Chapter 2
Assessing the Broadband Demand Gap

Before implementing specific demand stimulation strategies, policy-makers must conduct a diagnostic that allows them to determine the size and sources of the demand gap. This process begins by estimating the percentage of the population that can purchase broadband, yet still do not. Once this gap is quantified, it is necessary to understand the drivers of this so-called "failure." Is it because a portion of the population cannot afford to purchase a subscription at current prices? Or is it because they lack the necessary digital literacy that allows them to access the Internet? It could also be the case that while potential users have a computer (or comparable device), they cannot find any online content, applications, or services that would motivate them to purchase broadband service.[1]

This chapter explains the different concepts and provides examples of methodologies for measuring the demand gap and constructing a diagnostic of structural factors affecting adoption. It would set the stage to explain a variety of approaches and policy solutions to meet the adoption targets.

2.1 Measuring the Broadband Demand Gap

Measuring the demand gap is the first step in the development of a diagnostic that will lead to the formulation of demand stimulation policies. Given the interrelationship of fixed and mobile broadband leading to complementarity and/or substitution scenarios, this exercise is not trivial. Moreover, measuring demand gaps in the aggregate for a whole country is not necessarily a suitable approach for the development of targeted policies. Therefore, any attempt at measuring the broadband demand gap has to be conducted at a disaggregated level (county, department). This section first addresses how to measure the demand gap in fixed broadband, then moves to the mobile broadband gap, and finally discusses the interrelationship between both domains.

[1] While one of these three reasons could be found to be the dominant one in certain population groups, the likely scenario is one of high correlation between the three variables.

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2.1.1 The Fixed Broadband Demand Gap

Demand gap is defined as the difference between either households or individuals that could gain access to broadband but do not acquire the service. This is not a statistic that is typically being tracked by either regulators or made public by operators. In recent years, however, policy makers, driven by the need to develop national broadband strategies and plans, have in some instances been able to estimate this metric.

While most countries have fairly accurate estimates of broadband subscribers, they lack a solid grasp of network coverage, defined as the proportion of the population of a given country that is "served" by broadband technology. This metric (and the supporting coverage maps) should be calculated both for fixed and mobile broadband.

In the case of fixed broadband, coverage needs to be estimated in terms of the number of households that are served by broadband providers (i.e., where residents have the option to purchase service from telecommunications carriers, cable TV operators, or fixed wireless providers such as WiMax). Even this number can be sometimes difficult to estimate. For example, the development of the United States' National Broadband Plan introduced the notion of the "underserved" household. "Underserved" means that the resident can get access to broadband, but at a download speed below the target stipulated by the broadband plan (in this case, 2 Mbps). Therefore, a first level assessment should consider three categories of fixed broadband coverage: "served," "underserved" (download speeds lower than the target), and "unserved" (no service at all). The problem with the "underserved" category is that in emerging countries, a large portion of households can gain access to service download speeds much lower than those stipulated in a broadband plan (for example, 256 kbps). Given the hurdle to improve the level of service to the "underserved" population, the general consensus is that for the time being, at least in emerging countries; attempting to reach mass-deployment levels of broadband, this category should not be considered as part of the estimation of the broadband demand gap.

Another difficulty in assessing fixed broadband coverage resides in the interpretation of operator-provided information. The introduction of certain modifications to existing telecommunications and cable TV networks enables broadband deployment in its most basic mode. In the case of telecommunications copper networks, xDSL service requires the installation of equipment at the central office, while in the case of cable TV, cable modem service requires the upgrading of its networks to bi-directional 750 MHz capacity. The implication of this situation is that a residence could have either wireline telephony or cable TV coverage, but the infrastructure is not upgraded to the point where it may have the capability of handling a subscriber's request for service. The question of interpretation, then, is whether that residence should be considered "served" or "unserved". It is generally accepted that, in the case of emerging countries, if a telecommunications

Table 2.1 Developed countries: fixed broadband demand gap (2011)

Country	Households covered (%)	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
Korea, Rep.	100	93	7
Spain	93	61	32
Sweden	100	89	11
United Kingdom	100	68	32
United States	96	64	32

Sources Katz and Galperin (2012) based on ITU data

fixed network or a cable TV system serves the customer, he/she should be included in the "served population" category.

With these two caveats in mind, the demand gap can be calculated by using a standard coverage metric estimation. For example, Table 2.1 presents data on the fixed broadband demand gap for select developed countries.

As shown in Table 2.1, the broadband demand gap is not only an emerging market phenomenon. In certain developed countries (such as Germany, Spain, Italy, the United Kingdom, and the United States), an important portion of households lack broadband connectivity for reasons other than service availability.

In the United States already in 2009,[2] for example, 96 % of households were served by cable modem technology, while 82 % could acquire broadband service from the telecommunications operator. However, as indicated in the statistics of Table 2.1 in 2011, only 64 % of households purchased service. Therefore, 32 % of households could have access to broadband services, but choose not to acquire a subscription. As expected, the demand gap in this country varies by state as shown in Fig. 2.1.

As Fig. 2.1 indicates, the broadband demand gap is larger in less-developed states. In Mississippi, for example, it is 60 %, while the supply gap (non-served households) is 9 %. In a more economically-developed state such as Georgia, where service penetration is higher, the supply gap is 8 %, while the demand gap is 34 %.

In a European country such as Germany, according to the National Broadband Strategy published in February of 2009, 98 % of all households (39,700,00) could already access broadband service. Of these, 37,600,000 could be served by xDSL, 22,000,000 were served by cable TV (and therefore could buy broadband via cable

[2] Rather than providing the latest statistics, the purpose of the following examples is to demonstrate how to calculate the demand gap and provide a comparison among countries based on orders of magnitude.

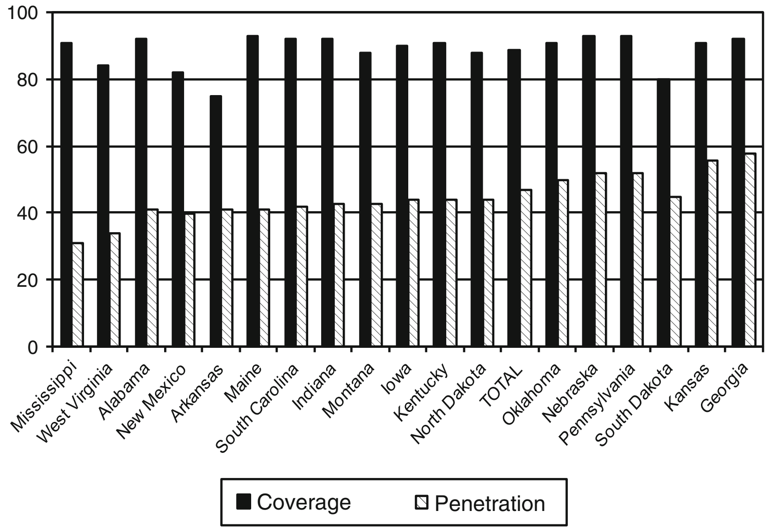


Fig. 2.1 United States: supply and demand gap for states with lowest broadband penetration (percent of households) (2009). *Source* FCC (Table 14 of HSPD1201); US census Bureau

modem), and 730,000 could access broadband via fixed wireless or satellite. However, despite the near-complete coverage, only 58 % of households purchased broadband, signifying a demand gap of 40 %.

The fixed broadband demand gap is, as expected, a more serious problem in emerging countries. Table 2.2 presents statistics for coverage and demand for Latin America countries.

Latin America displays an average demand gap of 43 %, which means that less than half of covered households are purchasing broadband subscriptions. As Table 2.2 indicates, more extensive coverage results in a higher demand gap. These metrics, typical of emerging countries, indicate that supply in Latin America does not appear to be the dominant hurdle to increasing broadband penetration. They demonstrate, rather, the criticality of demand stimulation strategies targeting either the affordability or the awareness structural factors.

2.1.2 The Mobile Broadband Demand Gap

Measuring the demand gap in mobile broadband presents methodological problems as in the case of fixed broadband networks. First, it is generally agreed that policy makers should consider at least 3G networks to be the technology benchmark when measuring mobile broadband coverage. While 3.5G, HSPA, or LTE networks are the obvious platforms to provide a relatively smooth Internet access experience, in

Table 2.2 Latin American countries: fixed broadband demand gap (4Q2012)

Country	Coverage (%)	Household penetration (%)	Demand gap (%)
Argentina	96	40	56
Bolivia	40	4	36
Brazil	94	34	60
Chile	78	50	28
Colombia	81	32	49
Costa Rica	95	36	59
Ecuador	80	26	54
Mexico	62	53	9
Peru	59	20	39
Average	76	33	43

Sources for coverage Katz and Galperin (2012); penetration based on ITU

emerging country contexts, it is advisable to measure coverage once again at a slightly lower speed, such as the one comprised by the whole WCDMA family.[3]

Secondly, the concept equivalent to the "underserved" category in fixed broadband exists in the case of mobile broadband as well: in this case, it is labeled the "gray" zones. These represent the areas covered by wireless networks affected by either capacity or signal propagation limitations. Again, while some national broadband plans have been very emphatic about measuring these zones (see Germany's National Broadband Strategy), in the case of emerging countries, it might be convenient to set this measurement aside for the next few years.

Thirdly, mobile broadband adoption needs to consider the device utilized to access the Internet. The first category of devices includes, quite naturally, all modems that can be relied upon to access the Internet from a PC, a laptop, or a netbook. These devices include dongles, USB modems, and air cards. The integrated devices such as tablets, and smartphones that provide adequate screen formats and interface to surf the web, respond to emails, and access common web platforms such as Google, YouTube, or Facebook comprise the second category. This category would exclude feature phones, which, by virtue of their small screen formats and keyboards, have limited broadband access ability. For example, the pioneering work of Horrigan (2012) on the value of mobile broadband to close the digital divide in the state of Illinois focuses only on smartphone adoption.

In light of these issues, how should mobile broadband coverage and adopters be measured? Beyond shipment statistics and installed base for selected operators, the number of subscribers that own an Internet suitable device connected to a 3G or higher performance network is not readily accessible. On the other hand, the

[3] For example, when Japan implemented its (1) New IT Reform Strategy which was set in 2006 by IT Strategic Headquarters (headed by the Prime Minister) and (2) the Digital Divide Elimination Strategy which was set in 2008 by the Ministry of Internal Affairs—both of which aimed to eliminate all broadband zero areas by the end of FY2010 (March 2011), 3.5G was considered the minimal broadband service.

Table 2.3 Developed countries: mobile broadband demand gap (2011)

Country	Population covered (%)	Population connected (%)	Demand gap (%)
Australia	97	89.10	7.9
Denmark	97	57.51	39.49
France	98.20	32.86	65.34
Germany	86	34.76	51.24
Israel	99	54.36	44.64
Italy	91.86	48.19	43.70
Korea, Rep.	99	97.13	1.87
Spain	90.60	36.68	53.92
Sweden	99	85.10	13.90
United Kingdom	95	42.56	52.44
United States	98.50	71.91	26.59

Source Katz and Galperin (2012)

number of 3G and 4G subscribers is easier to access. Therefore, it would be advisable to gather those statistics to measure the mobile broadband demand gap. Mobile broadband coverage should be measured in terms of 3G coverage, a metric provided by either the ITU or commercially available databases such as GSMA Intelligence. However, the estimates provided by these sites are only presented at the national level, preventing a detailed regional analysis.

Table 2.3 presents statistics on mobile broadband demand gap for selected developed countries.

As the Table 2.3 indicates, with a few exceptions (Australia, Republic of Korea, United States), the mobile broadband demand gap of countries studied is higher than the fixed broadband demand gap. These numbers should be interpreted with the caveat that the latter measures the household gap while the former measures population.

In the case of emerging countries such as those of the Latin America region, the mobile broadband demand gap is even higher (see Table 2.4).

As Table 2.4 indicates, the average mobile broadband demand gap in Latin America is 57 %, which means that 57 % of the Latin American population could purchase a mobile broadband connection but do not. This difference requires an analysis of the obstacles faced by users to acquire broadband service. An understanding of such factors will allow policy makers to deploy the relevant initiatives to tackle these obstacles. This is addressed in Chap. 3, 4 and 5 below.

2.1.3 Demand Gap and the Interrelationship Between Fixed and Mobile Broadband

Until now, we have treated the demand gap within fixed and mobile broadband as two independent phenomena. This treatment is somewhat artificial since both technologies are offered within adopters' same universe. Naturally, each platform

Table 2.4 Latin American countries: mobile broadband demand gap (2012)

Country	Population covered (%)	Population connected (%)	Demand gap (%)
Argentina	92	21.87	70.13
Bolivia	29	6.92	22.08
Brazil	84	32.83	51.17
Chile	82	27.04	54.96
Colombia	96	8.69	87.31
Costa Rica	93	36.22	56.78
Ecuador	86	21.92	64.08
Mexico	77	20.63	56.37
Peru	63	11.70	51.30
Average	78	20.86	57.14

Fuentes For coverage, Katz and Galperin (2012); penetration based on GSMA Intelligence

meets specific requirements. Mobile broadband adds the mobility premium to the Internet access experience. At the same time, at least for now, due to given technology and shared resource limitations, mobile broadband networks are not the most suitable platform to fulfill certain applications, like downloading movies or playing massive parallel games. This factor notwithstanding, it is generally assumed that, given their ease of deployment, mobile broadband networks are very appropriate to fulfill coverage requirements in emerging countries. If that were to be the case, how should policy makers think about the interplay between both platforms?

At the initial steps of diffusion processes, mobile broadband technology represents a complementary technology to fixed broadband. The early adopter of mobile broadband is, most likely, already a subscriber of fixed broadband. In this situation, mobile broadband complements fixed broadband by providing the added value of mobility. An example of this situation is that of Mexico (see Fig. 2.2).

As the Mexican example indicates, mobile broadband subscribers through the end of 2010 were likely already fixed broadband customers belonging to high socio-demographic segments for which mobile broadband represented an added value proposition to meet their Internet connectivity needs.

However, the complementarity consumption pattern is not the only trend. In many cases, especially in emerging countries, mobile broadband represents a substitute to fixed broadband. This occurs under three possible situations: (1) when the fixed broadband service is not being offered in the area where the customer resides, (2) when the quality of fixed service is at a disadvantage with respect to the mobile offering (for example, in terms of speed), or (3) when the user decides to consolidate services to reduce expenditures and acquires the mobile service that provides both connectivity and mobility. It is important to mention that the last situation can occur in the context where the applications and services to be accessed are interchangeable between the two platforms. While this is possible, as it was mentioned earlier, there are services that are better suited to the fixed technology and cannot be fully accessed by mobile broadband. Additionally, a

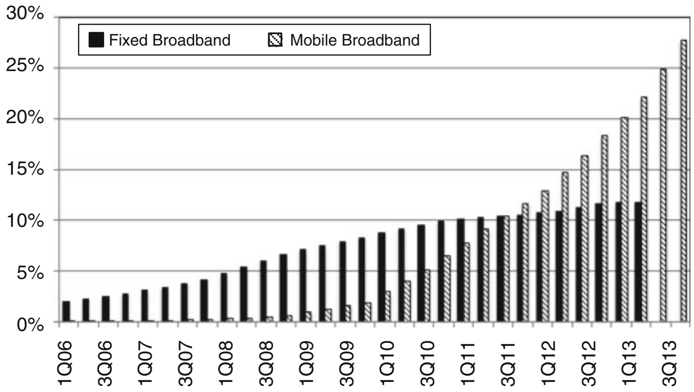


Fig. 2.2 Mexico: penetration of fixed versus mobile broadband (2006–2013). *Source* Katz (2012)

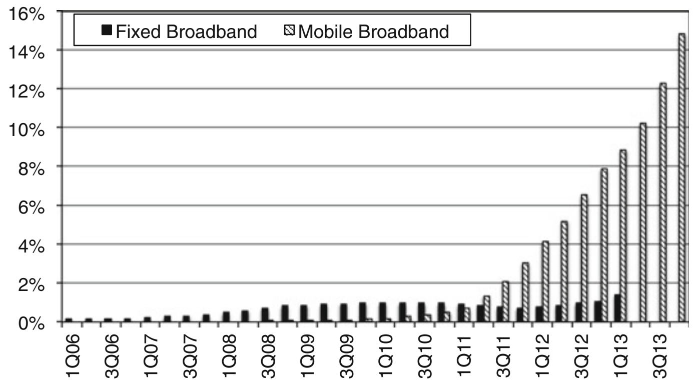


Fig. 2.3 Bolivia: penetration of fixed versus mobile broadband (2006–2013). *Source* Katz (2012)

limiting factor of mobile broadband's substitution power is the prevalent pricing plans that institute caps on the amount of data subscribers can download on a monthly basis. However, as will be shown in Chap. 4, capped mobile broadband offerings are highly suited to deliver broadband service to population at the bottom of the socio-demographic pyramid.

The case of Bolivia is a good example of substitution of fixed broadband by mobile broadband service (see Fig. 2.3).

Bolivia is a country that arrived fairly late to the Internet revolution. At the outset of mobile broadband in the country, the adoption of the fixed platform had not reached 1 %, a common scenario in many emerging countries. Not surprisingly, the high price of the offering contributed to this limited adoption. In the second quarter of 2010, the least expensive plan for a 2.5 Mbps download speed cost the equivalent of US$ 325/month. That year, a wireless service providing broadband connectivity to a PC via a USB modem was priced at the equivalent of US$ 16.38. The cross-elasticity of both offerings resulted in a decline in the number of fixed broadband lines and a dramatic increase in mobile broadband accesses, a classic case of substitution. The Bolivian example could be quite applicable to the experience of other emerging countries.

In considering the substitution scenario to understand the broadband demand gap, it is important to include in the broadband subscribers numbers those users who purchase only mobile broadband service and add them to the customers who have acquired fixed broadband. Therefore, the broadband demand gap that considers mobile broadband subscriptions has to be quantified according to the following formula:

Broadband Demand Gap = Broadband Coverage (C) – Broadband Subscriptions (S)

C = Population covered by fixed and mobile broadband + Population covered only by fixed broadband + Population covered only by mobile broadband

S = Subscribers of fixed and mobile broadband (complementarity) + Subscribers of only fixed broadband + Subscribers of only mobile broadband (substitution)

According to this formula, the precise estimation of the broadband demand gap requires a solid understanding of parameters such as the degree of complementarity of fixed and mobile platforms, to avoid double counting of mobile and fixed subscribers. Unfortunately, this type of statistic does not exist for the time being in most countries, which obliges the policy maker to continue relying on demand gap assessment by technology. Some countries are currently conducting field research aimed at evaluating the degree to which both technologies complement or substitute each other. As was discussed earlier, the answer will depend on factors such as geography and socio-demographic segment. The first results of such a research are being generated primarily in developed countries. Horrigan (2012) published the results of survey research conducted in the state of Illinois testing the hypothesis of mobile broadband contributing to closing the digital divide. The results indicated the existence of only a small portion of households accessing the Internet through mobile platforms: of 86 % of at-home broadband subscribers, 53 % had fixed broadband and smartphones, 26 % had only fixed broadband, and only 7 % had only smartphones. The interesting finding is that the 7 % of subscribers that accessed the Internet only through smartphones tended to have a low income (below $20,000), lower education than the general population and lived in rural areas. While the activities these users conduct on the Internet are less data intensive than those that have both fixed and mobile broadband, one could argue that the latter contributes to some extent to close the digital divide.

A similar conclusion was formulated by Bohlin et al. (2011), who estimated in their study of Sweden broadband that the probability of using mobile broadband exclusively tends to increase if the respondent is aged 35 years or less, and has low income.

The primary caveat is that both studies were conducted in an environment of widely diffused fixed broadband. In emerging country settings, with less fixed broadband coverage, the substitution power of mobile broadband is much larger.

2.2 Understanding the Residential Broadband Demand Gap

Once the broadband demand gap is quantified, policy makers need to understand the factors driving that gap. In this section, the obstacles and drivers of the residential demand gap will be first reviewed. At its conclusion, the same approach will be followed for the enterprise side, focusing primarily on small and medium enterprises.

To reiterate, the primary topic in this section is the adoption gap. An adoption gap is found in places where broadband infrastructure is in place but often underutilized. This is a typical low demand case that reflects a low desirability for the services offered or a relatively high cost of ownership. The broadband demand gap can be the result of multiple factors. In fact, the obstacles could be different by region of the country, and by socio-demographic group.

Research on the variables affecting broadband diffusion is quite extensive. For example, Hauge and Prieger (2010) point out that income, educational level of the head of household, and household age composition are the main predictors of broadband adoption. Other studies mention variables that are more specific to countries or regions. Navarro and Sanchez (2011) indicate that, *ceteris paribus*, gender is a strong predictor in Latin America, where females are 6 % less likely to adopt broadband. In the United States, several studies underscore the importance of factors such as ethnicity and mastery of the English language (Ono and Zavodny 2007; NTIA 2011). Other factors such as the location of potential subscribers (rural versus urban), the presence of school children in the household (Horrigan 2014), and the penetration of broadband in the location where the potential adopter resides are also important factors driving Internet adoption (see Chaudhuri et al. 2005; Vicente and Lopez 2006; Grazzi and Vergara 2011).

At the highest level of analysis, the residential broadband demand gap is the result of three obstacles:

- Limited affordability: certain portions of the population either cannot acquire a device or purchase the subscription needed to access the Internet
- Limited awareness of the potential of the service or lack of digital literacy
- Lack of relevance or interest: the value proposition of applications, services, and content does not fulfill a need of the adopting population

Each of these three obstacles are driven by one or a combination of four structural variables:

- Income levels: the socio-demographic group, measured by income, does not only influence the affordability barrier, but is also correlated with limited awareness and lack of relevance
- Education levels: the education attained by the potential user influences the degree of digital literacy and is related to interest in accessing the Internet
- Age: similarly, the age variable is inversely related to digital literacy and content relevance
- Ethnicity: as a result of linguistic and/or cultural structural factors, ethnic group belonging can impact the level of interest in accessing the Internet

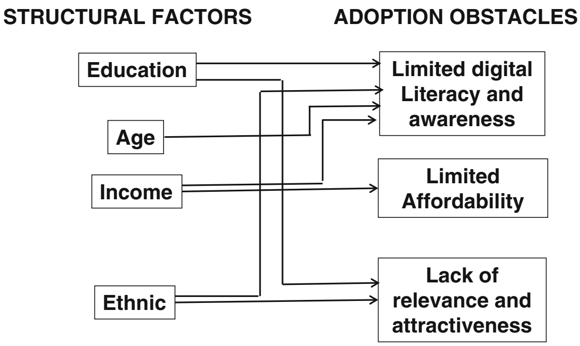
These relationships have been depicted in Fig. 2.4.

The research literature has also studied the role played by other structural variables, such as gender. For example, a gender gap was detected in some Latin American countries (see Universidad Alberto Hurtado 2009 for Chile; INEI 2012 for Peru; and Rectoría de Telecomunicaciones 2011 for Costa Rica). Our research in Ecuador (Katz and Callorda 2013) found that in townships where broadband was installed, the average income of women in households with no computer or Internet usage was lower than that of men two years later. However, if the household had a computer or the family accessed the Internet prior to broadband deployment, the effect on average income was similar for men and women. This would indicate that a gender gap does exist at lower socio-demographic levels. In support of this finding, research by Hilbert (2011) concluded that the gender gap disappears when control variables such as income and education are included in the analysis. Beyond the importance of socio-demographic level as the primary explanatory variable, the maturity of the technology also helps erasing gender differences. For example, research conducted in Asia by the Korea Network Information Center (KANIC) showed that the gender composition of Internet users has shifted toward equality from 33 % female in 1999 to 45 % female in 2002. These findings should be taken into consideration when examining the viability of gender-based policy initiatives for having a positive contribution to stimulating adoption (these will be discussed in detail in Sect. 3.12).[4]

The following section will explain each of the three obstacles—affordability, awareness, and relevance—and link them back to the structural variables. In each section, studies and data regarding the obstacles and driving variables in developed and emerging countries are presented.

[4] While the gender issue is negligible as one of the structural variables within this analysis, the gender divide still needs to be addressed. Please see "Digital literacy for Women" section (currently, Page 65 of the World development Report).

Fig. 2.4 Broadband adoption structural factors



2.2.1 The Affordability Barrier

The economic barrier remains a key factor in limiting broadband adoption. However, it would seem that in developed countries with higher household incomes, the economic barrier takes second seat to either low digital literacy or cultural inadequacy.

In the United States, broadband non-adopters amount to 22 % of households (34.6 million). Within this group, the head of household is older than 65 years old (30 %), has not completed high school studies, belongs to a household with less than US$ 30,000 income (41 %), and has a limited understanding of the English language (Pew Center, 2012). In a study by the National Telecommunications and Information Agency (NTIA 2011) researching the reasons of non-adoption, 24 % of respondents mentioned affordability of either devices or service. If the household already had a PC, 37 % of respondents mentioned broadband affordability as a barrier. Conversely, the households that did not have either a PC or broadband amounted to 21 %. Consequently, in the United States, if a household already has a computer, broadband affordability becomes an important adoption barrier. The Pew Research Center, in a research similar to that of the NTIA, found that 19 % cite cost which was made up of 13 % saying they do not have a computer and 6 % saying it is too expensive.

In a statistic close to that of the United States, a 2009 survey among Australia's non-adopters showed cost to be the most common deterrent cited amongst this group: 26 % of respondents reported that it was too expensive (Australian Government Information Management Office 2009).

In Spain, a study (ONTSI 2011) indicated that of the 7 million non-adopting households, 42 % indicated affordability as a primary barrier to adoption. The distribution of this population is, not surprisingly, tilted towards households of the lower socio-demographic segments. For example, 52 % of households with monthly income of less than 1,100 Euros mention affordability as a primary barrier; that percentage decreases to 16 % among households with incomes higher than 2,700 Euros.

In the United Kingdom, of the 24 % of non-adopting households, only 16 % mentioned the affordability barrier, while 66 % mentioned lack of perceived content relevance. In a similar study conducted in 2010, the percentage citing cost as an obstacle to adoption was 23 %. This statistic suggests that as prices decrease, digital literacy and relevance structural factors (to be discussed in the next section) have more of an impact.

Moving now to emerging countries, the importance of affordability increases among the reasons mentioned for non-adoption. For example, in a household ICT survey conducted in Brazil, 48 % of non-adopters of broadband mentioned cost as being the dominant reason (CGI 2012). In research conducted as part of the National Household Survey, 60 % of Mexican households with no computer and no broadband connection mentioned cost of access as the dominant reason (INEGI 2011). In Chile, the number was slightly less: 37 % (Subtel 2009), while in Costa Rica, it was 60 % (Rectoría de Telecomunicaciones 2011). The percentage mentioning affordability as the dominant reason in Chile was quite close to households surveyed in Colombia: 39.9 % (MITIC 2011). In Puerto Rico, 16 % of non-adopters mentioned price as being too high (Puerto Rico Broadband Task Force 2012).

Research conducted in Sub-Saharan Africa indicates that while availability does play a role in this difference in uptake, the cost of broadband services in the region is prohibitively high. In 2006, the average price for basic broadband in Sub-Saharan Africa was US$ 366 per month, when in India the average rate ran from $6 to $44 per month (Williams 2010).[5] In much of Europe, these rates ranged from $12 to $40 per month.

Not surprisingly, a 2011 study demonstrated that many of the countries with low broadband adoption rates were the same countries with the highest annual costs for broadband per gross national income (Point Topic, 2011).[6] This list of countries included Kenya, where the average annual cost for broadband amounted to 79.25 % of gross national income. In comparison, the cost of broadband access in Switzerland—which ranks amongst the top 10 countries in the world in terms of broadband penetration—amounted to a mere 0.07 % of gross national income.

A compilation of all the statistics reviewed earlier indicates that affordability remains a preeminent variable in explaining the non-adoption of broadband, particularly in emerging countries (see Table 2.5).

As the data in Table 2.5 suggests, the lower the level of disposable income, the higher the importance of the affordability barrier becomes. This conclusion is supported as well by the penetration of broadband by decile of the socio-demographic pyramid.

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[5] https://openknowledge.worldbank.org/bitstream/handle/10986/2422/536430PUB0Broa101Official0Use0Only1.pdf?sequence=1

[6] http://broadband.about.com/od/barrierstoadoption/a/Affordability-As-A-Barrier-To-Broadband-Adoption.htm

Table 2.5 Percentage of households mentioning affordability as reason for not purchasing broadband

Country	Percentage (%)	Source
United States	24	NTIA (2011)
United States	36	Horrigan (2013)
United Kingdom	16	OFCOM (2012)
Spain	42	ONTSI (2011)
Australia	26	AGIMO (2009)
Chile	37	Subtel (2009)
Brazil	48	CGI (2012)
Colombia	40	MITIC (2011)
Costa Rica	60	Rectoría de Telecomunicaciones (2011)
Mexico	60	INEGI (2011)
Puerto Rico	16	PRBT (2012)

The statistics of Table 2.6 confirm the disparity regarding broadband adoption between the top three deciles and the three bottom deciles of the socio-demographic pyramid. While the difference between the bottom and top of the socio-demographic pyramid is smaller in emerging countries, that is due to the overall lower penetration of broadband in these economies (see Table 2.7).

While still present in developed nations, it is reasonable to conclude that the affordability barrier to broadband adoption at the bottom of the pyramid is a phenomenon more prevalent in emerging countries (see Fig. 2.5).

As observed in Fig. 2.5, an exponential relationship exists between income per capita purchasing power parity in US dollars (horizontal access) and broadband penetration at the bottom of the pyramid (vertical access). When per capita income of a country surpasses US$ 20,000, fixed broadband adoption at the base of the pyramid exceeds 20 %. This situation confirms that higher income, to a large extent, largely solves the affordability problem.

This conclusion for emerging economies is further supported in studies conducted at the country level. For example, in research conducted by the Costa Rican government, in households with a monthly income higher than 750,000 Colones (local currency), computer and fixed broadband adoption exceeds 80 %; in households with incomes lower than 750,000 Colones, the adoption of both technologies decreases to 60 % and under (see Fig. 2.6).

In another study conducted in Chile, broadband adoption in the highest quintile reached 73 % in 2009, while within the lowest quintile, adoption is 10 % (see Fig. 2.7).

Similar results were obtained in a research conducted in Colombia, where broadband penetration in top social strata was 83 %, while adoption in the bottom was only 2 % (see Fig. 2.8).

Table 2.6 Broadband penetration at bottom 3 deciles versus top 3 deciles of socio-demographic pyramid (2012)

Countries	Broadband penetration (bottom 3 deciles)	Broadband penetration (top 3 deciles)	Countries	Broadband penetration (bottom 3 deciles)	Broadband penetration (top 3 deciles)
Algeria	0.37	12.90	France	33.60	80.83
Argentina	4.43	41.73	Georgia	0.67	7.43
Australia	50.23	91.67	Germany	39.23	91.83
Austria	37.27	83.40	Greece	15.20	65.90
Azerbaijan	0.17	3.63	Guatemala	0.70	5.47
Bahrain	16.67	79.10	Hong Kong, China	46.93	97.87
Belarus	3.50	45.67	Hungary	24.70	75.27
Belgium	39.77	92.57	India	0.33	12.67
Bolivia	1.13	21.83	Indonesia	0.07	4.60
Bosnia and Herz.	5.47	18.83	Iran	1.80	17.47
Brazil	4.63	50.07	Ireland	29.93	76.97
Bulgaria	7.70	47.77	Israel	29.73	72.67
Cameroon	0.13	2.33	Italy	22.13	72.57
Canada	47.03	91.03	Japan	57.10	65.93
Chile	12.73	41.27	Jordan	4.27	17.53
China	7.87	40.20	Kazakhstan	0.13	13.53
Colombia	4.37	26.47	Kenya	0.20	4.70
Costa Rica	5.83	39.17	Korea, Rep.	92.03	100.00
Croatia	14.97	76.17	Kuwait	11.87	60.00
Czech Republic	17.80	84.23	Latvia	27.33	73.43
Denmark	65.47	89.83	Lithuania	28.87	70.83
Dominican Rep.	1.37	11.13	Macedonia	4.57	35.13
Ecuador	0.67	21.37	Malaysia	9.77	45.43
Egypt, Arab Rep.	0.70	11.77	Mexico	4.33	46.10
Estonia	30.63	88.20	Montenegro	7.00	40.87
Finland	51.80	98.13	Morocco	1.33	15.43
Netherlands	71.60	86.17	Norway	74.40	89.47
Nigeria	0.10	12.23	Peru	0.63	25.07
Poland	25.97	83.20	Switzerland	53.37	94.03
Qatar	25.80	100.00	Tunisia	0.47	8.37
Romania	6.27	38.97	Turkey	13.57	54.27
Russia	10.10	46.37	Turkmenistan	0.00	0.63
Saudi Arabia	18.43	63.83	Ukraine	1.40	21.57
Serbia	8.17	48.47	United Arab Emirat.	29.03	100.00
Singapore	60.57	96.80	United Kingdom	41.10	97.10
Slovak Republic	17.97	73.93	United States	49.57	83.17

(continued)

Table 2.6 (continued)

Countries	Broadband penetration (bottom 3 deciles)	Broadband penetration (top 3 deciles)	Countries	Broadband penetration (bottom 3 deciles)	Broadband penetration (top 3 deciles)
Slovenia	31.53	85.93	Uruguay	4.10	38.60
South Africa	0.57	11.97	Uzbekistan	0.00	4.33
Spain	30.30	80.60	Venezuela	5.47	45.37
Sweden	62.20	95.77	Vietnam	0.30	20.50

Source Euromonitor (2012)

Table 2.7 Weighted average penetration in the bottom 3 deciles versus top 3 deciles of socio-demographic pyramid (2012)

	Broadband penetration (bottom 3 deciles) (%)	Broadband penetration (top 3 deciles) (%)	Difference (in percentage points)
Developed countries	38.83	84.60	45.77
Emerging countries	4.80	27.81	23.01
Mean	19.39	52.15	32.76

Source Euromonitor (2011); calculated by the authors

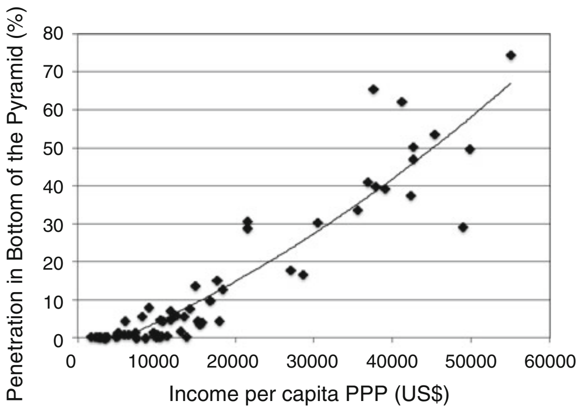


Fig. 2.5 Relationship between level of economic development and broadband adoption at the bottom of the pyramid (2011). *Source* Katz and Callorda (2013) based on Euromonitor and IMF

Since the penetration in the bottom of the socio-demographic pyramid is highly correlated with the average household income and the GDP per capita of a given country, it is expected that nations that undergo rapid economic growth or implement poverty-reduction programs would witness a reduction in the broadband affordability gap. Brazil is a clear example of this effect (see Fig. 2.9).

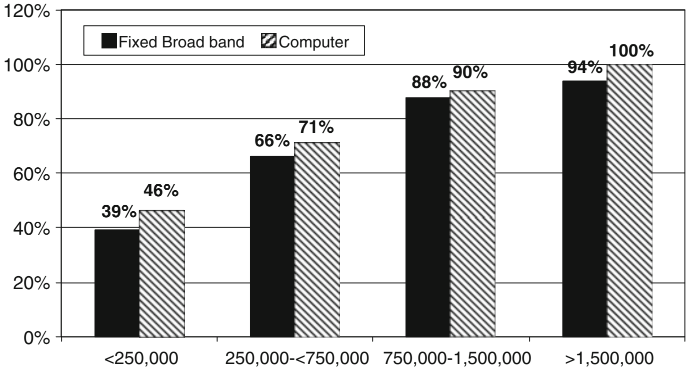


Fig. 2.6 Costa Rica: household computer and fixed broadband access by income (2010). *Source* Costa Rica. Rectoria de Telecomunicaciones

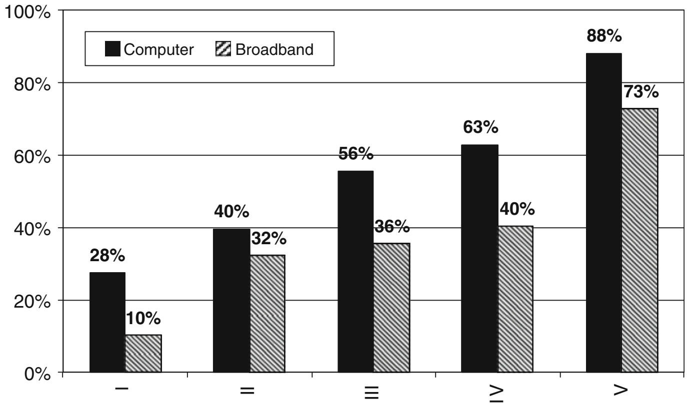
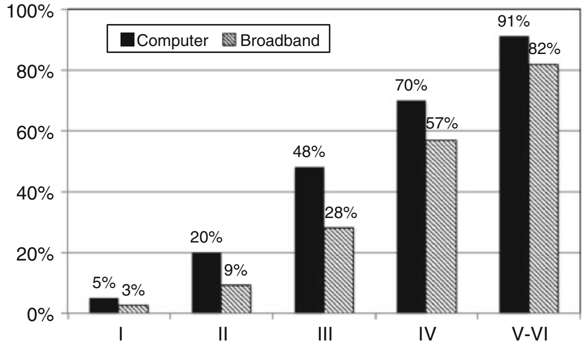


Fig. 2.7 Chile: household computer and broadband access by socio-demographic quintile (2009). *Source* Universidad Alberto Hurtado

Fig. 2.8 Colombia: household computer and broadband access by socio-demographic strata (2010). *Source* SUI; National Department of Statistics



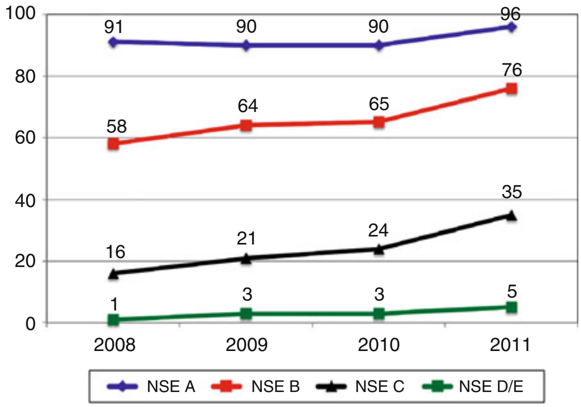


Fig. 2.9 Brazil: household adoption of broadband internet (by socio-economic segment) (2008–2011) *Source* CGI Household Survey. *Note* The classification of socioeconomic level in Brazil is based on the level of instruction and ownership of goods per the Criteria of Economic Classification Brazil (CCEB), which is a part of the Associação brasileira de empresas de pesquisa". It is based on household presence of color TV (0–4 points), radio (0–4 points), bathroom (0–7 points), automobile (0–9 points), maid service (0–4 points), washing machine (0–2 points), DVD (0–2 points), refrigerator (0–4 points), and freezer (0–2 points). On the other hand, the head of the household's level of instruction is also considered depending on whether he or she has a complete higher education (8 points), incomplete higher education (4 points), complete secondary education (2 points), complete primary education (1 point), or if they are illiterate (0 points). In the event that the total number of points is greater than or equal to 35, the household falls into category NSE A; if it totals between 23 and 34 points, category NSE B; between 14 and 22 points, NSE C; between 8 and 13 points, NSE D; and if the points total between 0 and 7 points, they fall into category NSE E

As demonstrated in Fig. 2.9, the increase of fixed broadband adoption in Brazil between 2008 and 2011 is essentially a phenomenon of the upper and middle classes. The figure shows that the penetration jump in the B and C segments could be linked primarily to the income redistribution policies put in place by the administrations of presidents Lula and Rousseff. Segments D/E have not increased their adoption of fixed broadband over time in any significant way, because, the social policies put in place cannot break through the broadband affordability barrier at the bottom of the socio-demographic pyramid.

However, if the economy does not grow or no poverty reduction programs have been actively implemented, the affordability broadband gap tends to increase. For example, in Mexico the increase in broadband penetration has been significant within the higher deciles (VIII to X) between 2008 and 2010 while rates stagnated amongst the lower tiers, therefore accentuating the socio-demographic digital divide (see Fig. 2.10).

The evidence collected both at the aggregate and country level confirms the importance of the affordability variable in explaining a substantial portion of the broadband demand gap. In this context, two policy levers are particularly relevant to affect this dimension of the digital divide. At a macro-economic level, all

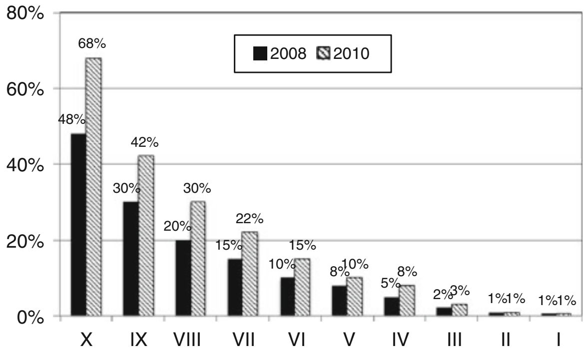


Fig. 2.10 Mexico: household internet adoption (by income decile) (2008–2010). *Source* INEGI (2011)

Table 2.8 Latin America: wireless penetration at the bottom of the pyramid (three lowest deciles)

Country	2007	2008	2009	2010	2011	2012
Argentina	43.27	48.30	54.10	58.97	62.90	65.93
Bolivia	21.10	27.50	38.23	49.37	59.97	69.37
Brazil	47.37	57.43	62.50	66.33	68.90	70.80
Chile	49.80	57.53	69.97	78.07	82.07	85.47
Colombia	51.50	64.20	68.13	73.47	76.63	78.87
Costa Rica	35.13	44.17	45.80	51.00	55.27	58.20
Ecuador	35.87	42.27	49.37	54.27	59.40	63.80
Guatemala	35.97	37.17	38.47	38.97	39.80	40.53
México	39.13	46.70	56.50	60.97	64.80	68.03
Peru	13.97	17.77	22.20	26.90	31.90	36.77
R. Dominicana	34.10	40.90	46.67	50.43	53.83	56.97
Uruguay	45.17	55.13	63.90	68.90	73.07	77.80
Venezuela	14.80	15.20	15.57	15.90	16.20	16.57
Total	42.92	48.47	53.34	53.35	57.29	60.70

Source Euromonitor (2012); compiled by Katz and Callorda (2013)

programs aimed at reducing poverty levels (such as the ones implemented in many countries of Latin America, such as Argentina, Brazil, and Venezuela) will, without doubt, have an impact in reducing the demand gap. At the ICT sector level, policies aimed at reducing the pricing of services will necessarily stimulate adoption. The types of programs that could be put in place and their expected impact will be reviewed in Chap. 4.

It should be mentioned, however, that remedies for this market failure—the affordability barrier—should be sought out not only in the area of state intervention in the fixed broadband space, but also through alternative technologies like mobile broadband. In this sense, the potential of mobile broadband to tackle the affordability barrier at the bottom of the pyramid merely replicates the experience of wireless in addressing the universalization challenge of the voice telephony. Table 2.8 illustrates how mobile telephony has been gradually penetrating the bottom of the socio-demographic pyramid in the Latin American region.

As seen in Table 2.8, the combination of pre-paid offers and policies of "calling party pays" has enabled voice telephony penetration rates to reach, on average, 60.70 % at the bottom of the socio-demographic pyramid in 2012, up from 42.92 % in 2007. In this sense, the question is whether or not the mobile platform can replicate the universalization success achieved in voice telephony to broadband, but how it could be done. We will come back to this in Chap. 4.

2.2.2 Limited Digital Literacy

Beyond the affordability barrier, lack of digital literacy can explain a portion of the broadband demand gap. Digital literacy is the ability to navigate, evaluate, and create information effectively and critically using a range of digital technologies. Digital literacy encompasses all devices, such as computer hardware, software, the Internet, and cell phones. Research around digital literacy is concerned not just with being literate at using a computer, but also with wider aspects associated with learning how to find, use, summarize, evaluate, create, and communicate information effectively while using digital technologies. Digital literacy does not replace traditional forms of literacy; it builds upon its foundation.

The digital literacy barrier has been identified in numerous surveys attempting to explain broadband non-adoption. For example, in the United States (Horrigan 2009), 13 % of non-adopting households mentioned difficulty of use as a major barrier for adopting broadband. This answer comprised different reasons for difficulty (lack of training, age, physical handicap such as being visually impaired). Research conducted in the context of the United States National Broadband Plan found that 22 % of non-broadband adopters said that they were not comfortable using a computer because of limited digital literacy (Horrigan 2013). In Spain, digital illiteracy amounted to 29 % of the broadband non-adopting households (ONTSI 2012). This number is close to the one reported by non-adopters in Puerto Rico (31 %), which explained their behavior by saying that "they do not need broadband or the Internet" (PRBT 2012). In the United Kingdom, lack of digital ability was only cited by 4 % of non-adopting households (OFCOM 2012). This metric is close to the results of a comparable Australian survey, where 7 % of non-adopters found "the Internet to be too complicated" (AGIMO 2009). In the Colombian research cited earlier, 8.6 % of households surveyed responded that they did not know how to use computers as an explanation for not adopting broadband (MTIC 2011).

As indicated in the Fig. 2.4 above, limited digital literacy is determined primarily by two structural variables: education level and age. In addition, income level (as correlated with education level) remains a contributing factor. However, digital illiteracy could be particularly high in certain socio-demographic groups, such as the elderly, the unemployed, the disabled, and certain female groups.

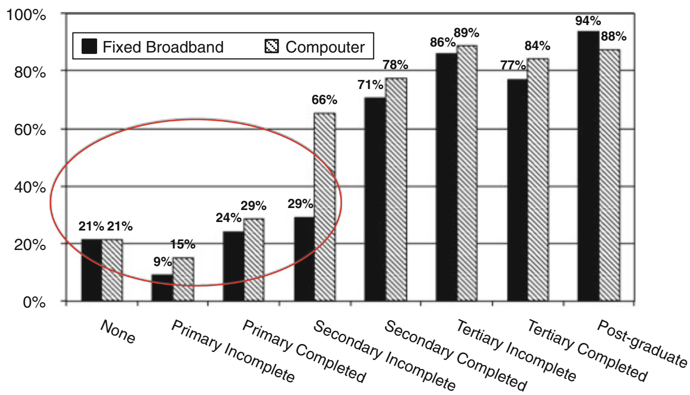


Fig. 2.11 Costa Rica: household computer and broadband adoption by level of education of head of household (2010). *Source* Costa Rica. Rectoria de Telecomunicaciones

2.2.2.1 Broadband, Digital Literacy, and Education

The first indication that educational level and broadband adoption were intrinsically linked was found when comparing country broadband demand gap and household education across countries. For example, the Republic of Korea has one of the lowest broadband demand gaps in the world: 93 % of households have adopted fixed broadband, which would indicate an adoption gap of 7 % (given the 100 % coverage level). On the other hand, Korean citizens complete on average an additional year of education compared to citizens in Japan and the United States. Additionally, Korean households have 50 % more aggregate years of education than households in the United States. This statistic would suggest a correlation at the aggregate level between education and broadband adoption.

Further research at the country level confirmed this initial evidence. For example, in Costa Rica, broadband adoption doubles when the head of household has completed high school (see Fig. 2.11).

As Fig. 2.11 indicates, while computer ownership increases substantially after the head of household completes primary school, broadband adoption jumps after some years of secondary education have been fulfilled. This fact would indicate that, beyond the general influence of the education level variable, affordability plays a stronger role (considering that schooling and income are correlated) in the case of broadband subscription than in terms of purchasing a computer. The combined impact of household income and level of education in the Costa Rican study can be clearly visualized in Fig. 2.12.

As the data in Fig. 2.12 suggest, the overall direct relationship between household income and fixed broadband adoption is clear. One exception to this trend is seen in second decile households where the head has a tertiary education: in this case, adoption is significantly higher than households below the eighth decile. This anomaly could be explained by the existence of households where the

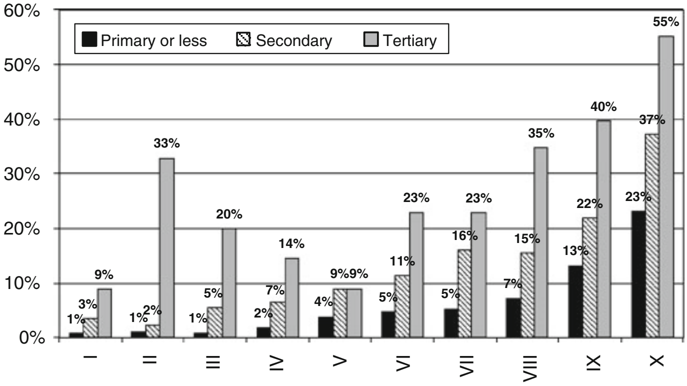


Fig. 2.12 Costa Rica: household broadband penetration by income decile and education (2010). *Source* Costa Rica. Rectoria de Telecomunicaciones

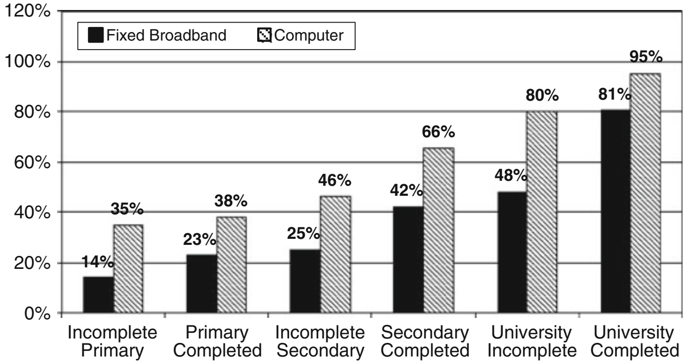


Fig. 2.13 Chile: computer and fixed broadband adoption by education level of head of household (2009). *Source* Universidad Alberto Hurtado (2009)

head is a recent university graduate who has not yet been able to earn an income commensurate to his or her educational achievement.

Beyond the direct relationship between income and broadband adoption, the influence of education is quite relevant. Particularly, above the sixth decile (where affordability represents less of a barrier), education becomes a determining factor. The higher the educational achievement of the head of household, the higher broadband adoption is.

The importance of education in explaining broadband adoption has also been detected in a study in Chile (see Fig. 2.13).

In the case of Chile, fixed broadband and computer adoption approaches the 50 % household penetration after secondary school has been completed. A similar finding was produced by a study in Puerto Rico conducted in the context of the state's broadband strategy development (Fig. 2.14).

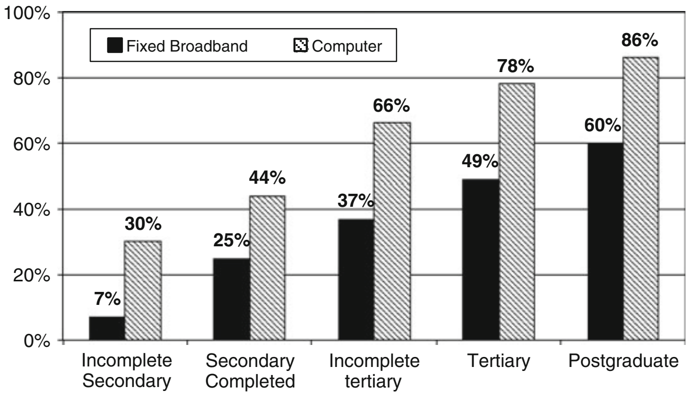


Fig. 2.14 Puerto Rico: computer and fixed broadband adoption by education level of head of household (2011). *Source* PRBT (2012)

The study of the education variable reveals the complex interrelationship it has with the affordability factor. At lower income levels, the affordability variable is stronger than the educational in predicting adoption. On the other hand, at income levels higher than the sixth decile, demand is less elastic to income, and educational achievement becomes preeminent.

Again, from a policy perspective, despite the importance of sector specific initiatives such as digital literacy programs, classical education programs will ultimately have a significant contribution to stimulating broadband demand.

2.2.2.2 Broadband, Digital Literacy, and Age

Studies conducted in the developed world have all pointed out the existence of a generational gap linked to limited digital literacy. In the United Kingdom and the United States, for example, the average age of a non-adopting household is over 65 years old (OFCOM 2012).

Research in the emerging world suggests the existence of a threshold of 30 years old, after which Internet use tends to decline significantly. For example, in Chile the percentage of non-adopters doubles after 30 years old (Universidad Alberto Hurtado 2009). In Peru, the percentage of Internet users within the 19–24-age bracket is 61 %, compared to 37 % amongst the 25−40 cohort (INEI 2012). In Brazil, the percentage of Internet adopters 24 years old or younger is 81 %, compared to 48 % amongst the 35–44 age group. In Costa Rica, the adoption of fixed broadband tends to decline significantly after 45 years old (see Fig. 2.15).

The difference between the 30-year threshold for Internet usage and persisting broadband penetration at the 35–44 bracket is explained by the presence of children in the household. Children tend to act as change agents in a household, stimulating Internet usage and sustaining broadband adoption. This indirect influence cancels some of the generational gap identified in numerous studies. In

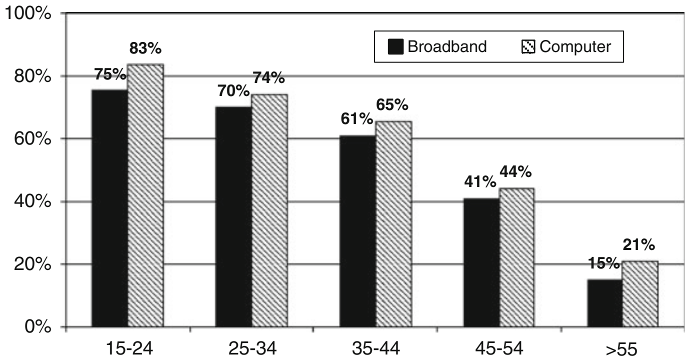


Fig. 2.15 Costa Rica: household fixed broadband and computer adoption by age cohort (2010). *Source* Costa Rica. Rectoria de telecomunicaciones (2011)

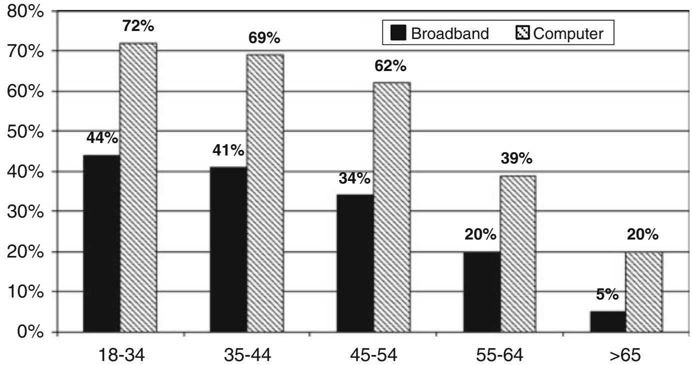


Fig. 2.16 Costa Rica: household fixed broadband and computer adoption by age cohort (2010). *Source* PRBT (2012)

the case of Chile, the presence of children in the household increases the probability of acquiring a broadband subscription from 39 to 43 % (Universidad Alberto Hurtado 2009). In Peru, the probability increases from 43 to 57 % (INEI 2012). In Costa Rica, the effect was not general across ages, but when controlling for income and education, the presence of children as a stimulus for adoption becomes very strong in households where the head has a low level of education. In Costa Rica survey data confirms this trend. Broadband adoption drops 14 percentage points after 54 years old (see Fig. 2.16).

The digital literacy generational gap poses more serious problems for some countries than others. Asian countries like Hong Kong, Japan, and Singapore, for instance, have some of the world's fastest growing aging populations. Even in these countries, seniors appear resistant to broadband use and adoption. Research suggests that governments and institutions could potentially change this trend by focusing on the socialization of technology to make it more widespread throughout this demographic (Computer Supported Cooperative Work 2011).[7] Programs addressing the generational gap will be presented in Sect. 3.1.2.

2.2.3 Lack of Content Relevance or Interest

Since broadband is a platform used to access Internet content, applications, and services, the relevance of such content offers an incentive to purchase a subscription. Conversely, the lack of cultural relevance could serve as a barrier to adoption. Cultural relevance could be conceptualized either in terms of content suited to the interests of the adopting population or in terms of language used for interacting with applications/services or consuming content.

The relevance dimension has been identified in several studies in the developed world. For example, Horrigan (2009) estimated that, according to his survey, 50 % of non-broadband households linked non-adoption to "lack of relevance/interest." In the survey, lack of relevance was driven by "no interest", "busy conducting other tasks", or other unspecified reasons. Interestingly enough, the percentage of non-adopting households citing lack of relevance (50 %) was higher than the percentage citing affordability (35 %). In a study conducted in 2011, the non-broadband adopting households that provided the "lack of relevance" explanation only decreased to 47 %, while affordability dropped to 24 % (NTIA 2011). When disaggregating non-broadband households between those that have or do not own a computer, "lack of relevance" jumps to 52 %, and affordability drops to 21 %.

"Lack of relevance" consistently outranks affordability structural factors in most studies conducted in developed nations. For example, in a study conducted in the United Kingdom in 2011 (OFCOM 2012), 66 % of non-adopting households said "lack of relevance" explained their decision not to purchase a broadband service. Again, this percentage was substantially less than those households that alluded to the affordability barrier (16 %). Interestingly enough, in a similar study conducted in 2010 (OFCOM 2012), the affordability barrier was mentioned by 23 % of households surveyed. This suggests that, as prices for broadband service decline, the cultural relevance factor gains in importance. In other words, from a policy standpoint, once the economic obstacles are tackled and affordability becomes less of an explanatory factor of non-adoption, the lack of relevance or interest variable gains weight. In the case of Australia, affordability (26 %) was somewhat more important than lack of relevance (19 %) (AGIMO 2009).

As expected, lack of relevance as a barrier in developed countries is prevalent in very circumscribed socio-demographic categories. In the United Kingdom, the non-broadband households that cite lack of relevance tend to be lower income households with people over 65 years old. In a study conducted in Spain

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[7] https://sites.google.com/site/technologyamongseniors/

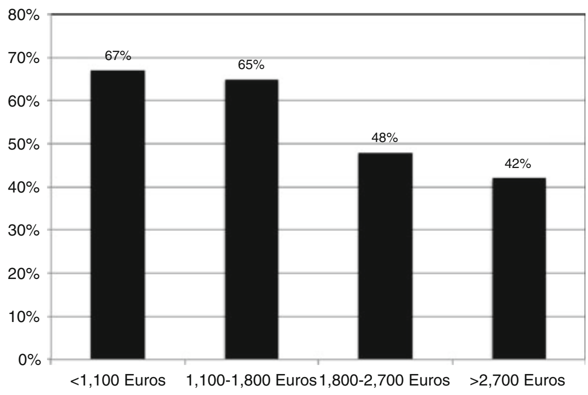

Fig. 2.17 Spain: lack of relevance as reason for non adoption by income (2011). *Source* INE (2011)

(ONTSI 2012), lack of relevance of Internet content is inversely proportional to income levels (see Fig. 2.17).

In at least one study conducted in a developed country, the linguistic factor contributed to the lack of relevance. That was identified in the United States among the Hispanic population that had recently immigrated to the country. It is important to consider, however, that, as in the United States, the linguistic barrier is strongly correlated with economic and educational factors. Therefore, it is still difficult to tease out the socio-demographic variables in order to isolate the linguistic factors.

The language barrier has been identified in the emerging world as well. For example, in Peru, only 8 % of those individuals whose first language was not Spanish are Internet users. That percentage increased to 40 % among native Spanish-speakers. In the Middle East North Africa (MENA) region, the relatively low availability of native-language content is cited as a major challenge to broadband demand (World Bank, Broadband Strategies Toolkit Chap. 7). Focusing on the development of local-language digital content may be the key to increasing the uptake of broadband in these instances. This issue will be discussed at length in Chap. 6.

Beyond language, lack of content relevance remains a strong variable influencing non-adoption. For example, in Colombia, 20 % of non-broadband households justified their behavior explaining that they did not view the Internet "as being necessary" (MITIC 2011).

The lack of relevance variable presents some complexity in terms of its understanding. Two interpretation options are open to policy makers. One option is that the consumer has evaluated the offerings in terms of applications, services, and content and has not found them relevant to his/her needs. Under this premise, policy initiatives should be oriented toward increasing the perceived value of broadband by expanding the range and utility of offerings (these are called "demand pull" policies). The second option is that the consumer does not have enough information to make a decision of adopting broadband. The policy implication in this case is that the consumer needs to be made aware of the potential of the technology (called "awareness" policies).

2.2.4 Broadband Diffusion Cycles and the Importance of Adoption Structural Factors

The importance and weight of each of the three residential demand structural factors—affordability, awareness, and relevance—is not homogeneous across the broadband diffusion cycle. Some are more important than others, depending on the level of adoption of the technology in a given country. This is a critical concept that needs to be understood before deploying demand stimulation policies.

The studies of both fixed and wireless broadband adoption in developed countries would indicate that residential broadband adoption tends to proceed along three clearly defined stages (see Table 2.9).

In stage 1, at lower levels of adoption, the factor constraining penetration is supply-driven. Price does not play a significant role because the first group of adopters is relatively price insensitive. In his research on broadband adoption, Varian (2002) found that the first group of subscribers is fairly price insensitive, while the next generation exhibits an elasticity of demand between −1.3 and −3.1. The second variable affecting broadband adoption is device availability. For example, Chinn and Fairlie (2010) found in their study of Internet usage in 161 countries between 1999 and 2001 that the main factors affecting adoption are possession of a computer and awareness of benefits. Ono and Zavodny (2007) confirmed this finding; relying on microdata for United States from 1997 to 2003, they found that the possession of a computer to use Internet remains the main barrier. Vicente and Lopez (2006) obtained a similar result for Europe using data for 15 countries in 2002. Obviously, current research should indicate that smartphone ownership becomes the first barrier to broadband adoption.

In stage 2, beyond a coverage tipping point, the most important, variable driving penetration is affordability. When Chinn and Fairlie (2010) extended their study up to 2004, they found that the price of the service started to be relevant in the explanation of the levels of Internet adoption. When affordability becomes a more important barrier, elasticity coefficients increase dramatically. For example, using survey data from 100,000 households in the United States, Goolsbee (2002) found that in areas where service is available to a majority of households, a decline in broadband prices of 10 % yields an increase in penetration ranging between 21.50 and 37.60 % (with a mean value of 26.50 %). A similar price reduction in areas where the service is not available to a majority of consumers would result in an increase in penetration ranging between 15 and 30 %. There are three reasons why elasticity is higher in areas with full service coverage. First, in areas with partial coverage, early adopters are less sensitive to prices and therefore, demand is inelastic. Second, in areas with full coverage, consumers have the opportunity of observing the benefit broadband generates, and they are willing to engage in cost/benefit analysis, whereby any reduction in pricing would increase the consumer surplus. Third, in areas with full broadband coverage, consumers also consider network effects when conducting a cost/benefit analysis.

Table 2.9 Stages of broadband adoption

	Stage 1	Stage 2	Stage 3
Ownership of access devices (computers, smartphones)	Low adoption	Medium adoption	High adoption
Availability of web applications and services	• Very low	• Limited	• High
Factors driving non-adoption	• Service coverage	• Affordability	• Digital literacy • Cultural relevance

Source Developed by the authors

Rappoport et al. (2002) also confirm the importance of the affordability barrier in Stage 2. In a survey of 5,225 urban households in the United States, the authors determined that a 10 % price reduction of broadband would yield an increment of 14.91 % in service adoption. Extending the analysis to the OECD countries between 2003 and 2008, Lee et al. (2011) found that 10 % price reduction of broadband results in a 15.80 % increase in penetration. In this last research, the impact of price reduction begins to diminish relative to earlier studies, anticipating the transition to next stage.

In Stage 3, at higher penetration levels, price elasticity coefficients start to diminish. In their study of price elasticity in the United States between 2005 and 2008, Dutz et al. (2009) observed that coefficients declined from −1.53 in 2005 to −0.69 in 2008. Coincidently, Cadman and Dineen (2008) estimated elasticity coefficients for OECD countries in 2007 to be −0.43. This could be due to a shift in consumer perception as to the value of broadband (and consequently the subscriber willingness to pay) from “luxury” to “necessity”. On the other hand, because of diminishing importance in the affordability barrier to adoption, as reviewed in the survey data earlier, structural factors related to limited digital literacy and cultural relevance take precedence.

Consequently, according to the research conducted up to now, the evidence regarding broadband adoption structural factors could be conceptualized as follows (see Fig. 2.18).

In Stage 1, the primary lever to foster adoption is service coverage. In Stage 2, affordability becomes the most important barrier, although digital literacy and cultural relevance begin to assume greater prevalence. In Stage 3, at higher penetration levels, price sensitivity becomes secondary, and the most important adoption barriers remain digital literacy and cultural relevance.

Moving to emerging countries, initial evidence produced by Galperin and Ruzzier (2011) confirms that regions whose penetration is within stage 2 (3–20 %) exhibit high elasticity. OECD countries, with an average penetration of 27.48 % have a price elasticity of −0.53, while Latin American countries (average penetration of 7.66 % in 2011) have an elasticity of −1.88.

While there is still not evidence available, two factors could change the sequential pattern of adoption structural factors outlined earlier. First, as a result of the increasing adoption of mobile broadband enabled devices (such as

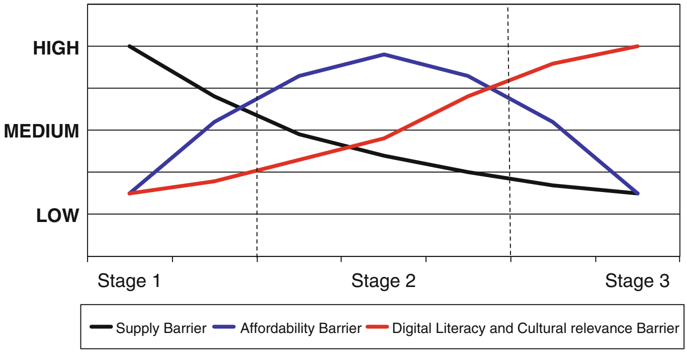

Fig. 2.18 Relative importance of broadband adoption structural factors in reaching advanced stages of broadband penetration. *Source* Developed by the authors

smartphones) and the deployment of 3G and 4G networks, the structural factors of Stage 1 could shorten up significantly, rapidly putting countries in the need to tackle the affordability barrier. Secondly, the increasing availability of applications and services could enhance the willingness to pay of subscribers, thereby altering the consumer surplus equation and reducing the elasticity coefficients. This could be an important factor in many emerging countries.

A final note should be made that, while the generic evolution model presented earlier is one followed by a large number of countries, in some contexts residential broadband adoption may skip Stage 1 and start directly from Stage 2 or skip Stage 1 and 2 and move directly to Stage 3. For example, in Japan, when DSL service started from scratch in areas only with dial-up connection, some ISPs experienced a jump-start in penetration rate of between 10 and 20 %.

2.3 Understanding the Enterprise Broadband Demand Gap

The structural factors and adoption obstacles of broadband among enterprises are different than those variables constraining diffusion among individual consumers. Notwithstanding the fact that broadband technology is a production factor with a positive contribution to the efficiency of business operations, small and medium businesses (especially microenterprises) in emerging economies have faced some broadband adoption impediments. Kotelnikov (2007) has defined four stages of ICT adoption within the small and medium business universe. Those stages are depicted in Table 2.10.

These four stages should not be considered in a static fashion, particularly in light of technological progress and price reductions. Nevertheless, data would support the notion that, particularly in emerging markets, these four stages remain a fairly common development path. This is illustrated by the still limited adoption

Table 2.10 Stages of ICT adoption in SMEs

	Basic communications	Basic information technology	Advanced communications	Advanced information technology
Telecommunications	• Wireline • Wireless • Facsimile		• Email • Broadband • Videoconferencing • File sharing • E-Commerce • VoIP	
Information technology		• Personal computer • Basic software (spreadsheet, word processing)		• Data base management • ERP • nventory management • CRM

Source Kotelnikov (2007)

of broadband within SMEs. Furthermore, while in many cases small businesses rely on the Internet, they do so in shared facilities as opposed to on their own business premises (see Table 2.11).

At the outset, the nature of the business of SMEs, especially micro-enterprises, explains the lack of broadband adoption. Katz (2009) argues that SMEs can be grouped in three categories, each of which has a different need for broadband services:

- "International" SMEs: regardless of their size, these units need broadband to gain access to international markets, deal with their supply chain, and support their logistics
- SMEs supplying large enterprises: as part of the supply chain of large firms, these SMEs require broadband to receive orders, process payments, and provide delivery information[8]
- SMEs operating in low value added industry sectors, primarily services: these firms have a low compelling need to purchase broadband since the nature of their business does not require the type of transactions mentioned in the other two categories.

Considering that the last category comprises a large portion of the SME population in emerging economies, it is natural to expect a delay in the adoption of broadband among small enterprises.

However, beyond this structural factor, other reasons explain the low level of broadband adoption, including 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

[8] A particular case of SMEs refers to start-ups initiated by an incubator program. See below in Sect. 3.4.3.

Table 2.11 ICT adoption among SMEs

Country	Personal computers (%)	Internet (%)	Broadband (%)	Year
Argentina	43	97	75	2007
Brazil	69	54	9	2009
Canada	99	99	99	2010
Chile	74	66	60	2006
Colombia	16	…	9	2010
Ecuador	…	47	…	2005
El Salvador	47	36	50	2005
Guatemala	32	15	16	2005
Mexico	87	73	45	2005
Nicaragua	39	15	11	2005
Peru	27	23	60	2009
Puerto Rico	…	…	74	2011
United States	…	…	75	2010
Venezuela	5	12	3	
Average	46	48	30	

Sources
Argentina Indec; Prince and Cook
Brasil SEBRAE
Canada Fleet (2012)
Chile http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CC8QFjAA&url=http%3A%2F%2Fwww.cnc.cl%2FCharla%2520PYMES%2520Mayo-08.ppt&ei=waiiUI77GY-88wTP84CgDQ&usg=AFQjCNGa00NabrVh3VzGOF2FSp5421_efg&sig2=Sxn1GM5GmynCRvKAS1J0sA
Colombia National Department of Statistics
Ecuador FENAPI
El Salvador, Guatemala, Nicaragua Monge-Gonzelez et al. (2005)
Mexico Select
Peru http://gestion.pe/noticia/304158/conectividad-pymes-banda-ancha-creceria-10-este-ano
Puerto Rico Puerto Rico Broadband Task Force (2012)
United States Connected Nation (2010) *Puerto Rico*: Puerto Rico Broadband Task Force (2012)
Venezuela Microsoft
Note Due to the fact that the sources and methodologies for estimating these statistics are not consistent, data in this chart should not be compared across countries

do not receive fixed monthly income because they operate outside of the formal economy of emerging countries. Their income is generally daily or weekly and is dependent upon the type of labor 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 cybercafés, and rented PCs.

Secondly, many of the entrepreneurs that run SMEs (which are primarily microenterprises in emerging countries) have very limited level of technological training. A large number of SME owners in these economies face a generational gap by not receiving Internet technology exposure growing up. Therefore, they lack the necessary training to operate a computer or use broadband to improve business efficiency. This lack of education translates into the anxiety of using technology and ignorance of its capability to create economic value. The limited availability and retention of a skilled ICT workforce also pose a problem for SMEs, particularly in emerging markets. Because of the systemic shortage of technical personnel, large companies offer wages to graduates of higher education that SMEs cannot match. Even when SMEs manage to hire graduates, retention rates are very low.

Broadband adoption by SMEs is also limited by the lag required to make the necessary organizational and business process changes to assimilate broadband and data transmission technologies. In general terms, SMEs (particularly in emerging countries) 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 % of Chilean companies used ICT to increase the efficiency of business processes other than accounting and finance. Yet, the survey made an even more worrisome observation: 80 % of companies reported that they did not implement ICT in areas other than finance and accounting because they lacked the technological expertise necessary to understand its benefits.

In sum, beyond the composition of the SME sector, which might structurally constrain the need to adopt broadband, the enterprise broadband demand gap is the result of three obstacles:

- Limited affordability: certain portions of the SME space either cannot acquire a device or purchase the subscription needed to access the Internet
- Limited technology training constrains the ability to purchase and effectively introduce broadband in the firm
- The assimilation of broadband to render efficiency gains in the small business requires the introduction of changes in organization, business processes, and even use of IT, all tasks that are well beyond the scope of expertise of small business management

These relationships have been depicted in Fig. 2.19.

Recognizing the benefits broadband holds for SMEs will have additional positive macro-level effects on the country beyond just penetration rates. Indian SMEs, for instance, spent a combined US$ 9.9 billion on the IT sector in 2009 alone, and this spending was attributed to the increased demand for high speed Internet and broadband (Access Markets International 2010).[9] Many of the firms also invested in hiring more employees to utilize this technology and industries such as e-commerce boomed.

The following section will explain each of the three SMEs obstacles—affordability, training, and assimilation. Each section presents studies and data regarding the obstacles and driving variables in developed and emerging countries alike.

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9 http://news.indiamart.com/story/india-smbs-recover-economic-downturn-and-move-ahead-12259.html

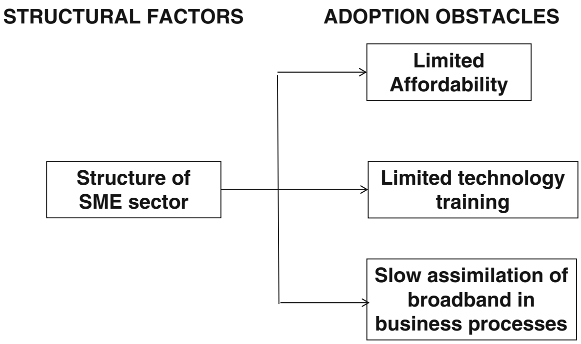

Fig. 2.19 Broadband adoption structural factors within enterprises

2.3.1 The Economic Barrier

As mentioned earlier, the affordability barrier is not only important for individual consumers, but also relevant in the case of SMEs, although this variable tends to be more important in the case of microenterprises.

In a survey conducted in Colombia among SMEs, 12.9 % of surveyed firms indicated that they did not have the economic means to pay for broadband service, while 9.3 % would like to buy broadband because of its utility, but found the service pricing to be too high. While the research does not break down the answers by size of firm, broadband adoption numbers help determine that most of the firms mentioning affordability as a barrier are concentrated among microenterprises: broadband penetration among firms with 11–50 employees is 79 %, while adoption among firms with less than 11 employees is only 7 % (National Department of Statistics 2010).

2.3.2 Limited Technology Training

The difficulties encountered in recruiting staff with technical skills to select, purchase, and operate ICT infrastructure serves as a critical limitation for adopting broadband. This factor was measured in a survey regarding the difficulty to recruit ICT trained personnel conducted among SME managers in Latin America (see Fig. 2.20).

As Fig. 2.20 indicates, the recruiting constraint is particularly acute in Argentina and Brazil. Katz (2009) also identified the problem in field research conducted in other countries such as Uruguay and Chile. The constraint in recruiting technical personnel is due to the fact that the educational system does not generate enough graduates in ICT-related disciplines. In that context, salary inflation “prices out” SMEs when it comes to attracting graduates, which end up working for large enterprises.

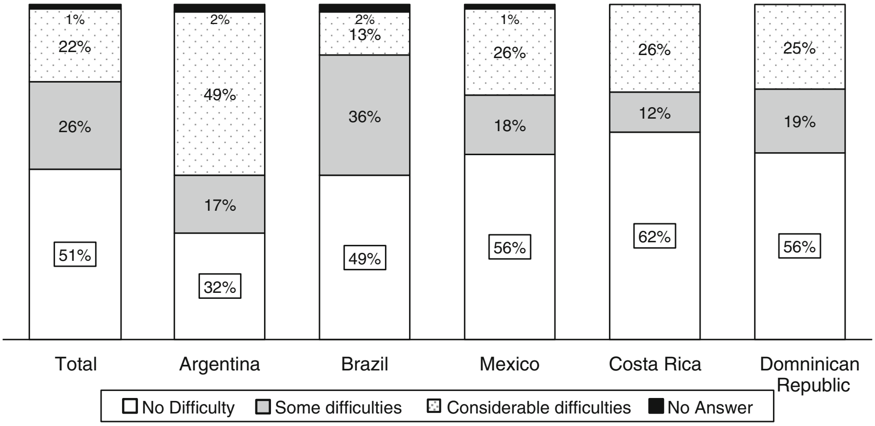

Fig. 2.20 Latin America: difficulty to recruit ICT trained personnel. *Source* UPS Business Monitor (2007)

In developing countries, the problem is not exclusive to smaller businesses. South Africa faces a similar situation. In 2012, the country reported an unemployment rate of 25 %, with more than 4.2 million adult citizens actively searching for employment to no avail. While the government attempted to address the situation by "creating jobs," a more in-depth analysis demonstrated that a lack of qualified workers contributed more to the problem than did a lack of available jobs. In fact, the country's business organizations reported more than 800,000 vacant positions, the majority of which were found in high-skilled industries such as information technology, engineering, and finance.

A 2012 survey of Malaysian CIOs concluded that the low digital literacy skills of organization executives negatively impacted business capabilities (Vanson Bourne 2012).[10] The CIOs "feared senior-level digital illiteracy is causing a lack of market responsiveness, missed business and investment opportunities, poor competitiveness and slower time to market." This sentiment was felt across many Asian markets, where business leaders appeared to fall behind their peers in more developed economies.

2.3.3 Slow Assimilation of Broadband

In order to 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

[10] http://www.cio-asia.com/resource/management-and-careers/leaders-low-digital-literacy-may-hamper-business-growth-malaysian-study/

cultural factors (such as entrepreneurial spirit, willingness to take risks in an organizational transformation), are referred to as the "accumulation of intangible capital."[11] Broadband alone does not have an economic impact. It rather enables the adoption of e-business processes that result in increased efficiency (such as streamlined access to raw materials and management of the supply chain, or better market access). Intangible capital accumulation and the adoption of e-business processes delay the full economic impact of broadband.

This gradual process of technology adoption and assimilation can be studied in the aggregate for economies as a whole. Certain companies, by virtue of the innovativeness of their management and their willingness to transform their enterprises, are the leaders that will initially reap the benefits of ICT.

The second wave of adoption is concentrated on industrial sectors whose structure and value chains tend to result in higher transaction costs. These network-oriented industries are concentrated in financial services, transportation, or retail distribution sectors. In these industries, complexity costs are so high that, in addition to increasing the number of information workers, they need to adopt technology to improve their productivity. This wave represents a move from firm-related adoption drivers to industry structure and economics. It is only in those economies that Jorgenson et al. (2007) call "IT intensive", where the concentration of industrial sectors more prone to adopt ICT is higher, that we can see the macro-impact of ICT on productivity.

Small and medium enterprises tend to adopt broadband in the third wave, after they have been able to make the necessary process and organizational changes needed to assimilate broadband-enabled applications. In light of this effect, these firms will naturally lag in the assimilation of broadband technology. 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 programs and, in the case of SMEs, offer consulting services that help firms capture the full benefit of the technology. Details of these specific proposals will be reviewed in Chap. 3.

2.4 Broadband Demand Gap Diagnostic

A diagnostic of broadband demand obstacles needs to precede the formulation of suitable policies. Building on the concepts presented earlier, the development of broadband demand stimulation policies needs to begin by conducting a diagnostic of the demand gap. This should follow a structured methodology tackling the following questions:

[11] Basu and Fernald (2007).

- Quantification of the residential demand gap
  - What is the coverage of fixed and mobile broadband services (portion of the population served or unserved)?
  - What is the percentage of the population served by both fixed and mobile platforms?
  - What portion of the population by administrative unit (such as departments or counties) purchases both fixed and mobile services (complementarity effect)?
  - What portion of the population purchases only mobile broadband services (PC connectivity devices, smartphones) (substitution effect)?
  - What portion of the population is served by fixed broadband and do not acquire a subscription?
  - What portion of the population is served by mobile broadband exclusively and do not acquire a broadband plan?
- Socio-demographic analysis of the residential demand gap
  - What is the profile of non adopters (by age, income level, education, gender, ethnic group)
  - Disaggregation of non-adopting population by region and administrative unit
- Quantification of the enterprise demand gap
  - What is the percentage of enterprises (primarily SMEs served by both fixed and mobile platforms?
  - What portion of the enterprises by administrative unit (such as departments or counties) purchases both fixed and mobile services (complementarity effect)?
  - What portion of the enterprises purchases only mobile broadband services (PC connectivity devices, smartphones)?
  - What portion of the enterprises is served by fixed broadband and do not acquire a subscription?
  - What portion of the enterprises is served by mobile broadband exclusively and does not acquire a broadband plan?
- Firm level analysis of the residential demand gap
  - What is the profile of non adopting enterprises (by size, and industrial sector)
  - Disaggregation of non-adopting enterprises by region

By answering these questions, policy makers will be able to develop a diagnostic of the broadband demand gap. With this diagnostic, policy makers need to start devising appropriate demand stimulation policies. The different examples of policy initiatives are reviewed in the following chapters.

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