are additional to the old (dial-up access). The objective is, therefore, to calculate those benefits, which they call "the broadband bonus".

The approach the authors used was to rely on price declines to "trace out demand curve for broadband". In doing so, they assume constant/falling nominal prices (falling real prices), which explains growing use at households.

A.3.1 Data utilized in measuring the consumer surplus of broadband

The data required for conducting the assessment of consumer surplus of broadband for the United States comprised the following sets:

- Number of broadband subscriptions
- CPI for Internet access
- Household use of dial-up and broadband
- Price of broadband service
- Estimation of revenues of household broadband services

In extending the analysis to other countries, the authors needed to gain access to data on number of broadband and dial-up subscribers broken down between residential and enterprise users extending back to at least 2002. In addition, residential and enterprise data series for the equivalent period is required.

A.3.2 Methodology

The objective of this methodology is to calculate a metric similar to the estimate of the broadband bonus developed by Greenstein and McDevitt (2009) for the United States: consumer surplus and net gain in producer revenue (broadband revenue minus lost dial-up revenue), expressed in a single currency for comparability.

The first step is to calculate broadband revenues for the whole country. This is done by multiplying the number of subscribers by a price index for the given country, expressed in real terms for the last year of the series. Estimates are calculated for each year of the series.

The second step is to estimate the consumer surplus. The basic methodological premise in measuring consumer surplus is that a decline in real prices, resulting from the combination of general price inflation with flat or no growth in nominal prices generates consumer surplus. Such declines are common in all these economies for broadband. By analysing the historical trend, one can observe the growth in consumer surplus, whose vector depends on the change in prices levels and change in revenue.

The third step adjusts the estimates for the replacement of dial-up by broadband, presuming that dial-up would have been used, had broadband never diffused. Since prices for dial-up service might not be available, Greenstein and McDevitt rely on estimates of cannibalized dialup revenue using OECD's figures for dial-up use and an estimate of the price of dial-up service, also from OECD, whose latest published number was for the year 2000. This allows seeing the size of dial-up revenue cannibalized by broadband.

The calculation of the so-called “broadband bonus” is done by adding broadband revenue to consumer surplus and subtracting cannibalized dial-up revenue.

A.3.3 Advantages and disadvantages

The model measuring consumer surplus originated from broadband services presumes a stable demand, since core factors shaping demand do not change substantially. In that sense, results are quite valid for the short run.

On the other hand, the analysis can yield conservative estimates. These might exclude gains to early adopters, shifts in demand linked to GDP growth, falling prices of PCs, greater capability of online system, and changing user willingness to pay. Furthermore, the methodology excludes indirect benefits. Having said that, the authors argue that given data availability internationally, there does not really exist an alternative approach for comparing countries.

Appendix B
Variables Utilized in Econometric Analyses

Table B.1 – Dependent variables in econometric studies

Author	Employment	GDPC
Crandall *et al.*	Yearly Growth Rate	Wages
Czernich *et al.*	-	GDPC
Katz *et al.* (2010)	Period Growth Rate	-
Kolko	Period Growth	Median Income
Koutrompis (2009)	-	GDPC
LECG	-	-
Lehr et al	Period Growth of Employment Rate, and Number Employed 1994-98	Average Salary and Median Income
Qiang & Rossotto	-	-
Shiedeler *et al.*	Yearly Growth Rate	-
Thompson & Garbacz	Yearly Growth Rate	-
Waverman *et al.*	-	Income
Katz (2010) – Latam		
Katz (2010) – Brazil	Yearly Unemployment Growth 07/06	Growth Rate Regional GDPC 07/06
Katz (2010) – Chile	Quarterly Rate 09/02	Growth Rate Regional GDPC 08/09
Katz (2010) – India	Yearly Growth Rate	Growth Rate Regional GDPC 07/08
Katz (2010) – Malaysia		
Katz (2010) – S. Arabia	Yearly Unemployment Growth 08/07	

Source: Compiled by the author

On the independent variables side, in addition to change in broadband penetration, a number of variables are utilized both in the economic and technology domain (see tables B.2 and B.3).

Table B.2 – Economic independent variables in econometric studies

Author	GDP	Establishments	Investment	Labor Force
Crandall *et al.*	Growth Rate 05/03 or 05/04	-	-	-
Czernich *et al.*	GDPC	-	-	Working Age Population
Ford & Koutsky	Gross Sales (Monthly) as a proxy	-	-	Population
Katz *et al.*	Period Growth Rate	-	-	Pop. Growth 2000-6
Kolko	-	Average Size	-	Pop. Density
Koutrompis	Millions USD	-	-	Employed Pop age 15-64
LECG	Per Hour Growth Rate	-	-	-
Lehr et al	-	Period Growth (99-02) and also 94-98 growth for General, ICT and Small	-	Number Employed
Qiang & Rossotto	Period Growth Rate	-	Period Average	Working Age Population
Shiedeler *et al.*	-	-	-	-
Thompson & Garbacz	Yearly Growth Rate	-	-	per Capita Participation
Waverman *et al.*	Period Growth Rate	-	Period Average	Working Age Pop
Katz (2010) – Latam	Growth Rate 06/04 or 09/07		Avg Invest. 03/01 or 06/04	
Katz (2010) – Brazil				
Katz (2010) – Chile				
Katz (2010) – India				
Katz (2010) – Malaysia	Growth Rate 08/07			
Katz (2010) – S. Arabia				

Source: Compiled by the author

Table B.3 – ICT independent variables in econometric studies

Author	Broadband	BB Saturation	Telephone Penetration	Cable Penetration	PC Penetration
Crandall	Lines Per Capita	-	-	-	-
Czernich *et al.*	Yes or No (Dummy)	-	1996	1996	-
Ford & Koutsky	Yes or No Availability	-	-	-	-
	Dummy, 2002				
Katz *et al.*	Penetration Growth 02-03	-	-	-	-
Kolko	Number of Providers (Proxy for Penetration) 2006, 1999	-	-	-	-
Koutrompis	Penetration	-	-	-	-
LECG	2007 Penetration	-	2007-1980	-	2007 Penetration
Lehr *et al.*	Zip: Yes or No Availability Dummy, 1999 also State: Penetration	Square Penetration (State)	-	-	-
Qiang & Rossotto	Broadband subscribers per 100 people, Internet users per 100 people	-	Period Average Penetration, mobile and fixed	-	-
Shiedeler *et al.*	Coverage Area/Total	BB squared	-	-	-
Thompson & Garbacz	Lines Per Thousand People	-	-	-	-
Waverman *et al.*	-	-	Period Avg. Penetration, mobile and fixed	-	-
Katz (2010) – Latam	Penetration Growth 03-06				
Katz (2010) – Brazil	Penetration Growth 05-06				
Katz (2010) – Chile	Penetration Growth 03-07				
Katz (2010) – India	Penetration Growth 07-08				
Katz (2010) – Malaysia	Penetration Growth 06-07				
Katz (2010) – S. Arabia	Penetration Growth 07-08				

Source: Compiled by the author

Among control variables, the following are being utilized (see Table B.4).

Table B.4 – Control variables in econometric studies

Author	Education	Union Membership	Climate	Roads	Dummys	Rent	Country Size	Time Trend	Urbanizattion	Racial Compos	Other
Crandall *et al.*	College Grads/ Pop	Union Share of Employment	Temperat. (mean) 1971-01	-	Census Regions	-	-	-	-	-	-
Czernich *et al.*	Years	-	-	-	-	-	-	-	-	-	-
Ford & Koutsky	-	-	-	-	-	-	-	-	-	-	-
Katz *et al.*	-	-	-	-	-	-	-	-	-	-	-
Kolko	Bachelor's Degree Per cent	-	Climate Index	Density	-	-	-	-	Metropolitan Pop	Dummy Black	Vacat. houses, Terrain slope, Family Structure, Age
Koutrompis	% GDP spent on education	-	-	-	-	-	-	-	% population living in areas with 500 + people/sq km	-	Regulation, Research and Development, Competition (HH Index), Broadband Investment, Industry shares
LECG	-	-	-	-	-	2002 Median	-	-	-	-	-
Lehr *et al.*	College Grads/ Pop	-	-	-	-	2000 Median	-	-	Dummy (local), also Percentage State	-	-
Qiang & Rossotto	Primary Education in 1980	-	-	-	Latam and Sub Saharan Africa	-	-	-	-	-	-

Author	Education	Union Membership	Climate	Roads	Dummys	Rent	Country Size	Time Trend	Urbanizattion	Racial Compos	Other
Shiedeler, *et al.*	College Grads/ Pop	-	-	-	Rural	-	-	-	-	-	-
Thompson & Garbacz	High School	-	-	-	-	-	-	-	2000, % pop living in urban areas	% Black	-
Waverman *et al.*	Primary Education in 1980	-	-		-	-	-	Yes	-	-	Rule of Law
Katz (2010) – Latam	Tertiary education in 2002										Globalization Index, Population Growth,
Katz (2010) – Brazil	Illiteracy Rate in 2002, Years of schooling										Gini, Interstate trade costs, Cost to create new business, Pop Growth
Katz (2010) – Chile	Schooling Years, population with some level of tertiary education						Region population as a per cent of country population		People living in urban centres by region		Contribution of Mining, finance, agricultural and trade sectors, Pop Growth
Katz (2010) –India	Participatio n rate in secondary schooling		Total road length per hundred sq. Km by area								Number of enterprises, banking offices, Pop Growth

Author	Education	Union Membership	Climate	Roads	Dummys	Rent	Country Size	Time Trend	Urbanizattion	Racial Compos	Other
Katz (2010) –Malaysia	Literacy Rate		Road development Index								Hospital, beds in hospital, Construction projects,
Katz (2010) –S. Arabia											Facilities authorized to provide health services, Tourism, Access to potable water, Number and value of projects funded by Gov.,

Appendix C
Dataset utilized for the Broadband Economic Impact Model in Latin America and the Caribbean

Country	Broadband Penetration				GDP per Capita (USD)		GDP % Growth		Tertiary Ed.*
	2003	2004	2005	2006	2003	2006	2004–2006	2006–2008	
Antigua		1.895217	6.848708	8.021321	9,283	11,893	6.719927	–0.91	
Argentina	0.680761	1.414778	2.392677	4.049863	3,409	5,480	7.87798	4.39	61.1355
Aruba	1.440901	7.021701	12.14815	13.58644	20,708	23,577			28.2821
Bahamas	3.446994	3.982853	4.111264	5.034426	18,722	20,864	1.328786	1.52	24
Barbados	10.84281	11.73019	12.61278	21.76533	10,736	12,568			37.2433
Belize	0.348107	1.02366	1.779003	1.940606	3,659	4,206	0.809929	–1.69	1.93629
Bolivia	0.064966	0.096824	0.141286	0.188041	915	1,224	4.059593	1.36	38.2594
Brazil	0.532261	1.717288	1.737905	2.533507	3,040	5,688	3.037594	2.68	20.1332
Chile	2.207713	2.969482	4.347687	6.191195	4,637	8,892	4.291679	1.23	41.0088
Colombia	0.15437	0.299831	0.740275	1.4371	1,902	3,715	3.973686	1.99	24.0214
Costa Rica	0.35591	0.656215	1.037667	1.892886	4,190	5,125	4.544442	1.57	18.9653
Dominica	3.913608	4.811205	5.040323	6.095567	3,880	4,713	4.72729	1.97	10.72
Dom. Rep.	0.162127	0.396652	0.671741	1.122532	2,167	3,686	5.503492	4.25	34.0052
Ecuador	0.054143	0.089943	0.20506		2,129	3,136	4.800852	2.78	26
El Salvador	0.325773	0.485673	0.698415	1.010967	2,173	3,067	2.671857	0.72	17.4876
Grenada		0.595925	3.143415	5.39179	4,353	5,489	0.909841	–0.80	4.57912
Jamaica	0.342105	1.018782	1.68686	2.543679	3,113	4,268	1.375247	0.88	19.1449
Mexico	0.415228	1.014174	1.825082	2.901158	6,788	8,887	2.985594	–1.57	21.7426
Nicaragua	0.082795	0.092845	0.1931	0.344669	771	958	3.179197	0.37	17.8016

Country	Broadband Penetration				GDP per Capita (USD)		GDP % Growth		Tertiary Ed.*
	2003	2004	2005	2006	2003	2006	2004–2006	2006–2008	
Panama	0.482104	0.527338	0.543597	3.429214	4,146	5,212	5.878246	6.64	42.6653
Paraguay	0.0088	0.05265	0.094848	0.265985	977	1,542	1.824164	1.08	25.9625
Peru	0.346132	0.828051	1.266787	1.720966	2,240	3,310	5.181286	5.28	31.9533
Puerto Rico	1.401598	2.215718	3.022524	3.822291					
Saint Kitts	4.176324	9.070481	13.22805	16.67537	7613	9807	5.011022	–1.27	2.17763
Saint Lucia	0.863984	2.322909	4.237365	6.591405	4558	5544	3.959406	–1.30	12.8799
St. Vincent	1.057967	1.216242	3.354612	5.160188	3529	4572	5.898707	2.13	5.66555
Suriname	0.044326	0.085065	0.221507	0.525646	2028	4236	4.378311	4.15	12.4278
Trin. & Tob.	0.067527	0.322236	0.819464	1.557852	8575	13706	8.678897	0.91	8.36397
Uruguay		0.812278	1.846309	6.38296	3365	5797	7.475425	5.96	35
Venezuela	0.453524	0.800805	1.333163	1.976625	3238	6792	10.90417	1.55	37.8436
Virgin Is.		1.354249	2.704353		22858				

Country	Population CAGR		Globalization Index		Investment	
	2004-2006	2006-2008	2001-2003	2004-2006	2001-2003	2004-2006
Antigua	1.32228	1.13726	51.4184	53.4364	49.6881	53.566
Argentina	0.951002	0.990163	62.1831	61.887	14.1111	18.5758
Aruba	1.7663	1.12019	45.7916	45.721	24.2819	30.5755
Bahamas	1.25176	1.20731	50.7877	51.4308	30.7857	29.4352
Barbados	0.255813	0.260716	50.9108	54.5533		
Belize	2.19363	2.0579	48.1822	53.0914	25.4651	18.3828
Bolivia	1.8949	1.76079	54.5436	54.0161	15.8215	12.4473
Brazil	1.16122	0.945924	59.6936	60.2267	16.7392	15.8831

Country	Population CAGR		Globalization Index		Investment	
	2004-2006	2006-2008	2001-2003	2004-2006	2001-2003	2004-2006
Chile	1.04999	0.999234	70.4928	72.3563	21.2559	19.9553
Colombia	1.53276	1.45501	54.9331	57.122	13.5683	18.2587
Costa Rica	1.62364	1.33853	62.6768	63.0847	18.3105	18.9363
Dominica	0.259903	-0.30326	44.2235	45.2084	24.2193	26.9405
Dom. Rep.	1.48418	1.39879	54.2123	58.7649	20.9322	15.2986
Ecuador	1.09192	1.05594	55.5249	58.0445	23.1569	22.5734
El Salvador	0.367946	0.459817	60.1884	63.3931	17.3507	
Grenada	0.307276	0.368135	50.8614	54.0943	37.6115	47.2309
Jamaica	0.613594	0.421592	60.1394	64.6869	29.1088	30.2767
Mexico	1.03077	0.982845	59.7317	60.6223	20.2126	19.5946
Nicaragua	1.27593	1.31174	55.0556	55.3051	26.7796	26.6601
Panama	1.74824	1.63994	63.8743	65.6557	16.6489	17.0393
Paraguay	1.90125	1.79783	52.6703	56.0895	17.3689	18.979
Peru	1.24472	1.14469	57.3015	60.4143	18.8677	18.2078
Puerto Rico	0.453512	0.427532				
Saint Kitts	1.29549	1.27908	42.2787	41.6706	50.7337	44.4276
Saint Lucia	1.00239	1.05036	46.7015	46.3896	24.1471	21.7151
St. Vincent	0.156975	0.09353	44.1024	45.4881	29.0094	32.6947
Suriname	1.16198	0.914182	46.0395	48.1803		
Trin. & Tob.	0.36223	0.389577	59.3721	57.8427		
Uruguay	0.097351	0.330656	62.1159	65.3281	11.9323	11.0733
Venezuela	1.75457	1.66241	60.8762	56.9202	22.3307	17.3638
Virgin Is.	0.081186	-0.1044				

Source: ITU.

Appendix D
Dataset utilized for the Broadband Economic Impact Model in Arab States

Country	Broadband Penetration							Broadband Penetration Annual Growth							
	2004	2005	2006	2007	2008	2009	2010	2004	2005	2006	2007	2008	2009	2010
Algeria	0.11%	0.41%	0.51%	0.85%	1.41%	2.34%	2.54%	83%	273%	24%	67%	66%	66%	9%
Bahrain	2.23%	2.96%	4.76%	7.35%	8.88%	11.93%	12.28%	49%	33%	61%	54%	21%	34%	3%
Djibouti	0.00%	0.01%	0.02%	0.13%	0.29%	0.61%	0.91%			100%	550%	123%	110%	49%
Egypt	0.11%	0.19%	0.34%	0.62%	0.98%	1.35%	1.79%	38%	73%	79%	82%	58%	38%	33%
Iraq	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%							
Jordan	0.20%	0.44%	0.88%	1.57%	2.49%	3.95%	4.73%	100%	120%	100%	78%	58%	59%	20%
Kuwait	0.91%	1.10%	1.28%	1.43%	1.57%	1.70%	1.68%	49%	21%	16%	12%	10%	8%	-1%
Lebanon	2.00%	3.21%	4.64%	4.64%	4.68%	4.69%	4.73%	12%	61%	45%	0%	1%	0%	1%
Libya	0.00%	0.00%	0.16%	0.16%	0.75%	1.01%	1.15%				0%	369%	35%	14%
Morocco	0.21%	0.82%	1.28%	1.54%	1.57%	1.54%	1.62%	2000%	290%	56%	20%	2%	-2%	5%
Oman	0.03%	0.54%	0.81%	0.79%	1.23%	1.52%	1.63%	200%	1700%	50%	-2%	56%	24%	7%
Qatar	1.53%	3.12%	4.78%	7.44%	7.61%	9.05%	8.38%	232%	104%	53%	56%	2%	19%	-7%
S. Arabia	0.30%	0.28%	0.88%	2.44%	4.01%	5.36%	6.23%	43%	-7%	214%	177%	64%	34%	16%
Syria	0.00%	0.01%	0.03%	0.04%	0.06%	0.17%	0.33%			200%	33%	50%	183%	94%
Tunisia	0.03%	0.18%	0.44%	0.95%	2.22%	3.60%	4.60%		500%	144%	116%	134%	62%	28%
UAE	1.53%	3.18%	5.16%	7.03%	8.98%	9.95%	10.51%	72%	108%	62%	36%	28%	11%	6%
Yemen	0.00%	0.01%	0.01%	0.05%	0.11%	0.23%	0.35%			0%	400%	120%	109%	52%

Country	Per Capita GDP Annual Growth (in constant 2005 prices)							Population Annual Growth						
	2004	2005	2006	2007	2008	2009	2010	2004	2005	2006	2007	2008	2009	2010
Algeria	3.63%	3.53%	0.46%	1.44%	0.85%	0.57%	1.50%	2.55%	0.61%	1.23%	1.31%	1.86%	1.63%	1.36%
Bahrain	1.73%	-0.09%	-4.69%	-5.04%	-6.49%	-7.23%	-3.52%	3.32%	7.96%	12.08%	14.01%	13.81%	11.02%	7.93%
Djibouti	1.98%	1.30%	2.85%	3.13%	3.80%	3.02%	1.55%	1.81%	1.84%	1.89%	1.91%	0.68%	2.51%	2.20%
Egypt	2.17%	2.56%	4.91%	5.18%	5.27%	5.28%	3.36%	5.04%	3.05%	2.46%	1.27%	2.00%	1.62%	1.49%
Iraq	42.63%	-3.39%	3.25%	-1.37%	6.34%	1.14%	-2.17%							
Jordan	6.19%	5.46%	4.94%	5.19%	4.27%	-0.67%	0.41%	4.32%	2.70%	3.23%	2.39%	3.60%	2.71%	2.92%
Kuwait	7.04%	6.96%	1.29%	0.26%	0.83%	-8.66%	-0.01%	3.13%	3.41%	3.13%	4.43%	4.09%	3.90%	3.44%
Lebanon	5.80%	-0.36%	-0.50%	6.52%	8.44%	7.72%	6.21%	1.71%	1.25%	1.11%	1.05%	0.69%	0.81%	0.66%
Libya	2.34%	7.67%	3.67%	3.72%	1.66%	0.26%	2.65%	2.02%	2.07%	4.51%	1.58%	0.66%	1.17%	1.49%
Morocco	3.72%	1.93%	6.67%	1.68%	4.54%	3.91%	2.27%	1.05%	1.00%	0.76%	1.25%	1.36%	0.95%	0.79%
Oman	1.56%	1.80%	2.91%	3.86%	9.56%	-1.68%	1.48%	1.81%	2.15%	1.96%	3.10%	3.29%	2.54%	3.08%
Qatar	10.43%	-6.27%	-0.47%	5.25%	5.90%	-5.07%	5.96%	9.72%	15.06%	19.21%	20.42%	18.42%	14.56%	10.03%
S. Arabia	1.28%	1.92%	0.00%	-0.80%	1.59%	-1.81%	-2.24%	4.58%	5.74%	2.39%	3.00%	2.35%	2.55%	2.45%
Syria	2.80%	3.75%	2.62%	3.48%	2.50%	4.11%	1.43%	2.94%	2.66%	-5.90%	0.00%	5.94%	11.08%	0.04%
Tunisia	5.05%	2.95%	4.55%	5.15%	3.44%	1.96%	2.55%	-2.66%	3.16%	2.07%	1.32%	1.41%	1.14%	1.14%
UAE	1.99%	-2.74%	-5.13%	-8.48%	-8.47%	-11.18%	-10.54%	7.69%	10.82%	14.67%	15.86%	14.93%	11.76%	8.29%
Yemen	0.82%	2.41%	0.10%	0.20%	0.53%	0.64%	0.74%	3.12%	3.11%	3.10%	3.34%	7.44%	-0.67%	2.22%

Country	Human Capital Rank	GDP	Oil Prices (Impact of Price Change)							Gross Capital Formation (As per cent of GDP)						
	2000	2000	2004	2005	2006	2007	2008	2009	2010	2004	2005	2006	2007	2008	2009	2010
Algeria	107.78	1794.41	13.33	14.56	6.62	3.79	14.97	-15.06	11.26	33.27	31.51	29.50	34.22	33.37	41.18	44.01
Bahrain	106.97	12489.47	9.77	10.24	3.71	2.46	9.74	-9.76	7.30	24.87	24.42	24.39	26.99	33.23	33.23	29.78
Djibouti	32.50	753.12								21.51	18.97	29.56	37.49	37.49	37.49	25.04
Egypt	93.09	1475.84	1.89	2.23	1.08	0.58	2.01	-2.27	1.69	16.94	17.98	18.73	20.85	22.39	19.26	18.89
Iraq	93.96	1083.82														
Jordan	99.25	1753.41	-2.64	-3.50	-1.59	-0.84	-3.46	2.72	-2.39	27.38	34.15	29.62	26.15	23.98	14.78	22.33
Kuwait	95.50	19434.40	17.83	19.45	9.00	5.15	20.46	-19.92	14.90	18.19	16.43	16.16	21.19	18.93	18.93	8.61
Lebanon	89.53	4612.20	-1.03	-1.22	-0.59	-0.30	-1.38	1.08	-0.88	22.16	21.94	22.86	27.70	30.60	30.18	30.00
Libya	118.68	6479.71	11.36	12.34	5.62	3.22	12.79	-12.81	9.58	11.55	9.92	21.00	25.40	27.90	27.90	34.88
Morocco	92.00	1285.74	-1.38	-1.95	-0.92	-0.47	-2.14	1.96	-1.41	29.13	28.80	29.43	32.48	38.12	35.97	35.76
Oman	91.61	8774.93	17.61	18.92	8.69	4.82	18.71	-16.48	13.01	25.57	23.15	24.22	30.64	29.72	29.72	29.80
Qatar	99.09	30052.76	19.66	20.80	10.09	5.77	23.67	-22.79	17.04	33.45	35.00	33.33	37.57	40.25	38.93	30.67
S. Arabia	93.26	9400.81	13.09	14.43	6.58	3.74	15.03	-14.47	11.07	19.19	18.24	18.73	21.45	22.17	26.13	26.46
Syria	104.25	1208.73	7.16	8.48	0.78	0.29	0.95	-0.95	0.71	17.41	17.55	17.52	18.46	13.80	16.31	24.30
Tunisia	115.33	2056.16	-0.11	-0.13	-0.14	0.14	0.07	-0.37	0.03	24.16	21.77	23.88	24.39	26.62	26.81	26.38
UAE	88.89	23270.69	15.20	15.26	7.52	4.50	17.67	-17.14	12.81	22.50	20.38	21.29	20.45	20.45	20.45	18.66
Yemen	74.28	532.72	11.55	11.49	5.13	2.81	10.16	-11.42	8.65	24.36	24.36	24.36	24.36	24.36	24.36	11.61

Country	Level of Globalization					Bank Credit					
	2004	2005	2006	2007	2008	2004	2005	2006	2007	2008	2009
Algeria	53.05	53.68	53.85	49.91	52.70	21.83	7.50	3.93	-3.34	-12.62	-8.89
Bahrain	69.10	68.44	69.17	69.30	69.67	47.80	49.63	47.03	56.46	67.27	79.32
Djibouti	46.16	45.78	47.95	48.35	49.19	26.65	25.03	24.13	26.49	27.47	32.32
Egypt	55.56	58.49	59.59	60.31	59.92	104.74	98.02	92.97	84.15	77.69	75.38
Iraq						10.10	-1.49	-5.30	-17.27	-24.91	-16.31
Jordan	70.01	71.66	71.67	73.09	73.20	90.71	109.74	104.97	110.11	107.42	99.31
Kuwait	67.05	67.92	63.91	65.56	64.90	70.16	61.96	62.36	68.83	65.05	65.05
Lebanon	69.99	70.95	71.26	64.88	65.11	177.56	176.79	190.34	181.63	169.05	165.02
Libya	46.13	46.52	46.63	46.99	54.50	-23.43	-43.28	-59.32	-55.63	-49.99	-65.93
Morocco	56.84	59.70	59.22	61.49	61.70	68.41	73.36	78.79	91.38	98.89	100.48
Oman	57.28	58.75	58.89	61.38	61.97	34.39	27.92	27.85	32.72	29.22	41.94
Qatar	58.60	58.77	65.87	68.50	69.58	42.73	44.14	41.99	50.07	53.68	75.66
S. Arabia	67.46	67.31	59.48	60.52	61.02	41.71	30.00	22.51	17.40	-3.99	0.60
Syria	42.39	43.24	44.54	45.20	44.59	30.65	35.63	33.51	36.07	36.83	45.10
Tunisia	60.32	62.22	61.21	62.16	62.19	71.12	70.81	70.83	70.34	72.04	75.16
UAE	74.32	73.98	69.72	70.90	71.00	50.82	57.98	66.61	74.80	88.76	114.52
Yemen	43.24	42.45	44.39	45.42	46.63	7.00	6.01	4.84	10.30	11.29	19.34

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