



Identifying best practices for supporting broadband growth: Methodology and analysis

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ABSTRACT

This paper presents a methodology for identifying best practices followed by various countries worldwide for supporting broadband growth. It also investigates and analyzes these practices using data concerning broadband penetration, access technologies, market, prices and services for OECD countries during the period 2004–2006. The methodology used to locate the best practices is based on three main steps: (a) the presentation of the main factors that have a major impact on broadband growth; (b) the definition of what is a “best practice” based on quantitative criteria and (c) the calculation of a best practice index and a good practice index, which indicates that a country followed these best or good practices to support its broadband growth, respectively. This methodology indicated that Denmark, United States, Japan, Canada and Republic of Korea followed best practices for their broadband growth, while United Kingdom and the Netherlands followed good practices.

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1. Introduction

“Broadband networks will be as critical to the 21st Century as roads, canals and railroads were to the 19th Century and the Interstate Highway System and basic telephone networks were to the 20th Century”. Generally speaking, broadband describes high-speed, high-capacity data communication making use of a wide range of technologies that often have diverse characteristics and seem appropriate for certain network scenarios and situations. There is no specific (international) definition or unique standard for broadband and the range of service speeds varies typically from 128 Kbps (or 200 Kbps according to the Federal Communications Commission – FCC¹ – of United States) to 100 Mbps for broadband access. For instance, ADSL2+ supports speeds up to 16 Mbps, Cable up to 30 Mbps, while at the high end VDSL offers up to 52 Mbps and WiFi 802.11g up to 54 Mbps of aggregate bandwidth with next-generation fiber providing capacities to the home up to 100 Mbps. For the purpose of this paper, we consider as broadband connection every connection which supports speeds greater than 200 Kbps.

Broadband is a key element of the developments that are taking place in the electronic communications markets. Consumers are benefiting from lower prices and higher speeds and a variety of broadband offers due to increasing competition in this market. Therefore, one of the main objectives, in many countries, is to support broadband growth. For example, broadband is considered crucial to European competitiveness. To this direction, the European Commission (EC) has been particularly active in promoting broadband developments. In particular, the EC adopted an initiative supporting the Lisbon 2010 goals, i2010, where broadband take-up is considered an important factor for the emerging digital economy and competitiveness.

In general, the policies that the countries adopt for the development and deployment of broadband is strongly related to Internet and broadband penetration, as well as to the percentage of the population that live in rural or remote areas. In particular, counties with high penetration rates focus on the preservation and extension of these rates.

The main focus of this paper is to summarize the lessons learned from countries worldwide that present high broadband penetration rate. The policies adopted by these countries for supporting the broadband growth could be proved very beneficial for countries with very low broadband penetration rate (such as Greece). However, the high broadband penetration rate cannot alone stand as the criterion for considering a broadband strategy of a country as a best practice. There are more criteria and factors that have a major impact on the broadband penetration growth, which this paper tries to address.

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¹ http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-208A1.pdf, accessed on 11/2/09.

Until now, some research work has been presented concerning lessons learned from broadband development (Cava-Ferreruela and Alabau-Munoz, 2006; Frieden, 2005; Picot and Wernick, 2007).

Based on the above, this paper tries to quantify the above factors for locating the countries worldwide that followed best practices for supporting broadband growth. The rest of the paper is structured as follows: the section that follows presents the status of broadband worldwide concerning broadband penetration, access technologies, market, prices and services for OECD countries during the period 2000–2006. Based on the above, this paper is structured as follows: Section 3 describes the factors that affect the broadband growth, while Section 4 constitutes a methodology adopted for quantifying the above factors and for providing a definition of “best practice for supporting broadband growth” based on quantitative criteria. The results of this methodology are the best practice index (BPI) and the good practice index (GPI), which indicate that a country adopted best or good practices for supporting its broadband growth. Section 5 (i.e. “Best practice analysis”) presents the calculation of the best practice and good practice index and discusses the results. The last section (i.e. “Conclusions”) summarizes the results of the paper as well as the main characteristics of a best practice for supporting the broadband growth of a country.

2. Broadband worldwide

This section presents briefly an overview of broadband in OECD countries during the period 2004–2006. This section is, thus, focused on the comparative results of a survey conducted on an international level. In particular, the results presented in the following sub-sections fall into the following directions:

- broadband penetration,
- broadband access technologies,
- competition in telecommunications market,
- broadband access cost,
- broadband services.

Fig. 1 presents statistics concerning broadband penetration, Internet penetration and broadband access technologies.

The information presented in Fig. 1 is commented in the following paragraphs.

2.1. Broadband penetration

Regarding the number of broadband subscriptions, based on OECD data, it has increased 33% from 136 million in June 2005 to 181 million in June 2006. This growth increased broadband penetration rates in the OECD from 11.7 in June 2005 to 15.5 subscriptions per 100 inhabitants 1 year later (Fig. 1).

According to OECD data (www.oecd.org/sti/ict/broadband), in June 2006 six countries (Denmark, the Netherlands, Iceland, Korea, Switzerland and Finland) led the OECD in broadband penetration, each with at least 25 subscribers per 100 inhabitants. Denmark led (June 2006) the OECD with a broadband penetration rate of 29.3 subscribers per 100 inhabitants. This country along with Australia, Norway, the Netherlands, Finland, Luxembourg, Sweden and the United Kingdom presented a higher net increase between the second quarter of 2005 and the second quarter of 2006 (Fig. 2). Both Korean and Japanese broadband markets were advancing to the next stage of development during that period, where existing subscribers switch platforms for increased bandwidth. In Korea, fiber-based broadband connections grew 52.4% during 2005. Japan leads the OECD in fiber-to-the-premises (FTTP) with 6.3 million fibre subscribers in June 2006.

Given the fact that penetration grows, broadband providers in the OECD are increasingly offering voice and video services over this platform. The speeds offered by providers are also increasing.

2.2. Broadband access technologies

Regarding broadband technologies, DSL was (June 2006) the leading broadband platform, followed by cable modem access. In particular (according to OECD Broadband Statistics, June 2006, Fig. 1), DSL accounted for 63% (from 62% in December 2005) and cable modem for 29% (from 31% in December 2005). Other technologies (e.g. fiber, LAN, satellite and fixed wireless) accounted for 8% (from 7% in December 2005). Alternative technologies were usually related to the morphology of each country, the percentage of rural and remote areas, as well as to the broadband penetration. In particular, countries with high penetration rate seem to adopt more advanced technologies, as for example fiber to the home (FTTH), while countries with a high percent of rural population tend to wireless technologies or satellite.

The global trend in broadband access technologies was that cable and alternative technologies are gradually losing out (in terms of broadband subscriptions) to DSL worldwide (Cox, 2006). Whereas in 2004, cable operators and other technology providers still had a market share of 36.2%, in the first quarter of 2006, and in the first half of 2006 this figure declined to 32.8% and to 29.5% accordingly. The majority of countries present a trend in DSL broadband subscription. Although, it should be noted that in two countries (i.e. United States and Canada) cable has higher percent of the broadband market than DSL (Fig. 1).

2.3. Competition in telecommunication market

Competition is driving fixed and mobile players to invest in new technologies to reduce costs and position themselves in a converged environment (COM, 2006).

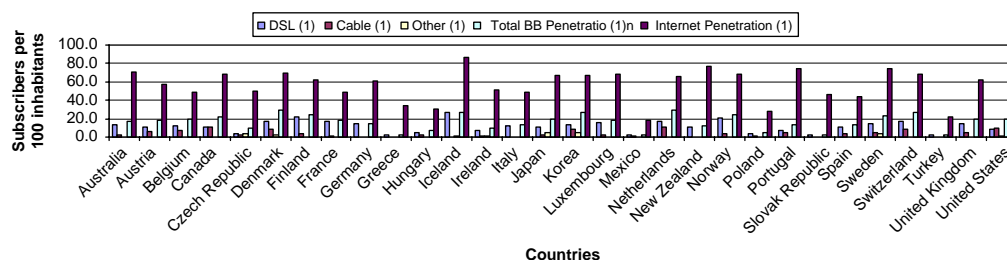


Fig. 1. Statistics concerning broadband penetration, Internet penetration and broadband access technologies. (1) OECD Broadband subscribers per 100 inhabitants, by technology, June 2006. (2) Internet Penetration per 100 inhabitants, Internet World Statistics, January 11, 2007 (September 18, 2006 for European countries) (<http://www.internetworldstats.com>).

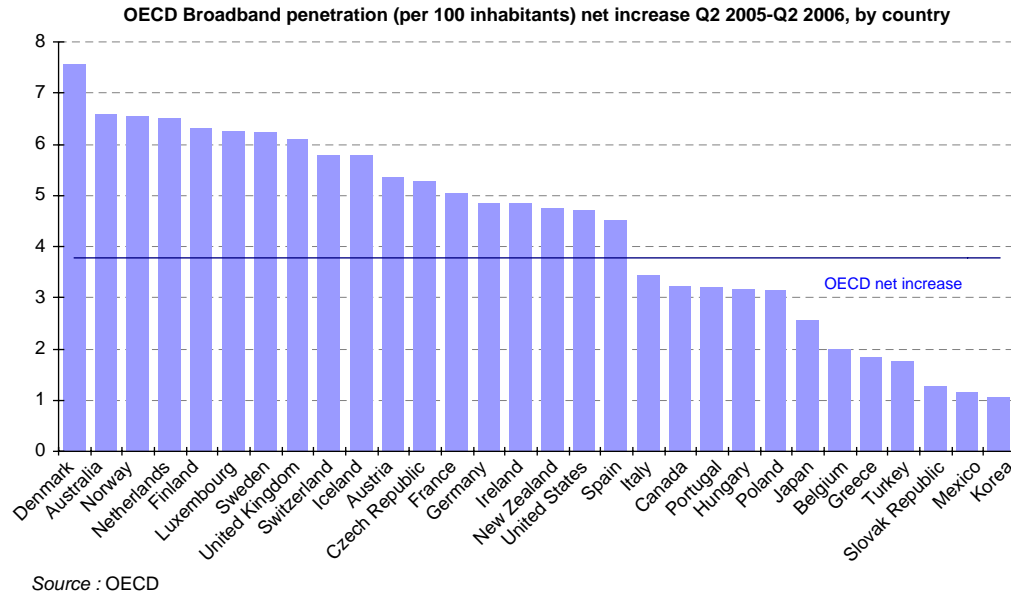


Fig. 2. OECD Broadband penetration (per 100 inhabitants) net increase Q2 2005–Q2 2006, by country (Source: OECD).

Operators offer portfolios of services, with different combinations of low-cost voice (including mobile), internet access and audiovisual content to attract and retain customers. After dipping significantly in 1999–2001, investment levels started recovering, with capital expenditure for the sector as a whole conservatively estimated to exceed €45 billion in the EU in 2005, an increase of approximately 6% compared to 2004 (COM, 2006).

In several European countries, the infrastructure is owned by incumbent telecommunication firms, some of which may even be state-owned. Although this practice was set in place to guarantee that the interested public is served, it may occasionally lead to additional bureaucracy and tardy adoption of technological standards. The liberalization of the local loop telecommunication infrastructure allowed the firms involved to behave more competitively and dropped broadband monthly fees to lower prices. Such an example is Sweden (Papacharissi and Zaks, 2006).

According to Höffler (2005), competition between parallel infrastructures incorporates opposing welfare effects. More specifically, Höffler (2005) said that infrastructure competition between DSL and Cable TV had a significant and positive impact on broadband penetration. Furthermore, competition is pushing broadband penetration as countries with more competitive markets (measured by market share of new entrants) tend to have a higher broadband penetration as well as a faster growth (ERG, 2005). In addition, Aron and Burnstein (2003) found that competition between providers is an effective catalyst for increased penetration. Finally, an interesting result has been extracted by Distaso et al. (2005), who said that while inter-platform competition drives broadband adoption, competition in the market for DSL services does not play a significant role. Distaso et al. (2005) also confirmed that lower unbundling prices stimulate broadband uptake.

2.4. Broadband access price

Regarding cost, it seems to present an important reduction in the last five years, while it is strongly related to the variety and quality of provided services, as well as to the access speeds of these services. At this point it should be mentioned that cost reduction is strongly related to the level of competition of the

broadband market. In cases of countries where the level of competition is low or the market is monopolistic, the cost is significantly higher, in relation to the GDP per capita. Flamm and Chaudhuri (2007) have found evidence that broadband price is indeed a statistically significant driver of Internet and broadband demand.

2.5. Broadband services

Given the fact that penetration grows, broadband providers in the OECD are increasingly offering voice and video services over this platform. The speeds offered by providers are also increasing.

Regarding the services, multiple play offers, which include voice, data and video services, seem to prevail, representing the first stage in a two-part evolution of converged information and communications technology (ICT) service delivery. This first stage has seen video, voice and data services being consolidated on a given infrastructure (e.g. cable networks). The second stage will include consolidation of access platforms on one IP network, allowing users to seamlessly access content while moving over a variety of wired and wireless networks.

According to the OECD (2006a) survey titled “Multiple Play: Pricing and Policy Trends” it appears that the services with higher supply are as follows:

- **Fast Internet:** As it can be extracted by the survey, there is a tendency for higher access speeds. The majority of the providers begin with access speeds of 512 Kbps and there are only few that offer lower speeds. The upper level for the access speeds appears to continuously increase, reaching speeds on the order of 100 Mbps (Japan).
- **Voice:** The majority of the surveyed countries include voice services in their offers. Currently, these services include unlimited calls plans, while VoIP emerges to prevail in this area.
- **Video:** The provision of video content also constitutes one of the basic services provided in the surveyed countries. Video services are usually provided through ADSL and cable networks. To this direction, video on demand and video a la carte are the two most common services of the offers provided.

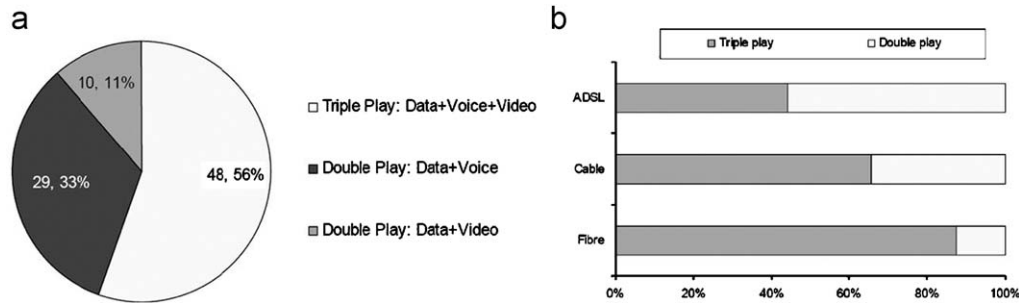


Fig. 3. (a) Multiple play availability among OECD countries, September 2005; (b) multiple play services by technology, September 2005 (Source: OECD).

Fig. 3(a) depicts the availability of different types of multiple play in OECD countries, while Fig. 3(b) depicts the availability of different types (by technology) of multi-play in OECD countries.

3. Factors supporting broadband growth

This section presents the main factors that affect broadband growth. Some of these factors are as follows:

- *The regulatory framework:* The regulatory framework of telecommunications is one of the major factors that can seriously affect broadband growth. In cases where the regulatory framework is insufficient, the telecommunications sector may malfunction.
- The structural changes that take place in the information and communications technology markets (e.g. increase of competition, privatization of public organizations, market liberalization, globalization, etc.).
- The changes of broadband services and of their use (e.g., VoIP, mobile telephony, 3G, WLAN, WiFi, WiMAX, digital television).
- The technological developments (e.g., creation of innovative and interoperable solutions in an IP environment, adoption of IPv6 protocol, creation of optical networks, content digitalization, increment of the computational power of personal computers, etc.).
- The users' need for fast content access. Since the demand for broadband infrastructures is led by the need for content access, the requirements for both broadband services and infrastructures are strongly interrelated.
- *The affordability:* one of the most important economic elements seems to be the income, compared to the cost of a broadband subscription.
- E (electronic)-readiness and in general the technological level of a country. E-readiness constitutes an essential measure of the e-business environment of a country and is defined by a collection of factors that indicate how amenable a market can be to Internet-based opportunities. Some of these factors are: (a) the connectivity and technology infrastructure, (b) the business environment, (c) the consumer and business adoption, (d) the legal, policy, social and cultural environment, etc.

It should be noted that the statistical data presented in this section are for OECD and European countries for the period 2000–2006.

3.1. Regulatory framework

As described in Wallsten (2005), the regulations and policies should focus on removing obstacles to competition (Aron and Burnstein, 2003) and to employ subsidies targeted at encouraging investment mainly in unserved areas (Goolsbee, 2002).

Investigating the regulatory frameworks of various countries (i.e. Ireland, Germany, Australia, United States of America, Portugal, Hungary and Turkey) it can be said that the regulations should support a competitive structure of market along with the existence of bodies that will hold continuous control of competitive structure of market. These bodies should have the authorization to take the necessary measures when needed. It seems that countries that have good conditions (e.g. economically developed countries, technologically advanced countries) for a quick broadband uptake such as Ireland, US and Germany did not present the predictable broadband growth (e.g. US and Germany) or satisfactory broadband penetration rate (e.g. Ireland) due to insufficient regulatory telecommunications framework (e.g. Germany), problems in the application of regulations because of appeals (e.g. Ireland) or bad application of regulations (e.g. US).

Furthermore, the regulatory framework should include the determination of effective process of appeals in order to avoid legal uncertainty with regard to National Regulatory Authorities (NRA) decisions, which discourages the investors in the telecommunication market. Examples of such cases constitute Germany and Ireland.

In addition, it seems that in cases where the market is not competitive enough, the NRAs should be able to impose penalties (p h. fines) that would be really avertive for incumbent operators.

In European Union (EU), the EU member states that correctly applied the EU regulatory framework for the electronic communications sector presented better broadband growth than others that do not. Examples of such cases constitute Ireland, Portugal and Hungary (Fig. 4).

Moreover, the independence of NRAs should be ensured, avoiding political interventions in the regulatory framework. For example, Germany presented important problems from the political intervention in the regulating environment. Reding (2007) said that greater consistency in regulatory approaches will trigger cross-border competition and therefore help European countries to move to a situation where the telecom sector is essentially left to market forces, subject to control only of competition law.

Finally, the correlation coefficient² among the broadband penetration presented in Fig. 1 and the ECTA Regulatory Scorecard (Fig. 4) is 0.56. This fact denotes a strong correlation among broadband penetration and the regulatory framework.

3.2. Financial, social and geopolitical factors

This paragraph presents briefly the relation between the broadband growth and financial, social and geopolitical factors.

² It should be noted that the correlation coefficient of two lists of values (in this case the regulatory scorecard and the broadband penetration) determines the relationship between the two properties. Although no causality can be implied among these properties, it is an indication about their relationship.

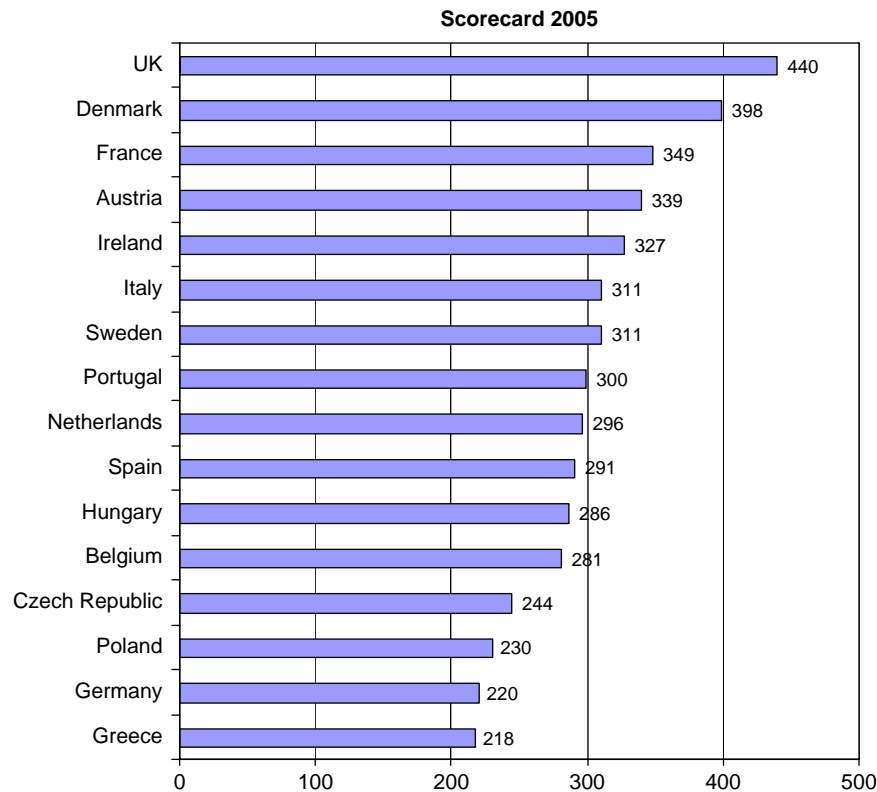


Fig. 4. ECTA Regulatory Scorecard (2005a, b) (Source: ECTA).

These factors, such as the gross domestic product (GDP), the GDP distribution in primary, secondary and tertiary sector and the GDP per capita, could be general for a country. Other elements could be special for a citizen such as the education level, the familial situation, the place of stay, etc.

Summarizing data for the general elements (GDP and the distribution of GDP in primary, secondary and tertiary sector), but also the special elements for broadband users, important conclusions can be extracted.

In particular, it seems that there is a cross-correlation between GDP per capita and broadband penetration. On the one hand, countries with high GDP per capita (such as Finland, Denmark and USA) present high broadband penetration. On the other hand, countries with low GDP (such as Greece, Turkey and Hungary) present low broadband penetration. However, there is no one-to-one equivalence, as there are countries with very high GDP per capita (such as Ireland) that do not present very high broadband penetrations. There are also differentiations in countries with almost the same GDP per capita (such as Greece and Portugal) that have different broadband penetration. These differentiations are mainly owed in the purchasing power that differs from country to country, in the cost of broadband subscription and in the different broadband strategies of each country. These conclusions are confirmed by the data presented in Fig. 5 that show the simple correlation ($= 0.596$) between the broadband penetration and GDP per capita in the OECD countries.

Finally, the correlation coefficient between broadband penetration (in December 2005) and the monthly DSL access cost in OECD member states (for speeds of at least 512 Kbps and free data of at least 1 Gbyte, November 2004) is about -0.507 (Fig. 6). This fact denotes that there is a strong relation between broadband access cost and broadband penetration. It also denotes that the cheaper the broadband access, the higher the broadband penetration.

Thus, we understand that affordability is an important determinant. This result is also supported by Flamm and Chaudhuri (2007). In order to compare the affordability of various countries, we define annual affordability as the product of:^{3,4}

[the amount of Kbps that can buy a user with 1 USD]*[the GDP per capita]

This amount is normalized in PPP so it can be used for comparisons among various countries.

Moreover, based on EUROSTAT's data, it appears that the broadband and Internet use by domestic users is differentiated depending on the educative level, the familial situation, the age, the place of stay, the economic situation and the work type. On the contrary, sex does not appear to play some role.

More particularly, the households with children allocate in bigger percentage broadband connection than the households that do not have children. Still, the young persons and, more general, the persons among 24–54 years old constitute the majority of Internet users.

Moreover, the higher educative level implies higher Internet use. Concerning the type of work, we can say that the majority of students are Internet users, followed by workers and finally the unemployed.

These statements are supported by the findings of Chaudhuri and Flamm (2005), who said “there is a strong correlation between race, age, levels of income and education and access decision”. According to them the “digital divide” is correlated with these factors, and that the poor, the less educated and non-whites are on the disconnected side of the divide.

Flamm (2005) finds that geographic terrain, income and population density are important determinants of broadband

³ United States Dollars, calculated in PPP.

⁴ In USD calculated in PPP.

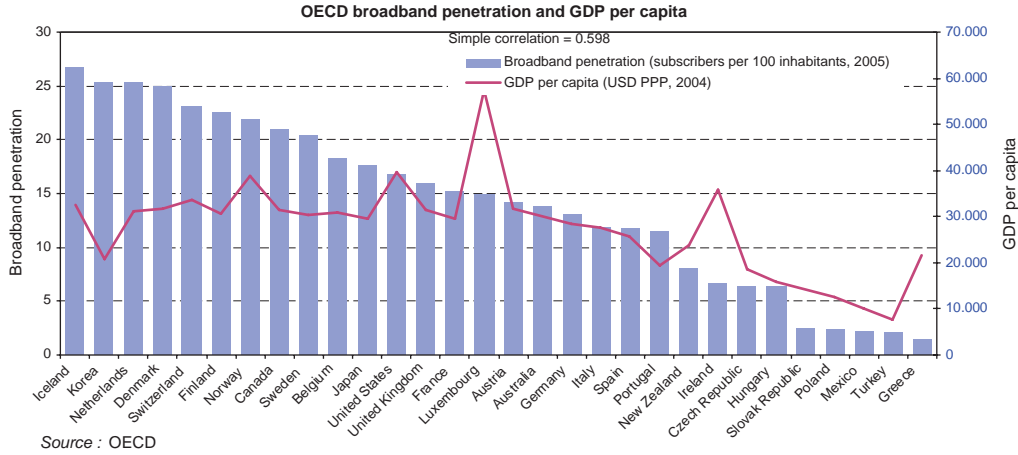


Fig. 5. OECD broadband penetration and GDP per capita (Source: OECD, 2006b).

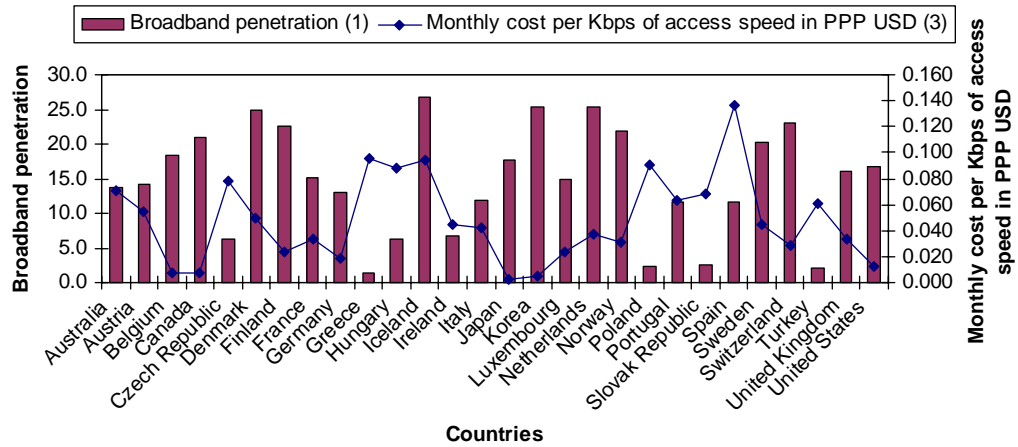


Fig. 6. Broadband penetration and monthly cost per Kbps of access speed in PPP USD.

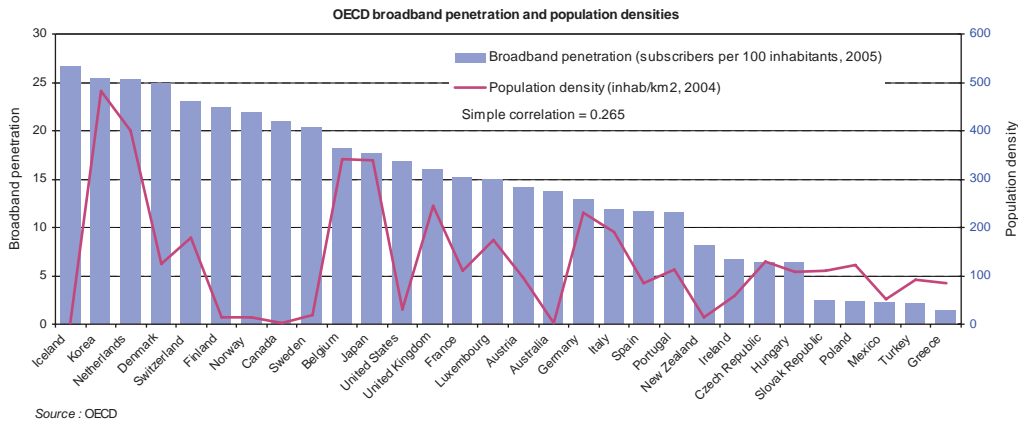


Fig. 7. OECD broadband penetration and population densities.

penetration. Furthermore, concerning the population density in an area, we can say that regions with low population density have smaller broadband penetration compared with semi-urban and urban regions. However, according to Fig. 7, we can say that there is no strong correlation between population density and broadband penetration in a country.

Moreover, even if the geographic terrain, population density, race, gender, education and age are important determinants of broadband penetration (Choudrie and Dwivedi, 2006) in an area, we propose to now take them into account when we are searching

for best practices worldwide. The reason is that all these factors are characteristics of a country but not results of a practice/policy of a country.

3.3. Technological level

Concerning the technological level of a country in ICT, some of the main factors that should be measured are as follows: (a) the connectivity and technology infrastructure, (b) the business

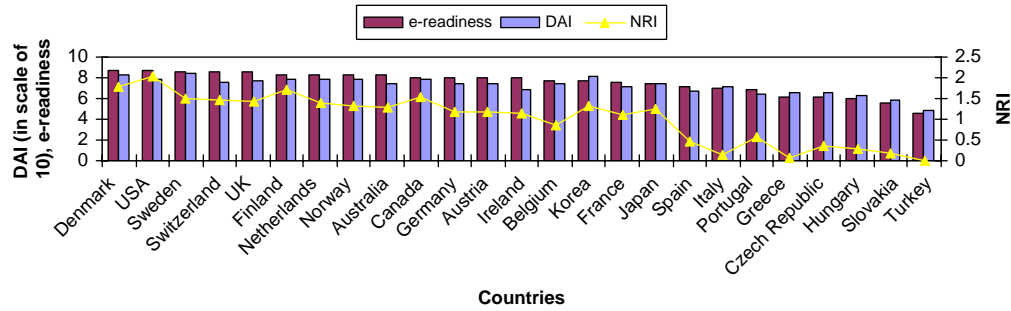


Fig. 8. Indices DAI, e-readiness and NRI.

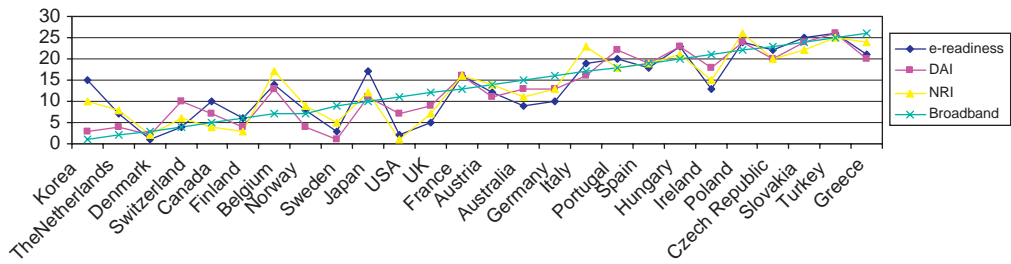


Fig. 9. Simple correlation of the countries ranks concerning broadband penetration and the indices DAI, e-readiness and NRI.

environment, (c) the consumer and business adoption, (d) the legal, policy, social and cultural environment, etc. The main indices that take into account the above factors and have been investigated are the following:

- International Telecommunication Union’s (ITU) Digital Access Index (DAI),
- Networked Readiness Index of World Economic Forum,
- E-readiness ranking of Economist Intelligence Unit.

Fig. 8 presents the ranking of some countries’ concerning these indices.

Furthermore, Fig. 9 presents the simple correlation of 26 countries rank concerning broadband penetration and the indices DAI, e-readiness and NRI.

It seems that there is a strong correlation between these indices and broadband penetration for many countries. For example, Greece is at the last rank (26th) concerning broadband penetration and it is also in the last places of classification of indices DAI (20th rank), e-readiness (21st rank) and NRI (24th rank).

Furthermore, it can be noticed that Internet penetration is an important factor that affects broadband penetration. Based on data presented in Fig. 1, it can be calculated that the correlation coefficient between broadband penetration and Internet penetration is about 0.83. This means that countries with low Internet use have low probability to present a high broadband penetration growth.

4. Definition of best and good practice index

Based on the factors presented in the previous section, this section aims at quantifying the above factors and defining two new indices: (a) the best practice index, which indicates that a country followed some of the best practices worldwide for supporting its broadband growth and (b) the good practice index, which, accordingly, indicates that a country followed some of the

good practices worldwide for supporting its broadband growth. In this section the criteria, their sources and the indices are presented.

4.1. Criteria

The first step of the methodology is to select the main criteria that could be used for defining the above indices. Based on the discussion in previous sections (i.e. Sections 2 and 3), these criteria are as follows:

- *The affordability of a user to buy broadband expressed by the Kbps per United States Dollars (USD, calculated in PPP) times the GDP per capita:* We refer to this criterion as “A”. This criterion has been presented in more detail in Section 3.1.
- *Annual average growth rates of Gross Domestic Product (GDP) per hour worked:* This criterion is referred as “B”. This criterion has been adopted because the growth of GDP could affect the affordability of the users in a country.
- *The Economist Intelligence Unit’s e-readiness rankings:* This criterion is referred as “C”. This criterion has been adopted in order to express the technological level of each country. The e-readiness rankings are a weighted collection of nearly 100 quantitative and qualitative criteria, organised into six distinct categories measuring the various components of a country’s social, political, economic and of course technological development. The underlying principal behind the rankings is that digital business is at its heart business, and that for digital transactions to be widely adopted and efficient, they have to thrive in a holistically supportive environment. E-readiness is not simply a matter of the number of computer servers, websites and mobile phones in the country, but also such things as its citizens’ ability to utilise technology skillfully, the transparency of its business and legal systems, and the extent to which governments encourage the use of digital technologies. As discussed in Section 3.3 before, E-readiness has a strong correlation between these indices and broadband penetration.

- *The broadband penetration growth rate:* We refer to this criterion as “D”. This criterion could be regarded as the main indication concerning the probability of a country to present high broadband penetration in future or not.
- *Broadband subscribers per 100 inhabitants:* This criterion is defined as “E”. This criterion has been adopted in order to express the current state of a country concerning broadband penetration.
- *Internet subscribers per 100 inhabitants:* This criterion is referred as “F”. Internet subscribers are implicitly broadband subscribers. For that reason this criterion has been adopted.
- *The Internet penetration growth rate:* This criterion is called “G”. This criterion could be regarded as the main indication concerning the probability of a country to present high Internet penetration in future or not.
- *The investment in information and communication technologies:* This criterion is the percentage of non-residential gross fixed capital formation, total economy and is referred as “H”. This criterion has been adopted in order to express the possibility of a country to improve its technological level.
- *The level of competition in telecommunications sector:* This criterion is called “I”. This criterion has been adopted in order to express the possibility of the broadband market in a country to present lower broadband access prices and thus to increase the affordability of the potential users.

We can categorize the above criteria into three basic categories. The first category contains technological criteria such as D, E, F and G. The second category contains financial criteria such as A, H and I. Finally, the third category contains social criteria such as B and C.

4.2. Data sources

To quantify the above criteria the sources used for each criterion are presented. (It should be noted that data for all the above criteria were available for the following countries: Australia, Austria, Belgium, France, Germany, Denmark, Greece, US, Japan, Ireland, Spain, Italy, Canada, Republic of Korea, United Kingdom, New Zealand, Norway, The Netherlands, Portugal, Sweden and Finland.)

- *Criterion A:* The data for the cost concern Internet access by DSL in OECD member countries, including tax, in November 2004 (apart from The Netherlands, Belgium, United Kingdom, Austria, Germany, Portugal, Ireland and New Zealand, for which the available data apply for 2002) (OECD, 2005a). The affordability was calculated as:

$$\text{GDP per capita} \times \left[\frac{\text{Monthly cost(USD PPP)}}{\text{Speed of connection downstream(kbit/s)}} \right]$$

- *Criterion B:* The data concern the annual average growth rates during 2000–2004 and are based on GDP per hour worked. These data have been drawn from the OECD productivity database.
- *Criterion C:* These data concern the 2005 e-readiness score and they were drawn from the report “The 2005 e-readiness rankings, a white paper from the Economist Intelligence Unit” (E-readiness, 2005).
- *Criterion D:* The data concern the broadband penetration growth rate during 2002–2005 and are based on OECD (2005b).
- *Criterion E:* The data concern the broadband penetration at June 2005 and are based on OECD (2005c).
- *Criterion F:* The data concern the Internet penetration at June 2005 and are based on Internet World Stats (2006).
- *Criterion G:* The data concern the Internet penetration growth rate during 2000–2005 and are based on Internet World Stats (2006).
- *Criterion H:* The data concern the ICT investment by asset in OECD countries, 2003 (2002 for Australia, France, Japan, New Zealand, Norway and Spain; 2001 for Italy) and present the percentage of non-residential gross fixed capital formation in the total economy. ICT equipment is defined here as computer and office equipment and communication equipment; Software includes both purchased and own account software. Software investment in Japan is likely to be underestimated, due to methodological differences.
- *Criterion I:* The data used for the level of competition in telecommunications sectors were drawn from ITU World Telecommunication Regulatory Database (<http://www.itu.int>). The level of competition in each country has been calculated as the average of the level of competition in each sector.

The sectors are as follows: Local services, Domestic long distance, International long distance, Wireless local loop, Data, DSL, Cable modem, VSAT, Leased lines, Fixed Wireless Broadband, Mobile, Paging, Cable TV, Fixed sat, Mobile satellite, GMPCS, IMT 2000, Internet services and International gateways.

The level of competition in each sector is denoted as follows:

- 0, in case of monopoly;
- 1, in case of duopoly;
- 2, in case of partial competition;
- 3, in case of full competition.

From the above, we obtain Fig. 10.

At this point it should be mentioned that the methodology proposed can be applied to any series of data that provide accurate values for the above-mentioned criteria, providing in all cases relevant and accurate results.

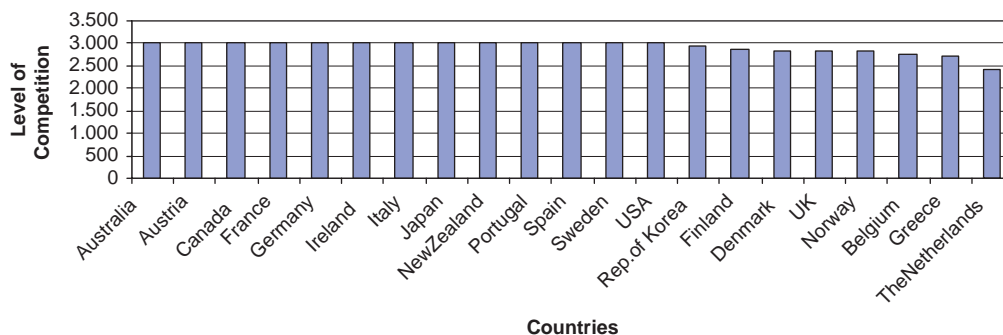


Fig. 10. Level of competition in telecommunications.

- The rest of the columns in Table 1 present the results of Eq. (1) listing as B or G the countries that could be regarded as best or good practices, respectively.
- The second column of Table 1 presents the results of Eq. (1) by having $W_A = W_B = W_C = W_E = W_F = W_H = W_I = 1$.
- Columns 3–7 of Table 1 present the results of Eq. (1) by changing W_A from 2 to 6 and keeping $W_B = W_C = W_E = W_F = W_H = W_I = 1$.
- Columns 8–12 of Table 1 present the results of Eq. (1) by changing W_B from 2 to 6 and keeping $W_A = W_C = W_E = W_F = W_H = W_I = 1$.
- Columns 13–17 of Table 1 present the results of Eq. (1) by changing W_C from 2 to 6 and keeping $W_A = W_B = W_E = W_F = W_H = W_I = 1$.
- Columns 18–22 of Table 1 present the results of Eq. (1) by changing W_E from 2 to 6 and keeping $W_A = W_B = W_C = W_F = W_H = W_I = 1$.
- Columns 23–27 of Table 1 present the results of Eq. (1) by changing W_F from 2 to 6 and keeping $W_A = W_B = W_C = W_E = W_H = W_I = 1$.
- Columns 28–32 of Table 1 present the results of Eq. (1) by changing W_H from 2 to 6 and keeping $W_A = W_B = W_C = W_E = W_F = W_I = 1$.
- Columns 33–37 of Table 1 present the results of Eq. (1) by changing W_I from 2 to 6 and keeping $W_A = W_B = W_C = W_E = W_F = W_H = 1$.
- The last column of Table 1 presents how many times (in percentage) each country has been calculated as good or best practice.
- The last row of Table 1 presents how many times (in percentage) each weight has contributed to the calculation of a country as good or best practice.

4.4.2. Step 3

Concerning the data presented in Table 1, we can make the following observations:

- *Observation 1:* Based on the last column of Table 1, some countries are almost always calculated as good or best practice. These countries are Korea, UK and USA.
- *Observation 2:* Sweden (by 56%), the Netherlands (by 39%), Japan (by 36%), Finland (by 36%) and Canada (by 33%) are the countries that are most frequently calculated as good or best practices.
- *Observation 3:* Some countries are calculated as best (or good) practices only when a specific weight is altered. The most significant case concerns France, Greece and Ireland during the alteration of W_B . In this case, we can say that Eq. (1) is conversely affected by factor B , due to the fact that the increment of the weight of this factor creates reverse results.
- *Observation 4:* Based on the data presented in the last row of Table 1, factor (E) affects the calculation of 35% (in average) of countries as best (or good) practices. The factors (A) , (C) , (F) , (H) have affected the calculation of the 23–29% (in average) of countries as best (or good) practices. Factor (I) has affected the calculation of the 14% (in average) of countries as best (or good) practices.

Based on the above observations, we propose to consider factor E (that is the broadband penetration) to have high importance. This is quite logical as it is considered as the most indicative factor for the calculation of the best practices for broadband growth. Therefore, we multiply this factor by 3 ($W_E = 3$).

Furthermore, factors A , C , F and H could be considered to have equal (among them) importance to broadband penetration

growth. However and based on observation 4, we consider that these indicators have lower importance than indicator E and higher than indicator I . Therefore, $W_A = W_C = W_F = W_H = 2$ and $W_{EI} = 1$.

Based on observation 3, indicator B has lower importance than factors A , C , F and H . This is quite logical as it is considered as a dependent factor and therefore it is assigned with weight 1 ($W_B = 3$).

Thus Eq. (1) could be changed to

$$\text{Score} = 2(A) + (B) + 2(C) + 3(E) + 2(F) + 2(H) + (I) \tag{5}$$

In the rest of the paper we will calculate both BPI and GPI based on Eq. (5).

5. Best practice analysis

This section presents the results of the calculation of best practices and discusses them.

5.1. Calculation of best practices

Based on Eqs. (2), (4) and (5), we calculated the Score for each country.

The average score is 78. Table 2 presents the following information for each country:

- The normalized values for each criterion [i.e. (A) , (\hat{A}) , (\hat{A}) , (C) , (E) , (F) , (H) and (I)].
- The Score.
- The Result, (i.e. “Best Practice” or “Good Practice”).

According to the data presented in Table 2, the practices of the following countries raised as best practices (in bold):

- Denmark
- United States
- Japan
- Canada
- Republic of Korea
- Sweden

Table 2 Best practices results.

Country	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	Score	Result
Korea	4	10	9	0	10	9	2	5	10	102	Best Practice
USA	2	6	10	1	6	9	4	10	10	98	Best Practice
Japan	10	5	8	1	6	8	2	4	10	93	Best Practice
Canada	3	4	9	0	8	9	3	6	10	92	Best Practice
Denmark	1	4	10	1	9	9	3	6	9	92	Best Practice
Sweden	0	6	10	1	6	10	2	8	10	90	Best Practice
Finland	0	6	10	2	7	8	2	8	10	89	
Netherlands	1	2	9	2	9	9	6	5	8	85	Good Practice
Belgium	3	4	9	1	7	6	5	6	9	82	
Norway	1	6	9	2	7	9	1	4	9	82	
UK	1	6	10	4	5	8	5	7	9	82	Good Practice
Austria	1	4	9	1	5	9	4	4	10	75	
Australia	0	5	9	4	4	7	4	7	10	73	
Germany	1	4	9	1	4	8	4	5	10	72	
France	1	6	9	3	5	6	7	4	10	71	
Ireland	1	10	9	10	2	7	6	2	10	64	
Portugal	0	2	8	2	4	8	5	4	10	64	
Italy	1	1	8	4	4	6	4	5	10	63	
Spain	0	3	8	2	4	5	8	4	10	59	
N. Zealand	0	3	4	2	3	10	10	4	10	58	
Greece	0	10	7	5	0	4	10	3	9	47	

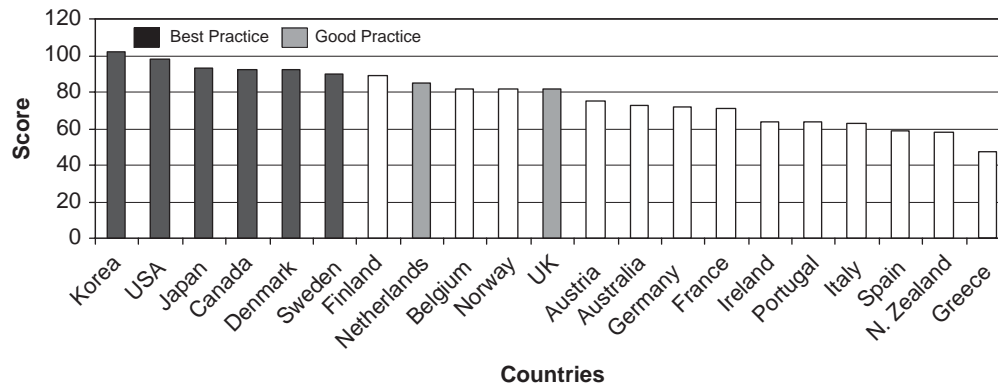


Fig. 11. Best practices ranking.

Furthermore, the practices of United Kingdom and the Netherlands came up as good practices (in italics).

The higher Score is achieved by Republic of Korea, while the lower Score is achieved by Greece (Fig. 11).

A considerable result is that Norway, Belgium and Finland are not presented either as best practices or as good practices, although their score is higher than the average score (89, 82 and 82, respectively).

However, this can be explained by the value of indicators *D* and *G* for these countries, which indicate that they presented small broadband and Internet presentation growth rates. In other words, we can say that there is a maturation concerning broadband growth in these countries. Therefore, these countries are not considered as best practices.

Comparing the results of Table 2 with ECTA Regulatory Scorecard (2005a,b) (Fig. 4), there is a relation between the effectiveness of the telecommunication regulation frameworks and the Score in Table 2. For example, the practices of Denmark and UK, which constitute best and good practices, respectively, present a high score in the Regulatory Scorecard 2005 as well.

Moreover, Germany and Greece and both appear with low scores in Table 2 (85 and 56, respectively), and also present low scores (220 and 218, respectively) in the Regulatory Scorecard 2005.

5.2. Discussion

Investigating the broadband strategies in the above countries (Denmark, Sweden, United States, Japan, Canada, Korea, United Kingdom and the Netherlands) and analyzing them, basic results can be extracted for the policies and practices that could be followed by a country to increase its broadband growth.

The governments of the above countries articulated a vision of what ICT could do for both public and private sectors' beneficiaries. Furthermore, the policies and strategies adopted by these countries for supporting broadband growth aimed at the following:

- *The improvement of users' dexterities in ICT*: United Kingdom, Republic of Korea and Japan adopted this action for supporting broadband growth. For example, in Republic of Korea the government has provided computer literacy training and education aimed at elementary and middle schools, housewives, the military and the disabled. A major Korean initiative in this area has been the three-year "10 Million People IT Education project", which was launched in mid-2000. A similar action in Japan is "IT Human Resource Development Plan".
- *The Internet penetration growth*: Most of the countries aim at the growth of Internet use, mainly in rural areas. For example, the Community Access Program (CAP) in Canada aims at

establishing free Internet access points in schools, hospitals and other public centres.

- *Tax exemptions/loans*: Many countries include in their policies and strategies, tax exemptions for enterprises or citizens who want to use ICT. Examples are Korea, Denmark and United States. In US, the largest Federal program supporting broadband development in rural and remote areas is the Federal Rural Broadband Access Loan and loan Guarantees Program where 1.4 billion US \$ loans and loan guarantees have been made available on Federal level to provide broadband services in rural areas. Denmark has introduced a special taxation scheme, which enables employers to offer PCs as well as broadband connections to their employees as a tax-free benefit. Considering the high levels of income taxes in Denmark, this implies that tax reductions in reality pay more than 50% of the costs. This scheme has become very popular and many companies provide this opportunity to all of their employees as part of their salary.
- *Development of broadband infrastructures and coverage of rural areas*: Almost all countries aim at the development of broadband infrastructures either for increasing the broadband supply in general or for creating new infrastructures in rural and underserved areas. For example, in Canada one of the most important initiatives is the Broadband for Rural and Northern Development Pilot (BRAND) Program, which aim at connecting underserved areas and unconnected communities.
- *Development broadband services*: Many countries aim at the development of broadband services for supporting e-health, e-government and electronic public services in general. Furthermore, some countries aim at the increment of use of e-services in the public sector. For example, in UK the Government together with industry plans to sponsor a "Digital Challenge" prize for a local authority and its partners – both public and private – to establish by 2008 universal access, advance public service delivery and provide a test-bed for best practice in e-government.
- *Improvement of the security of broadband connection/services*: Some of the above countries (i.e. UK and Japan) aim at improving the security on broadband connection/services. The UK's digital strategy aims at making the "UK the safest place to use the Internet".
- *Revision of the regulatory framework*: Almost all countries include regulation measures in their broadband strategies. The main reason is to support the competition. The best practice in this area has been adopted by UK, which presents the highest score in ECTA Regulatory Scorecard (2005a,b) (Fig. 4). The regulatory strategy in UK is set out by Ofcom, which has a duty to ensure that a wide range of electronic communications services –including high-speed data services – are available

throughout the UK. Ofcom has indicated that by the end of 2007/8, its “aim is to have encouraged the development of an environment in which there is much more competition and innovation in broadband networks and services”.

- *Broadband content development and digitization:* Almost all countries include broadband content development and digitization regulation measures in their broadband strategies. For example, in UK the Government aims at allowing people to use or reach any content, with any device, anywhere, anytime. According to the UK Government, content, whether as a business tool, for entertainment, a community portal, e-learning or generated by consumers themselves, is the key to driving up the effective use of ICT. Through the DTI's Technology Programme, the UK Government is already providing funding to encourage innovation and research in developing broadband content.
- *Supporting of synergies between private–public sectors:* Almost all countries support the synergies of private–public sector for increasing broadband growth and to create or exploit broadband infrastructures. For example, the Dutch Government takes the view that municipal and provincial authorities and housing corporations can play an important and useful role in the development of broadband, in partnership with market parties. Also in Japan, the Government emphasized that the private sector had to be the driving force, with the government limited to establishing the right framework for the private sector and to the non-private sectors (e-government, R&D and overcoming the digital divide). In spite of this, the central Japanese government, actually, supports roll-out of broadband facilities by offering attractive financing schemes, tax incentives and guarantee of liabilities.
- *Financing of research projects:* Many countries (such as UK and the Netherlands) provide funding to encourage innovation and research in developing broadband. As already referred, the UK Government is providing funding for developing broadband content. Also in Netherland “Kenniswijk” and “Broadband in Four Social Sectors” are the most funded projects (€9 000 000 and €2 400 000, respectively).
- *Bridging the Digital Divide:* Some countries (such as UK, Korea and Canada) aim at providing access to underserved areas and people with disabilities in order to close the digital divide. For example, in UK one of the main actions in UK's digital strategy is to “improve accessibility to technology for the digitally excluded and ease of use for the disabled.” One of the measures is the building of UK online centres. Furthermore, in Korea the Korean Digital Divide Act was established in 2001 and revised in 2002 (BREAD, 2005). It generated the five-year master plan for closing the digital divide, annual action plans, the “Digital Divide Closing Committee,” and launched the Korean Agency for Digital Opportunity and Promotion (KADO). The 2004 annual action plan consisted of constructing high-speed information network in rural areas, supporting assistive technologies for disabled people, constructing 80 Internet access centres, recycling of PCs and Digital TVs to disabled and non-profit organizations and providing IT education. KADO also developed content for disabled and the elderly, and engaged in international projects that aimed at closing the digital divide. Korean policies also included 30–50% discounts in telecommunication service charges to low-income and disabled users.

6. Conclusion

This paper presented a methodology for locating the countries that followed best practices for increasing their broadband

growth. According to this methodology the paper showed that Denmark, United States, Japan, Canada and Republic of Korea followed best practices for their broadband growth. Furthermore, it appears that United Kingdom and the Netherlands followed best practices for their broadband growth. Investigating the broadband strategies in the above countries and analyzing them, the main result is that the governments of the above countries articulated a vision of what ICT could do for both public and private sectors' beneficiaries. Furthermore, the policies and strategies adopted by these countries targeted at (1) the improvement of users' dexterities in ICT; (2) supporting the Internet penetration growth; (3) supporting the ICT use by tax exemptions and loans; (4) the development of broadband infrastructures and coverage of rural areas; (5) the development broadband services; (6) the revision of the regulatory framework; (7) the support of synergies between private–public sector; (8) the funding of research projects; (9) the bridging of the Digital Divide; (10) the improvement of the security of broadband connection/services; (11) the uptake of regulation measure and (12) the development of broadband content.

These results are in line with Frieden (2005). In particular, the cooperation of the private and public sector is of critical importance for the ICT development, where both types of sectors undertake roles that maximize the benefits. Nations achieving comparatively greater success in ICT development demonstrate the value in having a specific mission, achievable goals and policies designed to achieve success. The lessons learned by these countries could be followed by other countries with low broadband penetration or they could be used as a guide by the countries with low score in best practice index, such as Greece (Alexiou et al., 2005).

Our next step is to verify our methodology, based on the new data concerning the factors presented in this paper.

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