

**REGULATORY REFORM AS A TOOL FOR BRIDGING THE
DIGITAL DIVIDE**



ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

FOREWORD

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REGULATORY REFORM AS A TOOL FOR BRIDGING THE DIGITAL DIVIDE

Abstract

The digital divide touches all regions and economies of the world and threatens to slow progress towards the goal of an all-inclusive information society. Policy makers are faced with the divide's daunting complexity but have a range of policy tools that have proven effective in expanding access throughout the world. Of these tools, regulatory reform has had perhaps the largest impact in both developed and developing economies alike.

The severity of the digital divide in OECD countries is much less than in other parts of the world, due partially to higher income levels, but also as a result of important regulatory reforms initiated over the past several decades. These reforms have paved the way for competitive markets to develop and flourish with minimal intervention.

Regulatory reform can play a key role in non-OECD economies. Policy makers in developing economies should consider the regulatory reforms that have proven the most successful in the OECD, namely liberalizing telecommunication markets, creating a separate telecommunications regulator, opening spectrum for new wireless technologies and promoting the development of human ICT capacity.

As regulatory reforms take effect, telecommunication markets become more efficient and social and economic welfare are enhanced for all stakeholders in an economy via positive externalities. Telecommunications infrastructure can play a key role in economic development, which can create a virtuous cycle where incomes improve and access increases. Telecommunication technologies have also played an important role in enhancing total factor productivity in OECD economies and in employment growth.

As recent events have shown, telecommunication networks can also play a key public safety role in an economy, especially as a tool for disaster warning and recovery efforts. Economies with under-developed telecommunication markets and networks may face higher risks in the face of future catastrophes than economies with extensive networks and public safety systems in place. As a result, this paper includes a section on the need to examine the role of regulatory reform of emergency telecommunication services as a cost-effective and essential way to ensure the optimum contribution of ICTs to disaster warning and recovery.

This paper examines one narrow aspect of the digital divide, the effects of regulatory reform on telecommunication networks. While regulatory reform is only one part of the global digital divide problem, it can play a key role in helping telecommunication markets bridge some of the gaps on their own. It is therefore imperative that policy makers consider regulatory reform as a necessary but not sufficient step towards overcoming the digital divide.

Introduction

The digital divide is an important problem that policy makers face and it is much more complex than simply building out telecommunication networks and infrastructure. The divide is the result of a wide range of social factors, including but not limited to income, education and literacy. Telecommunication infrastructure alone will not guarantee that users will be able to access and take advantage of services on the network.

In many developing economies, low literacy rates decrease the utility of a number of Internet services available to users. The lack of software and instructions in minority languages also presents a huge barrier to ICT adoption in many parts of the world. However, one of the main hindrances to ICT adoption is simply income. For many, the cost of owning a mobile handset or even making a phone call is prohibitive. Therefore, policy discussions of digital divide policy must consider social, technical and economic factors.

Because of the digital divide's complex nature, researchers often must evaluate narrow aspects of the divide and make corresponding policy suggestions. This is not to imply that other aspects of the digital divide are not important or that the digital divide can be solved with individual, narrow remedies. Rather it reflects the need for a multi-disciplinary approach to ensuring equal access to ICTs.

This paper will focus on one element that can help improve access to telecommunications in all the world's economies, regulatory reform¹. While an economy's regulatory regime is only one aspect of the overall digital divide, proper implementation of key policies can effectively help expand networks, reduce prices, improve quality of service and increase user access. Telecommunication markets in many economies have grown and flourished under private sector control as long as certain regulatory elements were in place. This paper will examine the elements that have been the most successful throughout the OECD and look at ways in which they can be applied and adopted in developing economies as a way to expand access to telecommunications².

The paper will begin with a brief introduction to the digital divide, followed by key regulatory reforms that have laid the foundation for successful markets in the OECD. The paper will then highlight several non-OECD economies where regulatory reform has been successful and briefly examine how human capital investments can have long-term benefits for ICT adoption. Finally, the paper will conclude with an overview of the regulatory aspects of emergency warning and recovery.

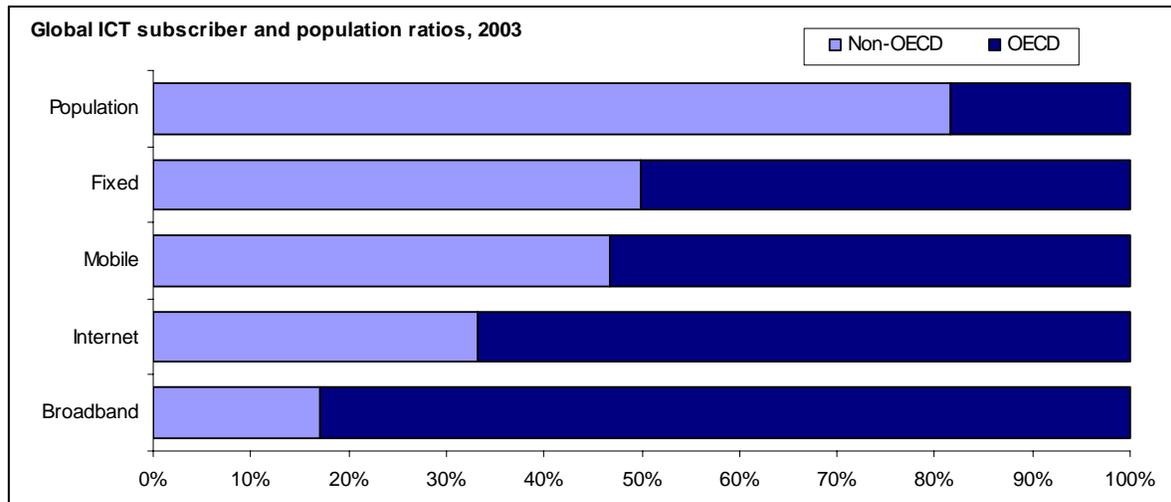
The scope of the digital divide

Telecommunication markets and regulatory policies in OECD countries have been particularly successful at extending access to rural and remote regions. While the digital divides in developing economies are often much more pronounced than those faced in the OECD, the fundamental problem remains the same: extending access to all in a society and all geographic areas. Elements from OECD country experiences can be extracted and applied in developing economies as a first step towards improving access. Policy makers in developing economies should consider the policy tools which have shown the most success throughout the OECD³, namely liberalizing telecommunication markets, developing a sound regulatory framework and fostering of effective competition among telecommunication providers⁴.

As mentioned earlier, the digital divide is a multifaceted problem, forcing policy makers to develop a multi-level approach to bridging it. Some of the problems include a dearth of physical infrastructure and telecommunication investment, difficult topography, low population densities, a lack of both general and ICT-specific skills, regulatory uncertainty and a lack of efficient market structures, institutions and competition. The situation has become much more pronounced for many developing economies, as

settlement payments from international voice calls have fallen, decreasing the availability of hard currency for network investments. Technologies such as Voice over IP (VoIP) offer benefits to users, but also reduce revenues for traditional fixed-line operators who may be responsible for providing access.

Figure 1. Figure 1. Global ICT subscriber and population ratios (OECD and Non-OECD)



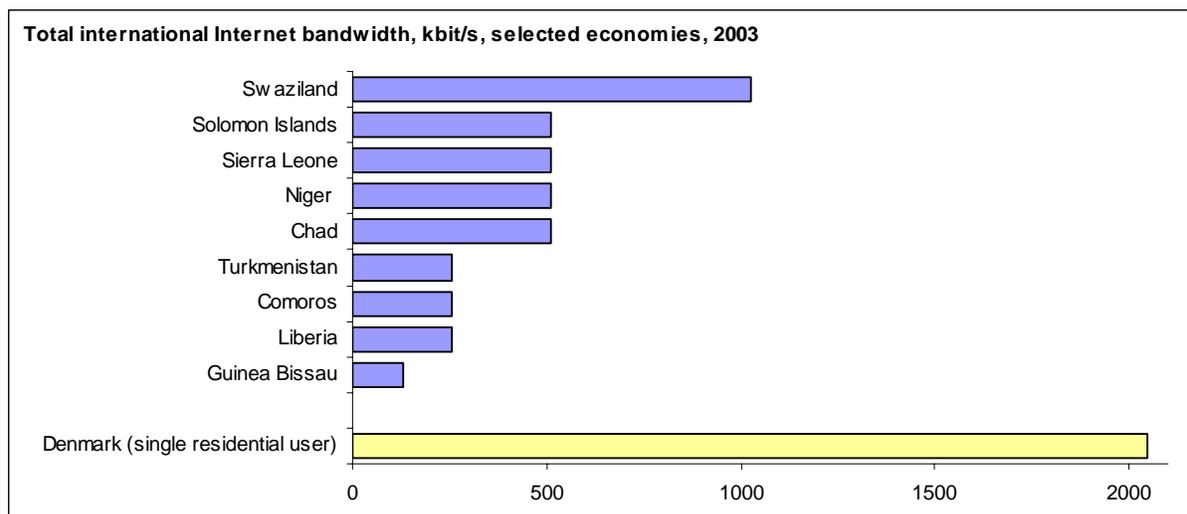
Source: ITU World Telecommunication Indicators Database.

Policy makers have been concerned about access inequalities since the introduction of telephone service more than 100 years ago. In the 1990's, the focus started shifting from providing access to voice services over fixed lines to dial-up Internet access. In 1995, 1998 and 2000, the United States Department of Commerce released its *Falling through the Net* reports that examined unequal access between rural and urban areas, race, education level, gender and age. In 2000, the OECD released *Understanding the Digital Divide*, which examined the unequal distribution of access throughout OECD countries. These reports, and many others from the same period, focused on Internet access at speeds of 14.4 to 56 kbit/s. Only a few years later, those previously characterised as “haves” as dial-up users would be considered “have nots” for the emerging broadband divide.

The digital divide has narrowed according to several measures of access around the world, although the divide varies significantly by technology (see Figure 1). OECD member countries account for only 18% of the world population but a majority of the world's fixed, mobile, Internet and broadband subscribers. Non-OECD countries have made significant gains in fixed telephony, accounting for just fewer than 50% of the world's fixed lines. The penetration of mobile telephony is also expanding quickly outside the OECD, in part due to calling-party-pays billing and pre-paid mobile minutes. Non-OECD countries make up 46% of the world's total mobile subscribers.

The gains made throughout non-OECD countries in Internet and broadband are impressive but there remains much room for increased growth. Internet subscribers in non-OECD countries accounted for only one-third of the world's Internet subscriber base in 2003. The subset of broadband subscribers shows an even greater disparity. Only 17% of the world's broadband subscribers were from outside the OECD in 2003. The significant progress among non-OECD countries in fixed and mobile telephony has taken time so as new technologies emerge, especially in OECD countries, there may be more pronounced gaps between OECD and non-OECD countries.

Figure 2. Figure 2. Total international Internet bandwidth in developing economies



Source: ITU World Telecommunication Indicators Database, *ITU Internet Reports: The Portable Internet*.

The digital divide has been most pronounced in the lowest income areas of the world. Often, the lack of basic network infrastructure significantly hampers the adoption of new end-user technologies. Internet technologies, which often require an expensive outside connection from the country to the world, have been particularly slow to reach users in low-income economies. As an example, the total population of Liberia must share an international Internet connection of just 256 kbit/s, the equivalent of just one baseline residential broadband connection in the OECD. Other developing economies face similar bandwidth constraints. A single 100 Mbit/s broadband user in a leading broadband country such as Japan has access to as much international connectivity as the 45 countries with the lowest international connectivity combined⁵. Figure 2 compares the total international Internet bandwidth available in several developing economies with broadband speeds available to a single residential user in another leading broadband country, Denmark.

The problem is particularly acute in many developing economies with low Internet connectivity and little local content available to domestic users. International bandwidth demands will remain high until Internet content and services are available on servers in domestic markets. The rollout of new Internet exchanges in developing economies has helped keep some data exchange local and lowered the international bandwidth costs. In Egypt for example, investments in Internet exchange points have typically had a return on investment of six months⁶. Operators have reported that the maintenance costs are negligible compared to the dramatic cost savings of keeping Internet data exchange local.

Local content and services – especially in local languages – will be a key to increasing demand. There is a symbiotic relationship between the development of content and the development of connectivity in many OECD countries. The experiences in developing economies should be similar, with increases in connectivity facilitating the development of local content.

In addition to more international exchanges, high-speed, international infrastructure is becoming more accessible in developing economies. A recent example is the new SAT3/WASC/SAFE submarine fibre cable extending from Spain and Portugal, down the west coast of Africa, around the Cape and over to the west coast of India. Coastal countries in Africa can tap into the fibre, while landlocked countries can establish connections via coastal countries. International Internet connectivity via satellite and terrestrial wireless services is also falling in price.

The digital divide is not simply about a lack of cabled or wireless telecommunication infrastructure to users. The actual network interfaces such as mobile handsets, PCs and PDA-type devices are often too expensive for individual users in many developing economies. However, secondary markets for handsets and computers are helping supply much-needed terminals to users in developing economies at affordable prices. Used handsets in the developed economies, for example, are often turned in and may eventually make their way to users in developing economies, providing inexpensive, mobile connectivity for users with low monthly incomes (see Box 1).

Box 1. Used handsets fuelling mobile growth in Cambodia

Cambodia's fixed-line penetration has grown from 0.04 to 0.22 lines per 100 inhabitants in the ten years leading up to 2003. Cambodia's low fixed-line penetration rate was more of a concern in 1993 than in 2003, due to the rapid take-up of mobile telephony. In 2003, Cambodia had 750 000 mobile subscribers compared to 30 000 subscribers on the fixed-line network – a ratio of 25 mobile phone subscribers per fixed line.

Much of Cambodia's rapid take-up of mobile phones has been due to the availability of second-hand mobile handsets and pre-paid mobile phone plans. Users can purchase mobile handsets for roughly USD 10 to use with a pre-paid GSM SIM card. With Cambodia's gross national income per capita at USD 310 in 2003, the initial handset cost is roughly three per cent of annual income. Mobile tariffs are relatively inexpensive with users often spending USD 5 per month on calls.

Internet access penetration rates in Cambodia are very low due to the low number of PCs (12 000 in the country), a sporadic electrical supply, expensive access charges and a lack of Khmer-language content. While PC-based Internet access has been slow to expand, Internet access provided over a mobile phone may offer the best method for delivering data services, especially as next generation handsets start reaching secondary markets.

Source : Ministry of Posts and Communications of Cambodia

Much of the digital divide effort is focused on extending telecommunication infrastructure and supplying terminals to users. However, illiteracy and a lack of IT skills are major components of the digital divide and must be considered and addressed alongside efforts to expand the physical network.

The combination of low literacy levels and low bandwidth presents policy makers in developing economies with a bandwidth paradox. Users in developing economies often do not have literacy or ICT skills sufficient to take advantage of low-bandwidth, text communication. Illiterate ICT users require audio and video technologies to take advantage of ICTs, helping to partially explain the rapid take-up of mobile telephony in developing economies. However, users in developing economies have such limited access to bandwidth that usually their only choices for communication are text-based. The result is an entire segment of the population underserved by text-based communication technologies.

Policy makers, telecommunication operators and aid agencies must be keenly aware of complex social situations in the planning and implementation of digital divide projects. Efforts to simply supply a village with Internet access, without considering social consequences can lead to failure of the project (see Box 2).

Box 2. Peruvian Community Access Struggles

Projects to bring ICTs to rural and underserved populations can have limited success if certain social issues within the community are not sufficiently addressed. In 2000, IDRC Canada and Red Científica Peruana established an Internet telecentre in the Peruvian Amazon in Marakiri Bajo as a way to preserve the indigenous culture and improve access to education, markets and politics. Marakiri Bajo had no running water or electricity and the telecentre was established using a generator and satellite communication links. One of the key components of the project was a video conferencing system that allowed people to access courses from educational institutions across Peru.

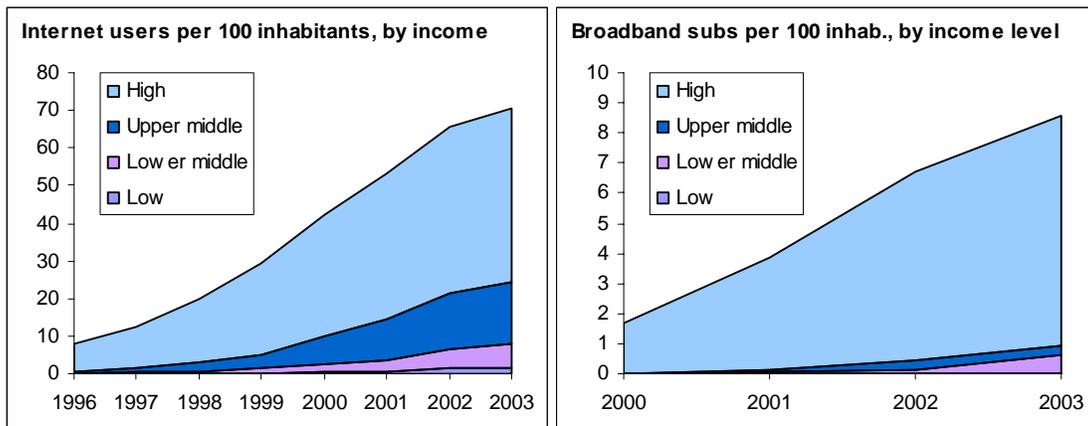
While the telecentre was intended to service the whole community of both indigenous Ashaninka and newer inhabitants, the “mestizos”, it was operated and used dominantly by the Ashaninka. The result was non-Ashaninka and people in surrounding communities were reported to feel excluded from the centre and the services it offered. In August of 2001, the telecentre burned down and the circumstances around the fire were unclear. The surviving equipment was eventually put to use to power a local radio station instead of another telecentre.

Source : Bjorn Soren Gigler, Including the Excluded – Can ICTs empower poor communities? Towards an alternative evaluation framework based on the capability approach.

Digital progress

While the digital divide is a very significant problem in developing economies, recent data show that people around the world have much better access to ICTs than they did even 10 years ago, with the largest improvements in middle-income countries. This has been possible with advances in technology and regulatory reform. However, just as the connectivity for a certain technology (e.g. dial-up Internet access) improves across income levels, a new technology (e.g. broadband) appears – leaving users in developing economies continually “playing catch-up” (see Figure 3).

Figure 3. Figure 3. Internet users and broadband subscribers per 100 inhabitants worldwide



Source: ITU World Telecommunication Indicators Database.

The cycle of technological development is likely to continue along the same path: adoption and commercialization of new ICT technologies in higher-income economies, slower penetration into lower-income markets, and the subsequent development of new technologies. In such a rapidly changing market, the “technologies of the day” are less important than the overall efficiency of the market and the regulatory environment. In a well functioning market, only technologies that are economically viable and efficient

will survive. Therefore, the role of policy makers should be to create an efficient and agile market that is capable of quickly integrating new technologies and keeping prices low for consumers via competition.

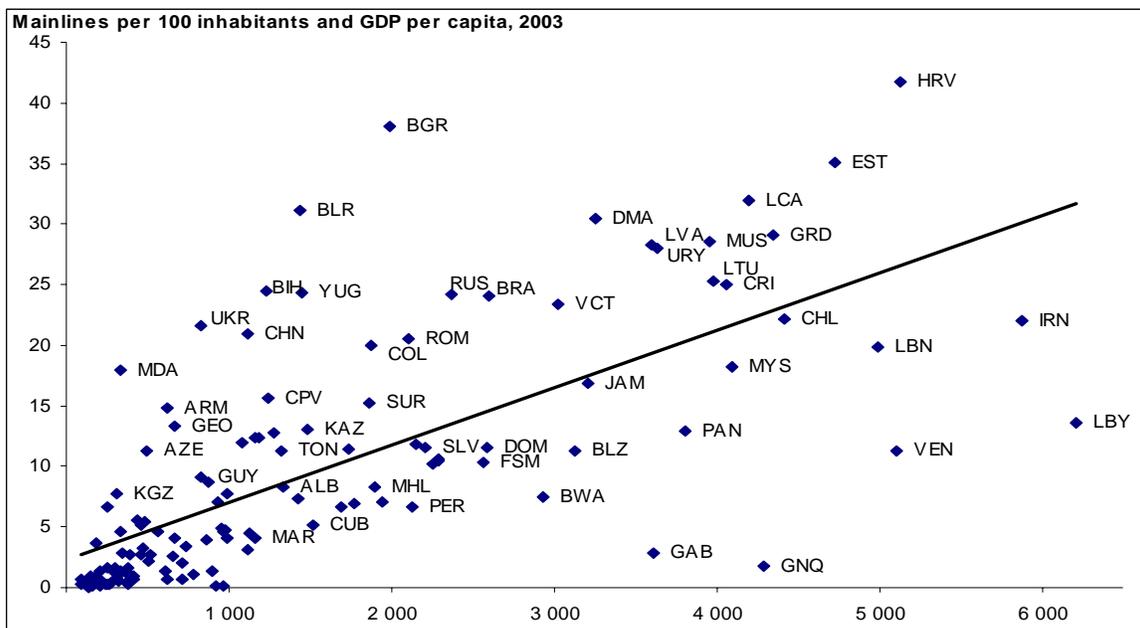
Over the past 20 years, the OECD has been urging governments to liberalize the telecommunication sectors in their countries. These policies have included setting up a regulatory framework, creating an independent and separate regulator, developing a strong foundation for regulatory action, encouraging competition throughout the sector and privatising telecommunication operators. These policies were often initially met with scepticism. However, over a period of two decades they have proven to be, on the whole, very effective.

In 2003, the 30 OECD countries accounted for 50% of the world's fixed-line subscribers, 53% of mobile subscribers, 67% of Internet subscribers, and 83% of the world's broadband subscribers. High income levels have certainly played a role in telecommunication penetration rates throughout the OECD, but sound policy, efficient markets and effective regulation have also been important components in the success.

While telecommunication liberalization is in the advanced stages throughout the OECD, policy makers in some non-OECD economies have also successfully applied the same market principles in their own economies with similar success. This paper will re-examine some of the basic policy instruments, with a focus on how policy makers outside the OECD are implementing them.

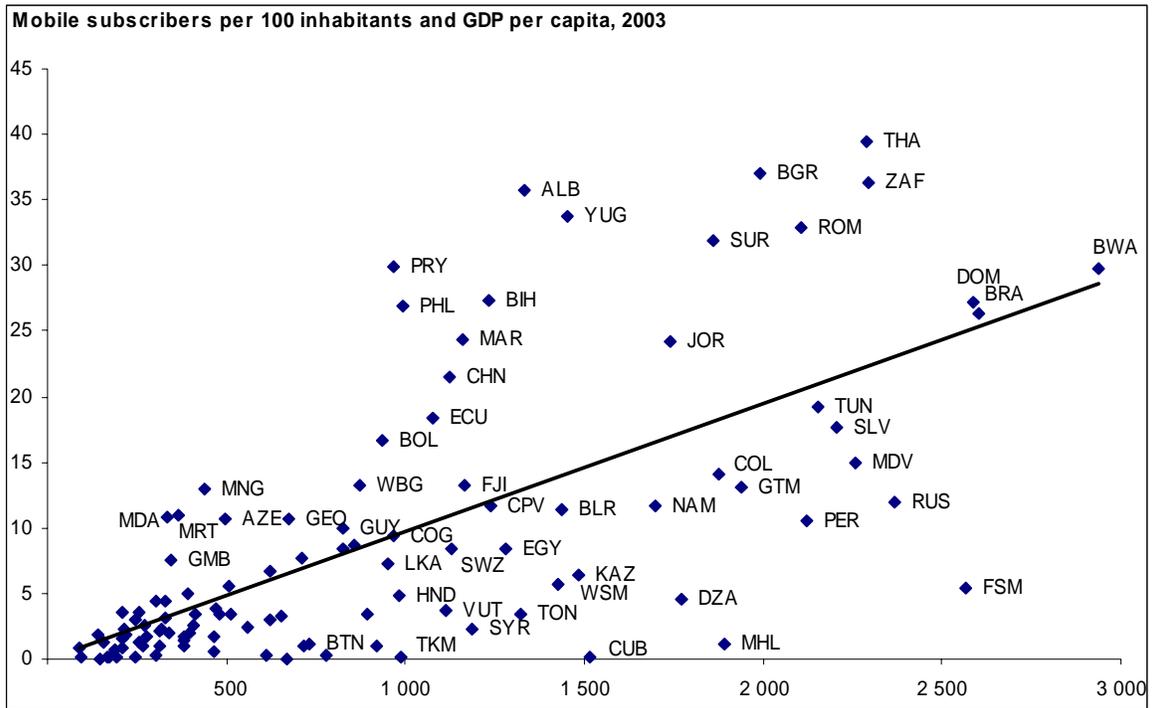
Before looking into specific policies, it is worth noting which countries have the highest telecommunication penetration rates at certain income levels. This allows policy makers to examine policy and market conditions that may have played a role in a country's ICT success. Penetration rates are only one measure of an ICT market, but it can be helpful to compare the adoption of communication technologies among countries at similar income levels. Policy makers have long noted the relationship between ICT access and GDP. Scatter plots of penetration rates over GDP can offer an effective way to see how countries compare with similar-income counterparts (see Figures 4, 5 and 6).

Figure 4. Figure 4. Fixed-line penetration and GDP per capita



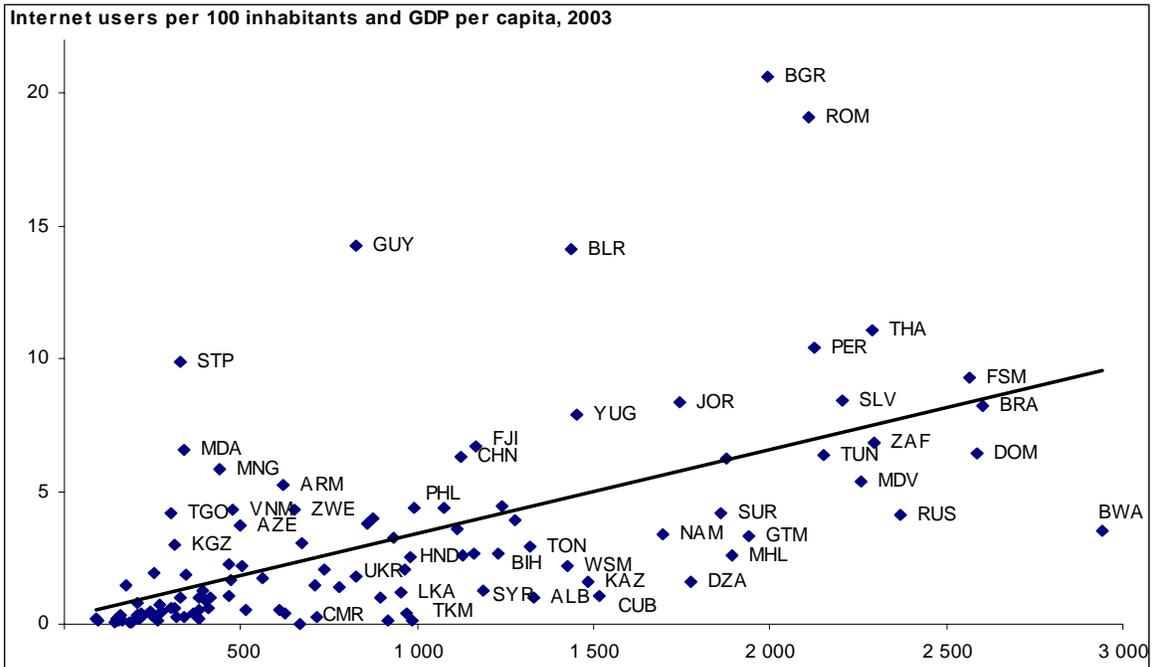
Source: ITU World Telecommunication Indicators Database.

Figure 5. Figure 5. Mobile penetration and GDP per capita



Source: ITU World Telecommunication Indicators Database.

Figure 6. Figure 6. Internet users per 100 inhabitants and GDP per capita



Source: ITU World Telecommunication Indicators Database.

Figures 4, 5 and 6 show scatter plots of various ICT subscriptions per 100 inhabitants by income level. A simple linear trend line is included for basic comparison but should not be considered a robust measure of the relationship between GDP and penetration rates. Economies are represented by their ISO 3-digit codes.

Figure 4 shows mainline penetration and GDP throughout the world in 2003. There is substantial variation among penetration rates at similar income levels with several economies having much higher penetration rates than their incomes alone would predict. The former Soviet Republics such as Armenia, Belarus, Estonia, Georgia, Latvia, Lithuania, Moldova, Ukraine and the Russian Federation all have higher penetration rates than other countries at similar income levels. At lower income levels, other examples include Cape Verde, China, Colombia, Romania, Brazil, Dominica, Mauritius, Sri Lanka, Grenada and Suriname. At higher income levels, non-OECD economies with relatively higher penetration levels include Bulgaria, St. Lucia, Bosnia and Herzegovina, St. Kitts and Nevis, Malta, Chinese Taipei, and Cyprus.

Figure 5 examines the relationship between the number of mobile subscribers per 100 inhabitants and GDP. The figure again includes a fitted trend line. Some economies in the chart have mobile penetration rates significantly higher than their levels of GDP would suggest. Examples include Paraguay, Albania, Bulgaria, Morocco, Thailand, South Africa, Romania, the Philippines, China, Ecuador, Bolivia and Mongolia. At higher income levels, economies with relatively higher penetration rates include Jamaica, Estonia, Lithuania, Seychelles, Malta, Slovenia, Chinese Taipei, and Hong Kong (China).

Figure 6 shows the relationship between GDP and Internet access. Several economies with relatively low income levels have impressive penetration levels. These include Bulgaria, Romania, Belarus, Guyana, São Tomé and Príncipe and Moldova. At higher income levels, economies such as Jamaica, Chile, Barbados, Latvia, Estonia, Slovenia, Chinese Taipei, Malaysia, Singapore and Hong Kong (China) have higher penetration rates than other economies at similar income levels.

The economies listed above have high ICT penetration rates for a variety of reasons, often particular to each economy. However, there are other elements of their success that are common among economies and OECD members as well. These typically include regulatory reform elements, such as market liberalization, effective competition, and the presence of a separate regulator.

Telecommunication market liberalization

The level of competition in the market is often a good indicator of telecommunication penetration rates. Economies with higher levels of competition usually benefit from lower prices and higher penetration levels. The contrast between penetration rates in monopoly and competitive markets, even within the same country can be pronounced (see Box 3).

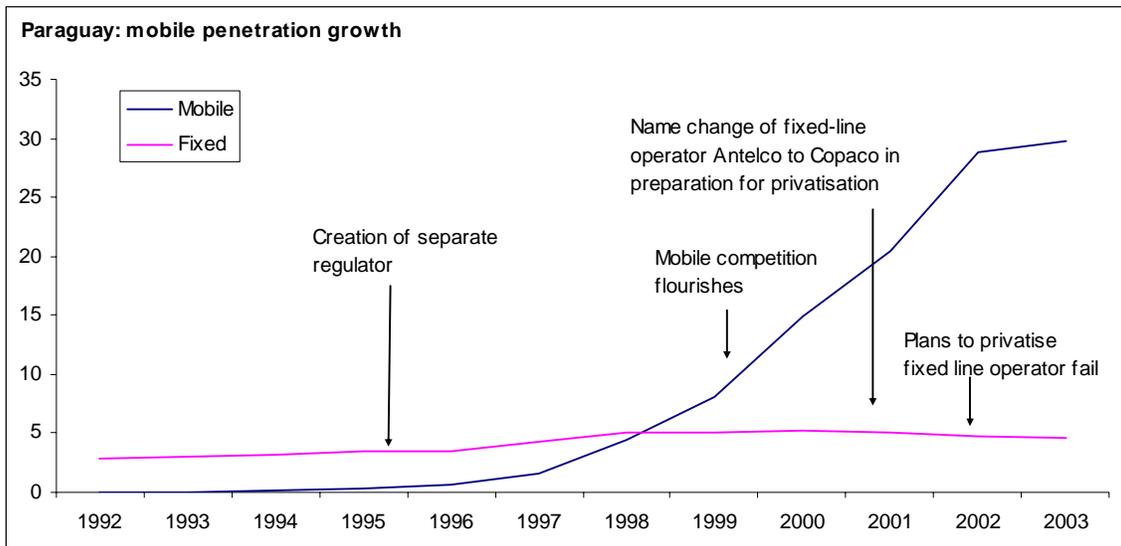
Liberalized markets in the same region and at similar income levels typically have penetration rates higher than those with non-liberalized markets. For example, the Latin American countries of Belize and Brazil have similar income levels but fixed-line penetrations vary considerably. In Belize, the incumbent operator maintains a monopoly on fixed-line provision and the penetration rate is low at only 11.3 lines per 100 inhabitants. In Brazil, the fixed-line market is considered fully competitive and the penetration rate is more than double that of Belize, at 24.1 subscribers per 100 inhabitants.

Mobile markets show similar trends. Competitive mobile markets typically show higher penetration rates than those which have not been liberalized. Jordan and Oman are good examples. Jordan's GDP per capita in 2003 was roughly USD 1800, less than one fourth of Oman's GDP per capita of USD 8 100. However, Jordan's mobile penetration rate of 22.9 in 2002 was higher than Oman at 18.3 (see Figure 7).

Box 3. Comparison of a competitive mobile and monopoly fixed-line network in Paraguay

The government in Paraguay started liberalizing the telecommunications market in 1996 with the creation of a separate regulator, Conatel. Mobile licenses were awarded and competition in the mobile market thrived, helping push mobile penetration rates towards 30 subscribers per 100 inhabitants in 2003. By contrast, the government-owned fixed-line operator still has a monopoly on the provision of fixed services. Plans to privatise the incumbent operator, Copaco (formerly Antelco), were initially delayed, and finally abandoned in June 2002. As a result, Paraguay's mobile market thrives while the fixed-line market languishes.

The efficiency of Paraguay's mobile market can be seen in regional comparisons. Paraguay's mobile penetration rate of 29.9 mobile subscribers per 100 inhabitants is just slightly under the regional average of 34.4 for the Americas. The fixed-line situation is very different. Paraguay's fixed-line penetration rate of 4.61 is much lower than the regional average of 34.5 fixed lines per 100 inhabitants.

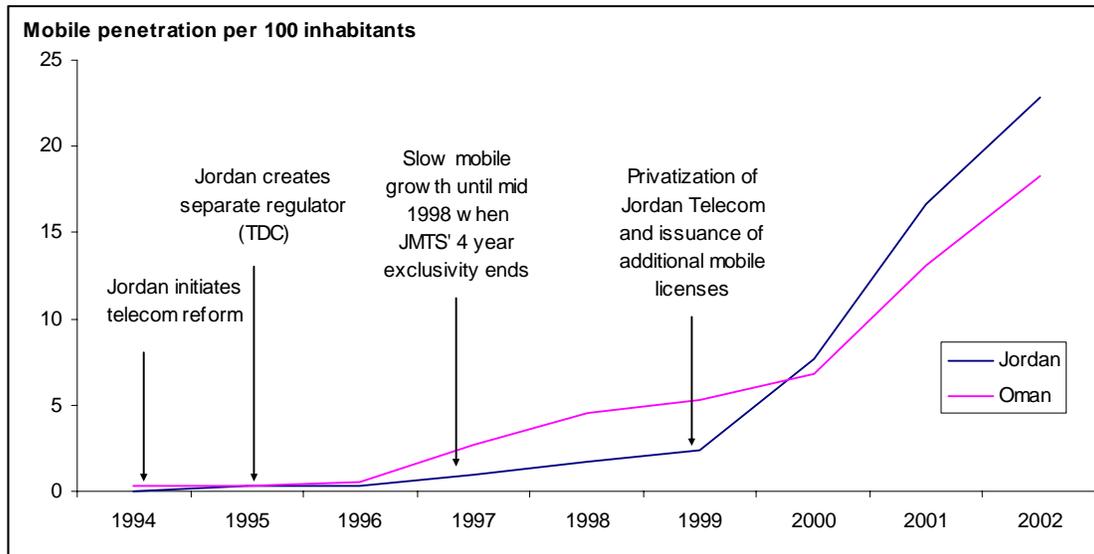


Source : ITU Telecommunication Regulatory Database

Much of Jordan's success in the mobile market can be attributed to the regulatory reforms started in 1994. Jordan lagged behind Oman in mobile penetration until competition was introduced into the mobile market in 1999. Oman's mobile growth has still been considerable, given the mobile operator's monopoly position. However, the liberalized market in Jordan eclipses Oman's growth, despite differences in income levels between the two.

Finally, markets with effective Internet competition often have higher penetration rates than their incomes alone would suggest. This can be seen in countries such as Latvia and Estonia, where penetration rates are as high as those found in many of the world's richest economies. Latvia's Internet penetration rate of 40.6 Internet users per 100 inhabitants in 2003 was higher than Chinese Taipei, France, Switzerland, Italy and Belgium despite the country having a GDP per capita of USD 3600 per year. Both Latvia and Estonia have very efficient ISP markets with a large number of licenses awarded to Internet service providers (ISPs). In 2004, Latvia had 195 ISP licenses, while Estonia had 112.

Figure 7. Mobile growth in Jordan and Oman



Source: ITU Telecommunication Regulatory Database.

The examples of Paraguay, Brazil, Jordan, Estonia and Latvia highlight the key role competition plays in increasing access. In the markets with competition, penetration rates increased faster than in similar markets with monopoly market structures.

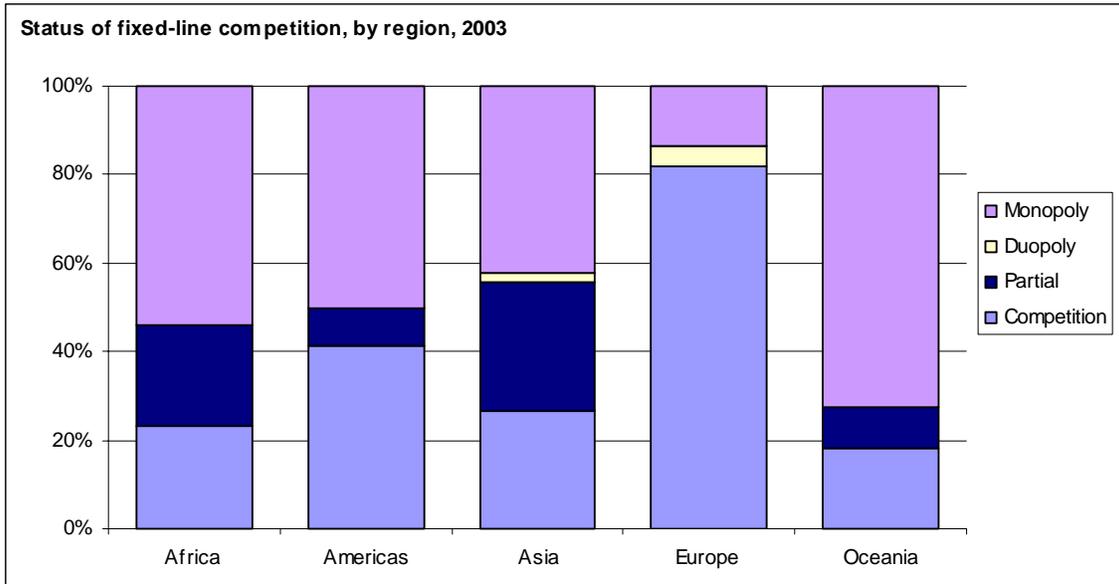
Regional statistics on the status of telecommunication markets highlight certain areas where competition has taken a greater hold than others. Figures 8 and 9 show the regional breakdown of market structure in mobile and fixed lines in 2003. At the end of 2003, slightly more than 80% of European economies had full competition in the fixed-line market. Monopoly providers operated in around 14% of economies. In Africa a majority of economies (54%) have markets with fixed-line monopolies. Only 23% of economies in Africa are fully competitive. In Asia, nearly 42% of economies still have monopoly fixed-line provision, in contrast with 55% with either partial or full competition.

Competition in the mobile sector is higher than fixed lines in all regions except for Europe. The level of full mobile competition in Africa, at 54%, is similar to the percentages for both Europe and the Americas. Competition in Africa's mobile sector helps account for Africa's robust growth in mobile services and increasing penetration levels.

On a global level, mobile markets have been traditionally more competitive than fixed-line markets. While fixed-line networks are characterized by an element of natural monopoly relating to the access network, mobile markets typically have multiple providers, each with a different frequency band assigned by the regulator. This typically allows for much more robust competition in the mobile market than fixed-lines.

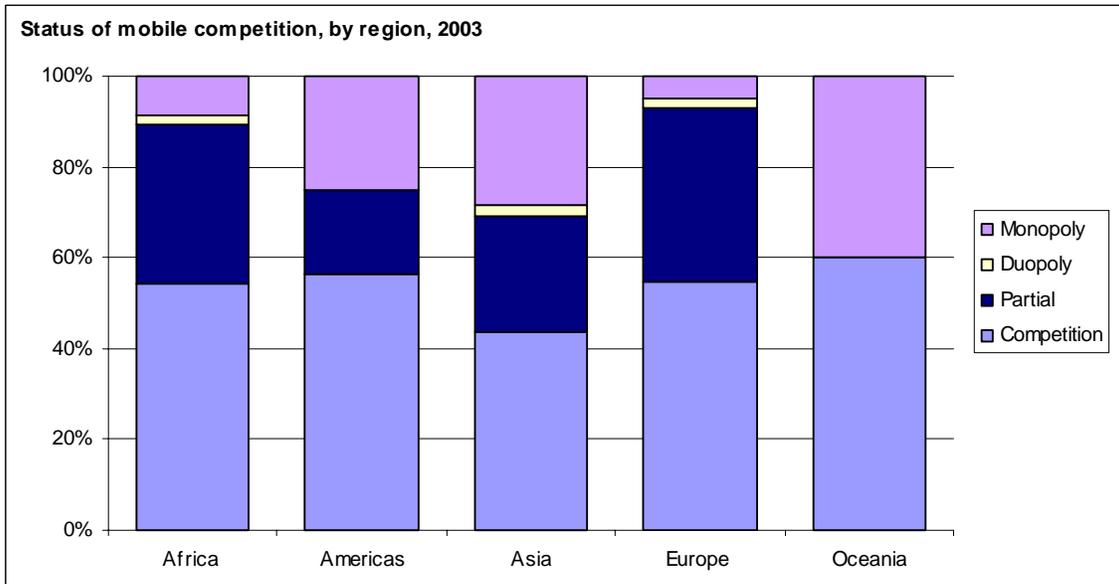
Competition in mobile markets is responsible for an innovation that has arguably played a vital role in reducing the digital divide throughout the world, pre-paid telephony. Since users in developing economies often have little or no access to credit, the introduction of pre-paid services in markets around the world has allowed users without credit to have mobile service. Pre-paid accounts now comprise 36% of all mobile accounts in the world⁷.

Figure 8. Figure 8. Status of fixed-line competition



Source: ITU Telecommunication Regulatory Database.

Figure 9. Figure 9. Status of mobile competition



Source: ITU Telecommunication Regulatory Database.

Regulatory independence

As telecommunication markets evolve, so does the need for a strong, effective regulatory regime. Effective regulation is important to ensure that markets function properly and services are delivered to

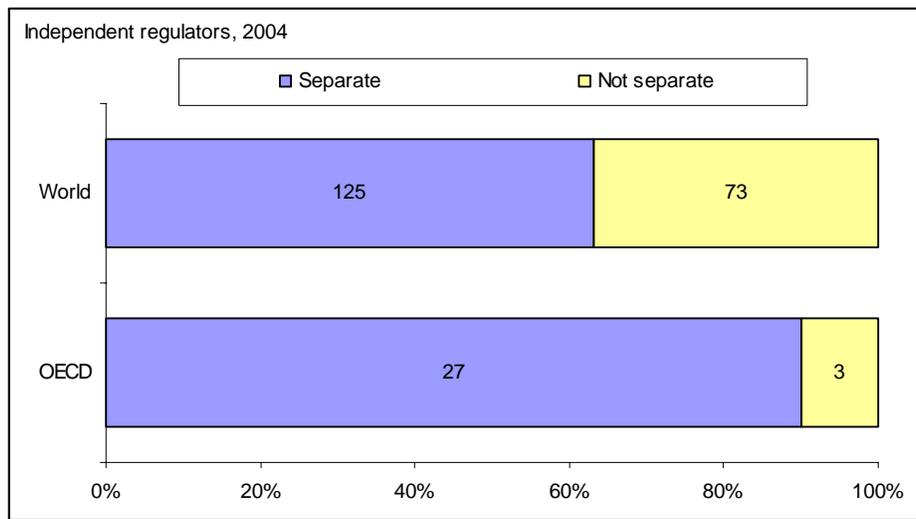
consumers and businesses efficiently and fairly. Evidence shows that one of the key elements of regulatory success is the existence of an independent and separate regulator, outside the influence of both government policy and private-sector interests.

The evolution of telecommunication regulation in developing economies is closely following earlier experiences in the OECD. In most countries of the world, telecommunication services were initially provided by the government. As the technologies improved and penetration rates increased, the limitations of monopoly provision became more pronounced.

In many countries, the first step was to separate the duties of service provision and regulation and put them into separate entities. This process is essential to promote impartiality and create a truly separate regulator who is not beholden to outside interests. The second step was to separate policy from regulatory functions ensuring that the regulator had sufficient authority to implement policy effectively.

In 2004, 90% of OECD countries had an independent regulator in comparison to 58% worldwide (see Figure 10). The role of the regulator varies from country to country, but common policy tools include privatising state-owned operators, licensing new entrants, determining interconnection policy, ensuring non-discriminatory access, setting price controls in non-competitive market segments, developing and enforcing competition regulation, and mandating universal service requirements.

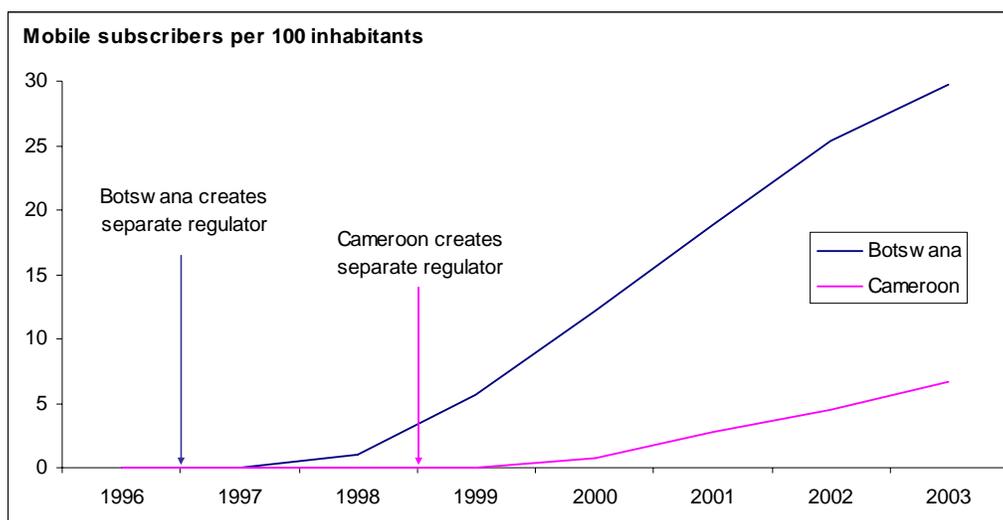
Figure 10. Figure10. The status of independent regulation in the OECD and worldwide



Source: ITU World Telecommunication Indicators Database.

Certain regions with traditionally low penetration rates have benefited from the introduction of separate regulator to oversee the development of the telecommunication market. In Africa, roughly two-thirds of economies have regulators who are separate from the government. In several African markets the introduction of a separate regulator has been immediately followed by rapid growth in mobile penetration. The examples of Cameroon and Botswana are given in Figure 11.

Figure 11. Figure 11. Growth in Africa and the creation of separate regulators



Source: ITU World Telecommunication Indicators Database.

The introduction of a separate regulator is an important first step when liberalizing a telecommunication market. However, the existence of separate regulator, in itself, does not guarantee the success of a market.

Several other elements must be in place to ensure the success of the regulatory body. First, the existing legal framework for telecommunications must be created. This usually entails the creation of a telecommunication law that facilitates the opening of the market and sets out the powers of the regulatory body. Second, the law must give the regulator the authority, autonomy, and means to effectively apply regulations in a market. These characteristics are important, especially in markets where incumbent operators have extensive political and financial power. At the same time, the regulator must have the authority to enact policies that will be vital to the development of the telecommunications market. These include, but are not limited to, mandating interconnection, unbundling the local loop and imposing open access requirements.

Regulatory reform is a process that takes time to achieve results, especially regulatory and administrative capacity building. Investment in capacity building in all countries involves initial costs but deliver high future returns.

Spectrum policy and wireless connectivity

Wi-Fi (IEEE 802.11)⁸ adoption has been very high throughout the OECD as users install wireless home systems, operators roll out commercial networks and equipment manufacturers build Wi-Fi connectivity into their products. The rapid adoption of Wi-Fi has pushed prices down and allowed entrepreneurs in developing economies to use off-the-shelf equipment to quickly roll out wireless networks.

These new wireless networks usually operate in license-exempt spectrum bands. Policy makers can help spur innovation in these wireless networks by making certain frequency bands license-exempt. On a global scale, the World Radio Conference in 2003 allocated spectrum in the 5 GHz band for license-exempt use. However, the most common and least-expensive Wi-Fi equipment operates in the 2.4 GHz

band which has not been harmonized for use worldwide. Spectrum policy makers in developing economies should thus examine ways to allow the rollout of Wi-Fi based systems.

New and evolving technologies such as WiMAX (IEEE 802.16)⁹ will also require new spectrum from regulators. Difficulties in obtaining spectrum for new wireless technologies will hamper the market in providing innovative solutions to the digital divide. Regulators in developing economies should examine existing spectrum allocations and work to accommodate new wireless technologies.

Success stories

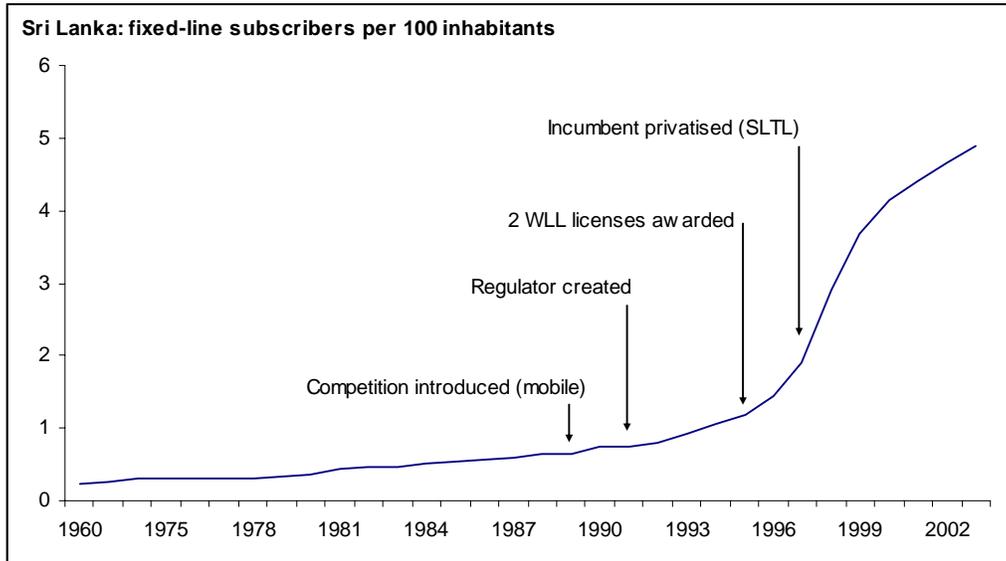
Asia has recently received considerable attention from telecommunication policy makers as Asian economies top the rankings in broadband penetration, broadband speeds, mobile penetration and mobile Internet use. Asian economies, those belonging to the OECD such as the Republic of Korea and Japan, and non-OECD economies such as Chinese Taipei and Hong Kong, China have received the most attention due to their top tier rankings. However, several developing economies in Asia have made significant progress in bridging the digital divide and building out networks. This section examines regulatory developments in three Asian countries: Sri Lanka, India and China.

The introduction of competition to markets has a profound effect on penetration rates, even when the competition comes via a different technology. Evolving wireless technologies such as WiMAX may dramatically increase the reach of backbone networks in developing economies, but other wireless technologies have already been implemented and have made a difference in competitive markets around the world.

The Telecommunications Regulatory Commission of Sri Lanka introduced competition to the fixed-line market in 1996, with the awarding of wireless local loop (WLL) licenses to Suntel and Lanka Bell. The licenses allowed each company to set up wireless last-kilometre connections to end users, and started a period of strong competition for fixed-line services. The awarding of licenses was part of a new regulatory framework put into place in 1991 with the creation of the separate regulator. The new regulatory framework and subsequent competition for fixed lines has led to rapid growth in Sri Lanka's access opportunities (see Figure 12).

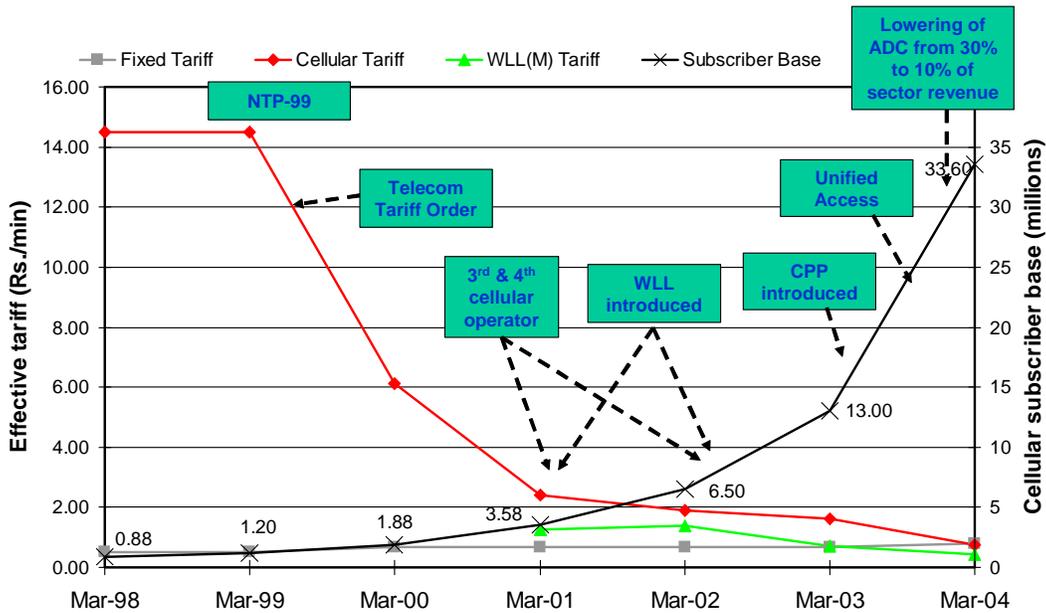
Sri Lanka's fixed-line market benefited from the competition provided by a wireless technology, highlighting the importance of inter-modal competition in telecommunication markets. As inter-modal competition continues to grow, so will the importance of technologically-neutral regulation.

Figure 12. Competition in Sri Lanka via wireless local loop



Sources: ITU World Telecommunication Indicators Database and <http://www.comunica.org/samarajiva.html>.

Figure 13. The effect of India's successful regulatory reforms on mobile penetration and price



Source: Telecom Regulatory Authority of India.

In India, the Telecom Regulatory Authority of India (TRAI) has completely restructured its regulatory framework to promote technological neutrality and take advantage of inter-modal competition. The decision was made, in part, due to the astounding success of several unregulated services (e.g. SMS, VoIP) that compete directly with regulated services. As a result, TRAI has been in the process of moving towards

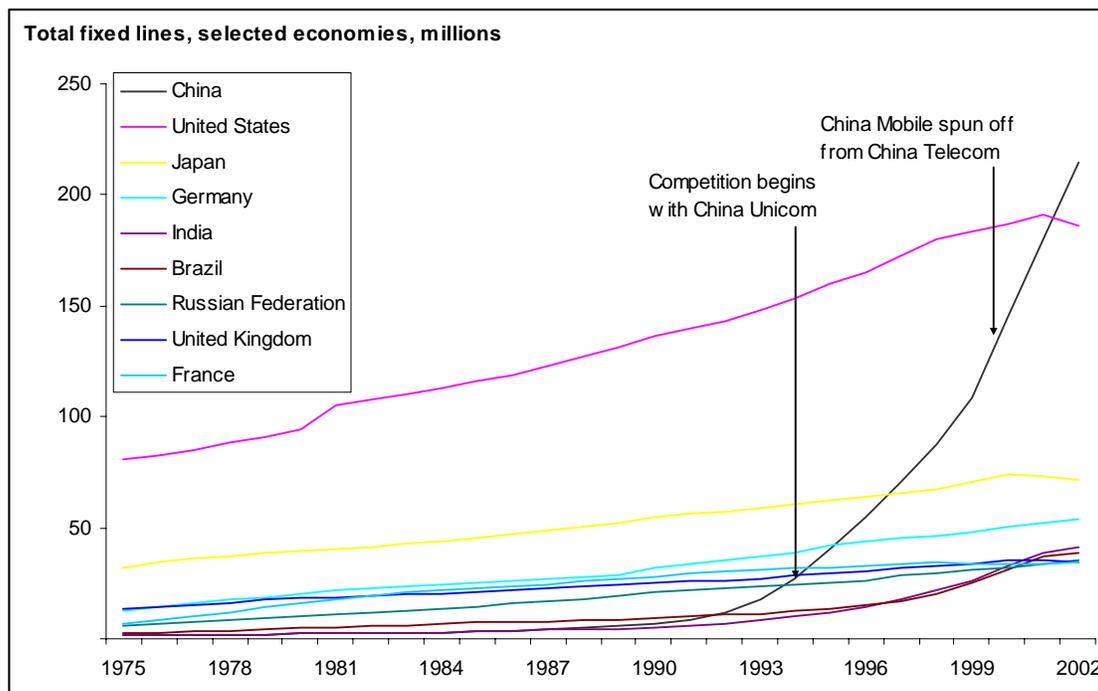
a unified licensing regime that would replace separate licensing based on technology, service or geographic area. Any licensee with one wired or wireless connection will be able to provide any service including: telephony, Internet access, broadband, television and other value-added services.

Also as part of the new regulatory framework, TRAI introduced new competition by issuing additional mobile licenses in 2001 and 2002 and awarding WLL licenses in 2002. In another important step, India moved from receiving-party-pays (RPP) to a calling-party-pays (CPP) structure in an effort to spur mobile take-up. India's reforms have been very successful, with a marked increase in mobile subscribers and a fall in mobile tariffs (see Figure 13). The reforms introduced by TRAI in India may eventually have an impact on the global telecommunication market, given India's large population and potential market size.

While India's large telecommunication market continues to grow, China now has the largest mobile and fixed-line markets in the world. In July 2004, there were 299 million fixed-line subscribers and 310 million mobile subscribers. Internet subscribers reached 87 million with a penetration rate of 6.7 subscribers per 100 inhabitants. Chinese broadband infrastructure is also growing at the rate of nearly 1 million new subscribers per month, with 18.8 million subscribers in July 2004.

Much of China's recent growth is a result of effective competition in the Chinese mobile and fixed-line markets. The Chinese government introduced competition into the market in 1994, with the creation of China Unicom. Neither the incumbent, China Telecom, nor China Unicom has been privatised but competition flourishes. The result of this competition has been a dramatic increase in both mobile and fixed access (See Figure 14).

Figure 14. China's regulatory reform and infrastructure growth



Source: : ITU World Telecommunication Indicators Database.

Human capacity building

Much of the research on telecommunication markets has focused on what policy makers can do to improve the amount of physical telecommunication capital in an economy. However, physical infrastructure is only one component of an efficient and vibrant telecommunications market, with human capital also playing a vital role.

Telecommunication markets are complex and require a wide range of skills from users who access the network, engineers who maintain it, and policy makers who regulate. As physical telecommunication infrastructure develops so must the capacity of users, network technicians and policy makers. High-capacity IP networks are of limited use in economies where users lack basic ICT knowledge. Up-to-date networks may fail in an economy that lacks competent technicians and engineers. Economies must also produce people with the skills to build and maintain networks, run telecommunication businesses as well as develop and enforce regulations.

Policy makers in several governments have focused on building an inclusive information society by targeting youth in schools. Programs that connect and educate students create a generation of savvy computer users who form the foundation of a vibrant telecommunication market.

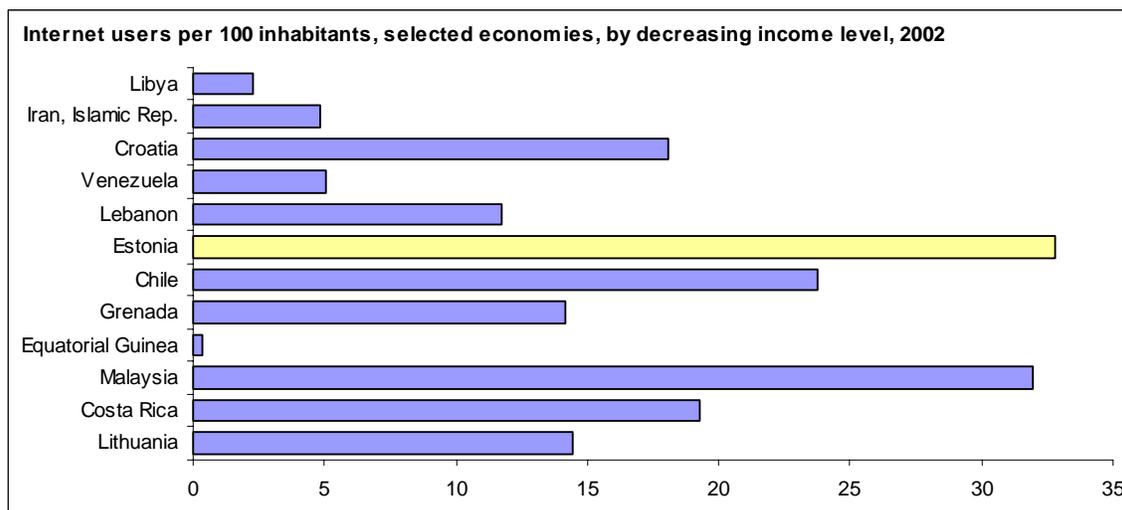
OECD countries have emphasized ICT skills in their efforts to connect all schools to the Internet, train students in ICTs and provide programs for non-students to obtain computer literacy. These efforts have paid off handsomely in countries such as Korea where a strong government push to supply ICT training to those affected by the 1997 financial crisis has helped fuel PC and broadband adoption. Policy makers in non-OECD countries have created similar plans and have boosted penetration rates. One such economy is Estonia where government initiatives aimed at promoting a computer-literate generation have been successful.

Estonian policy makers have been successful developing a broad base of ICT skills throughout the country. The government's flagship program, Tiger Leap, has successfully integrated information and communication technologies into classroom instruction, resulting in a new generation of students with computer skills who demand faster Internet connections, better content and more extensive telecommunication network coverage. In Estonia, introducing students to computers early in their studies has also helped move more students towards technical careers later.

The results have been strong impressive with Estonians achieving penetrations equal or higher than other richer countries in Europe. In June 2004, TNS Emor Internet usage surveys show that 52% of Estonians between the ages of 6 and 74 use the Internet. The same study finds that the most active Internet users are people between the ages of 12 and 24, 90% of whom use the Internet. The percentages are also high for primary school students where two-thirds of students between the ages 6 and 9 are Internet users¹⁰.

In addition to teaching ICT skills early to students, Estonia's policy makers have made promoting ICT use a priority. One example is new street signs giving the direction and distance to the nearest public Internet access point. The signs are marked with "@ Internet", an arrow and the distance to the nearest of 700 public Internet access points across the country. The government has also taken a pro-active approach to integrating computers and telecommunications into government activities. The Estonian government has paperless "e-cabinet" meetings where government cabinet members can examine documents and cast votes via computer. Estonia's projects have largely been a success, with mobile, fixed and Internet penetration rates as high as other leading European economies (see Figure 15).

Figure 15. Estonia's high Internet penetration rate among similar-income economies



Source: ITU World Telecommunication Indicators Database.

Regulatory aspects of disaster warning and recovery

Recent natural disasters have highlighted the importance of developed, and well-functioning telecommunication markets – as well as the importance of ensuring that users around the world have access to potentially life-saving emergency telecommunication services. A number of these services fall under the authority of the regulator as components of universal service requirements. Therefore, it is important to examine how the regulatory environment may need to evolve to ensure the best emergency services are available to the largest percentage of the population as possible.

On December 26, 2004, the world's largest earthquake in forty years unleashed a powerful tsunami on nations around the Indian Ocean's rim, causing cataclysmic damage. Estimates have calculated the initial loss of life at over 150,000 people, most of whom had no advanced warning of the approaching wave. Rescue workers, aid agencies and government officials mobilized quickly to respond to the crisis while engineers worked at re-establishing communication links with affected areas. SMS messages and mobile communications proved resilient in the aftermath of the devastation.

In the weeks following the disaster, the key priorities were providing clean water, food and shelter to those affected and minimizing the threat of disease. However, many of the discussions in the press after the disaster reflected on how communication networks could be used as an advance warning tool to mitigate the effects of future natural disasters. Indeed, as telecommunication networks expand, particularly mobile networks, so does the government's ability to quickly spread key information in times of crisis or danger.

Broadcast networks, such as radio and television, have typically been among the most cost-effective and efficient at sending mass messages quickly. However, as the number of mobile subscribers in an economy surpasses a certain penetration threshold, mobile phones offer a much more effective and constant method for locating users and passing along vital information. There are several benefits of spreading information via text messages to mobile phones. First, users typically carry their phones with them at all times and can be reached when away from a television or radio. Second, the low-data intensity of text messaging allows for messages to make it through even when circuits can not handle a simple voice call¹¹.

The telecommunication networks in the affected areas were used not only by the rescuers to pass information but also as a tool to locate people stranded in the aftermath of the tsunami. Sri Lankan network operators were able to identify 10,252 internationally roaming mobile phones on their networks at the time the waves hit land. After the Sri Lankan operators sent each roaming phone a text message asking users to contact emergency response, nearly 23% responded. As mobile network operators quickly re-established service to affected areas with the use of portable electric generators, any mobile phones appearing on the network could be quickly traced and emergency crews dispatched. The Swedish government asked its country's mobile operators to send text messages to all Swedish-registered phones in Thailand requesting users either call their families or contact the Swedish Embassy. Danish operators were able to provide information about all mobile phone communications between Denmark and Indonesia, Thailand and Sri Lanka just before and after the tsunami¹².

Finally, the Internet also played a key role in rescue and recovery operations after the tragedy as pictures of victims and missing people appeared on websites for families and relatives to search. Certainly the economies with extensive networks to begin with were, in one aspect, better prepared to deal with emergency response than other, less-developed telecommunication markets. Indeed, one of the most potent lessons from the tragedy has been how people from all countries of the world benefit in times of crisis from developed telecommunication networks in affected economies.

Emergency services in an economy are often handled by a number of government, public and private entities. Various agencies specialize in different aspects of disaster warning and recovery but coordination during a disaster has sometimes proven difficult. Telecommunication regulators are often involved with emergency communications during a disaster since there is often a requirement that emergency telephone services are provided as part of universal service requirements for fixed-line providers.

Existing emergency regulations have worked well in economies with high fixed-line penetration rates. However, most economies struggling with the digital divide lack the type of developed fixed-line infrastructure necessary to sufficiently cover the population, severely hampering the effectiveness of fixed-line emergency services. Since mobile phones greatly outnumber fixed lines in many developing economies, regulators should examine how existing policies may need to be reconsidered to take advantage of mobile telephony.

This section will briefly examine several emergency telecommunication services that are currently available, their benefits and possible ways they could be adapted to take advantage of new communication technologies. The list is only a small sample of the many emergency preparedness systems available around the world. These examples do not necessarily represent best practices but rather offer a glimpse into how telecommunication networks are currently being used to provide emergency services in several countries.

As mentioned earlier, the tsunami has helped highlight how telecommunication networks could be used as an important emergency broadcast system. Systems currently exist in Hong Kong (China), the United Kingdom and the United States that can notify users of danger in their area via either a mobile phone or a fixed line.

One of the proposals to come out of the discussions after the tsunami is an emergency SMS service that could send a bulk message to all mobile subscribers near cell towers in an affected area. The SMS messages could be targeted geographically, by cell tower, and sent quickly by the mobile providers. The efficiency of such a system would likely be highly correlated to the mobile penetration rate in a given area, highlighting the importance of expanded mobile access. Hong Kong, China's use of such a system during the SARS pandemic is probably the largest experience to date.

Hong Kong, China: SARS information by SMS

The government of Hong Kong, China used such a system in April 2003, broadcasting 6 million SMS messages in an effort to quell a rumour that the city would be quarantined during the SARS pandemic¹³. A rumour was purportedly started by a teenager who built a mock website stating Hong Kong was an “infected city”. Once the rumour started to cause panic in the city, the government quickly launched a blanket SMS that transmitted a message from the Director of Health announcing that there were no plans to declare Hong Kong an infected area.

Hong Kong, China’s use of the SMS broadcast was largely seen as a success. However, the experience highlighted some areas for improvement for future mass SMS warnings. Network congestion prevented some of the messages from arriving and many of the messages arrived up to six hours later.

United Kingdom: City Alert Texting System (C.A.T.S.)¹⁴

Mobile users in the United Kingdom can register the postal codes where they live and work with an emergency news texting service (C.A.T.S.) and receive detailed emergency messages when problems arise in any of their registered postal codes. The system can send warnings about critical events such as severe weather, chemical fires, terrorist alerts, traffic accidents and road delays. Users are given simple directions to follow in the text message to keep them out of danger. Subscribers are charged GBP 1.50 per postal code registered, which includes unlimited alerts for one year. C.A.T.S. services are currently available in several cities throughout the United Kingdom.

One drawback of the C.A.T.S system is the inability to pass information based on the physical location of the phone. Subscribers to the service input the zip codes where they spend most of their time but would not be notified, for example, if they happened to be near a dangerous situation in a zip code they had not registered.

SMS alert systems show great promise for early warning but there are several problems that must be resolved for them to be effective. For example, the authenticity of early-warning systems that rely on SMS must be verifiable by users. If they are not, malicious SPAM messages could start dangerous rumours and degrade the trustworthiness of such a system. Several challenges to building an early SMS warning system are given in Table 1 below.

Table 1. Table 1. Challenges to building an SMS early warning system

1.	Authenticity: Users must have a way to verify the authenticity of messages they receive. This involves developing methods to verify the source as well as educating the public on how to recognize “spoofed” messages.
2.	Local languages: Delivering timely, emergency information may require operators to send messages in several languages from the same cell tower. This would require a method for determining which language would be the most appropriate for a given subscriber.
3.	Voice messages in areas with low literacy areas SMS messages would be largely ineffective in areas characterised by low levels of literacy. In these areas a recorded voice message may be more appropriate for a mass broadcast. Mobile operators could send SMS messages to all subscribers who had ever sent an SMS from their phone (indicating a level of literacy) and voice messages to all other subscribers. Maximizing the number of SMS messages sent would help keep traffic levels lower on the network during the crisis.
4.	Prioritizing emergency calls Fixed-line networks can give priority to calls destined to emergency response numbers and a similar system

on mobile networks could help keep lines available for emergency personnel during peak-usage times around a disaster.

United States: Emergency fixed-line notifications

A number of communities throughout the United States have set up emergency fixed-line telephone notification systems to quickly contact residents in the case of a natural disaster or other emergency situation. These services have been particularly popular in areas of the mountain west, which are prone to wildfires that can spread quickly and shift suddenly, threatening entire communities¹⁵. In the case that a wildfire is approaching a community, an automated system can quickly call all residents in the affected area with a recorded message, telling them to take certain precautions or evacuate the area. The system usually makes a series of calls, first warning users to prepare and then a later call to leave the premises when they are in imminent danger.

Residential phone numbers are mapped to individual street addresses so calls can be made on a street-by-street basis or over an entire city or town at once. These systems have been successful at passing along important messages to residences but are limited to fixed-line telephones.

Fixed-line emergency notification systems typically work well in areas with high fixed-line penetrations. The success is partially due to the ability to “geo-code” a phone number to a stationary address (e.g. a house). Emergency personnel can then simply designate certain areas of a city or town, and with a simple database query, can have a computer send out bulk phone messages to affected homes.

A similar system could work for mobile users, although location information would need to be gathered by different means, either by a global positioning system (GPS) or via information gleaned from cell towers in communication with a mobile phone. Mobile phone manufacturers have begun including GPS capabilities into mobile phones, in part due to emergency service regulations mandated by governments. Rollout of these devices has been slow, due in part to satellite reception problems inherent in GPS systems. GPS position reporting from a mobile phone will only work when the phone has an unobstructed view of a good portion of the sky, typically outdoors. Phones that are indoors or in dense urban areas with high buildings will be unable to report their position accurately. Even outdoors, GPS systems require an initial “warm-up” period of up to one minute while the phone analyzes satellite signals to obtain its bearings.

Mobile operators can also determine the precise location of a mobile phone via triangulation of radio frequency (RF) communications with mobile towers in the near vicinity. One drawback is these systems are computationally prohibitive for operators with a large number of users on the network at any given time.

Policy makers and operators may be more inclined to look into a system which could leverage the both GPS position reporting and cell tower communication to broadcast targeted emergency communications in over a very small area. Otherwise, the most cost effective and efficient method for broadcasting an emergency message would be to simply send an SMS to all users serviced by a given tower.

The examples above looked at ways emergency communication systems can pass information on to a large number of people quickly. Other emergency systems have a much narrower focus, protecting an individual. Services in Ireland and the UK focus on the safety two vulnerable groups of people in particular, those whose work takes them to dangerous places alone and children.

Ireland: Mobile phone network protects lone workers¹⁶

The mobile operator O2 in Ireland has introduced a system to help lone workers who may enter dangerous or risky areas as part of their jobs, specifically social workers, community nurses and postal staff. With the system, the mobile user first records a message giving the details of the visit before leave. Once the mobile user completes the visit, he or she is required to confirm that the visit has ended safely by tapping a code into their phone.

If the mobile user does not log off, the system will send two phone calls, at five minute intervals, to check for a response from the mobile user. If the second call remains unanswered, emergency crews can quickly be dispatched to the area of the phone using details included in the pre-recorded message.

The system also includes a panic button users can press that immediately sends out a distress signal to an emergency response centre. Economies with high mobile phone penetration rates have also been able to take advantage of the technologies to locate missing children or individuals.

United Kingdom: Childwatch¹⁷

The Childwatch system in the United Kingdom is a registry of mobile phone numbers of people who associate with a particular child. The list could include friends, teachers, neighbours and family. If a child goes missing, an emergency message is quickly relayed to the entire list of mobile subscribers who associate with the child, asking if they know where the child is and where he or she was last seen. Often one of the contacts knows the whereabouts of the child and the chain of emergency procedures can stop. If no one on the contact list knows the child's whereabouts the police and other relevant agencies can then take swift action. The system has been credited with improving the chances of locating abducted children by decreasing the amount of time required to verify the abduction. It has also reduced the number of "false alarm" child alerts.

Telecommunication networks provide important early-warning functions during disasters but also play a vital role in coordinating and passing along information about survivors and victims to family and friends after a disaster. These systems can be used to arrange reunions or to identify victims, particularly internationally. The "I Am Alive" system was developed after the Kobe earthquake in Japan and provides a repository for survivor and victim's information after a disaster.

Japan: "I Am Alive" (IAA) system¹⁸

An earthquake in Kobe, Japan in January 1995 caused massive damage and claimed the lives of over 5000 people. The "I Am Alive" Alliance evolved in the aftermath of the earthquake as a way to gather and organize information about survivors and victims. IAA systems allow various organizations to accumulate and store information in a common database by use of automated data exchange. Information can be submitted to the IAA system by Internet, mobile phone or fax and then searched online.

The emergency systems mentioned above are only a few of many such systems around the world but highlight the availability of technologies that can notify users during emergencies and keep them out of harm's way. Regulators may be faced with significant challenges when working to incorporate new technologies into existing emergency system requirements. Open discussion of the difficult regulatory issues will be necessary to find solutions and ensure the economy moves closer to an optimum contribution of ICTs to disaster warning and recovery.

Conclusion

Telecommunication networks and services play an important role in modern economies as an enabling technology in traditional economic sectors and in new economic activities such as electronic commerce. Telecommunication technologies have also played an important role in enhancing total factor productivity in OECD economies and in employment growth¹⁹. As recent events have shown, telecommunication networks can also play a key public safety role in an economy, especially as a tool for disaster warning and recovery efforts. Economies with under-developed telecommunication markets and networks may face higher risks in the face of future catastrophes than economies with extensive networks and public safety systems in place. While the benefits of e-learning, e-health and e-commerce cannot be overlooked, the public safety aspect of telecommunication networks has recently intensified the focus on the need to ensure good ICT access to all the world's inhabitants.

This paper has looked at one narrow aspect of the digital divide, the effects of regulatory reform on telecommunication networks. While regulatory reform is only one part of the global digital divide problem, it can play a key role in helping telecommunication markets bridge some of the gaps on their own. It is therefore imperative that policy makers consider regulatory reform as a necessary but not sufficient step towards overcoming the digital divide.

The severity of the digital divide in OECD countries is much less than other parts of the world, in part to higher incomes but also as a result of important regulatory reforms initiated over the past 30 years. These reforms have paved the way for markets to develop and supply telecommunication services with the least amount of intervention. There still remain problems with the digital divide in the OECD, especially in rural and remote areas. However, operators in the OECD have expanded networks quickly and the scope of the problem should be well diminished in the next two years.

The situation outside of the OECD is more pronounced, with large parts of the population without basic ICT access in many economies and regions. Certain technologies, such as the mobile phone, have helped bridge the communication divide but the rapid pace at which telecommunication technologies are evolving has left many economies in a constant state of "catch-up". Regulatory reform can thus play a key role in many of these economies as a way to ensure the telecommunication market is given the best chance of succeeding on its own without intervention. Policy makers in non-OECD economies should consider the policies that have been the most successful in the OECD, namely liberalizing markets, creating a separate regulator, opening spectrum for new wireless technologies and developing human capital in regards to ICTs.

Policy makers throughout the world should be concerned about the digital divide, not simply because of the services ICTs provide to users but because of the externalities that accompany developed networks and ICT-savvy users. Telecommunications infrastructure can play a key role in economic development, which can create a virtuous cycle where incomes improve and access increases²⁰. Developing economies have increasingly been able to attract IT and service outsourcing from developed economies and these gains rely on a high-quality telecommunications infrastructure and a population with ICT skills²¹. Examples include India and Sri Lanka's call centres and the outsourcing of computer programming to Eastern Europe.

As mentioned earlier, an economy's regulatory regime is only one facet of a very complex problem that includes affordability, education and other social circumstances. Policy makers must take all into account when devising an overall digital divide strategy since many of the factors are interconnected. While the social situation in each economy varies drastically, the key principles behind regulatory reform have been tried and tested with success in countries and regions around the world.

NOTES

- ¹ The OECD report, *Providing Low-Cost Information Technology Access to Rural Communities in Developing Countries: What works? What pays?* (2004) takes a broader approach to the digital divide in the rural areas of developing economies, offering detailed experiences and evaluation of several business plans for telecommunication service provision.
- ² The OECD report, *The development of broadband access in rural and remote areas* (2004), highlights new technologies and policies that have helped extend access to rural areas within the OECD. Solutions for the digital divide in rural areas of the OECD can also be applied in rural areas of developing economies. <http://www.oecd.org/dataoecd/38/40/31718094.pdf>
- ³ For more information on the success of regulatory reform throughout the OECD, see The OECD Reports on Regulatory Reform Series, http://www.oecd.org/topic/0,2686,en_2649_37421_1_1_1_1_37421,00.html
- ⁴ The World Bank has a large number of publications on the effects of telecommunication competition in developing economies. For more information readers should consult InfoDev's Telecommunications Regulation Handbook, edited by Hank Intven, 2000. In addition, the World Bank publication, *Implementing Reforms in the Telecommunications Sector, Lessons from Experience*, Edited by Bjorn Wellenius and Peter A. Stern, offers examples from around the world.
- ⁵ ITU World Telecommunication Indicators Database.
- ⁶ Amr M. Aboualam, EgyNet, National and Pan-African IXP Special Workshop, ITU TELECOM Africa, May 6, 2004.
- ⁷ ITU World Telecommunication Indicators Database.
- ⁸ Wi-Fi is short for wireless fidelity. It is a term developed by the Wi-Fi Alliance to describe wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards. Wi-Fi is typically used as a means to connect computers wirelessly to the Internet over a range of up to 100 metres. (<http://www.wi-fi.org/>).
- ⁹ WiMAX is a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL. WiMAX should provide fixed, nomadic, portable and, eventually, mobile wireless broadband connectivity without the need for direct line-of-sight with a base station. WiMAX should be able to extend a wireless Internet connection within a typical cell radius deployment of three to 10 kilometres. At these distances, WiMAX equipment should allow up to 40 Mbit/s of connectivity, roughly the equivalent of 700 dial-up Internet connections. (<http://www.wimaxforum.org/about/faq/>).
- ¹⁰ Information from the Estonian Ministry of Foreign Affairs at: http://www.vm.ee/estonia/kat_175/pea_175/2972.html
- ¹¹ See the BBC story, "Text messages aid disaster recovery" at: <http://news.bbc.co.uk/2/hi/technology/4149977.stm>
- ¹² Story from the Boston Globe, December 29, 2004, "Internet, cellphones are aiding the search", at: http://www.boston.com/news/world/asia/articles/2004/12/30/internet_cellphones_are_aiding_the_search/

13 For more information, see “Text messaging used to allay SARS fears”, April 3, 2003 at:
<http://www.guardian.co.uk/online/news/0,12597,928906,00.html>

14 For more information see: <http://www.cityalert.co.uk/static/aboutcats.htm>

15 Services mentioned were from <http://www.intrado.com/>

16 For more information see:
http://www.techcentral.ie/techcentral/pcwork/wireless_mobile/guardian_to_protect_vulnerable_workers.xml

17 Information about the services is available at: <http://www.cityalert.co.uk/static/aboutcats.htm>

18 The IAA Alliance website is available in Japanese with main pages translated into English at:
<http://www.iaa-alliance.net/en/about/>

19 The *OECD Communication Outlook 2005* highlights how the telecommunications industry, over the past decade, has played an increasingly important role in economy-wide productivity growth and technological diffusion. The industry’s infrastructure and services provide a fundamental underpinning for information economies.

20 The OECD Report, *The New Economy: Beyond the Hype* (2001), concluded that ICTs have a large potential to contribute to more rapid growth and productivity gains. The OECD revisited the same topic in 2003 with *ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms* (2003) and found that the assumptions and conclusions drawn in 2001 still hold.

21 Rapid developments in ICT provide increasing opportunities for international sourcing. In particular, “knowledge work” such as data entry and information processing (IT services), research and consultancy services can be carried out remotely via the Internet and through multimedia conferencing. The *OECD Information Technology Outlook 2004* highlights the drivers and impediments to outsourcing of business services, the dynamics of business process restructuring, and the skills dimension of international sourcing