

Mobile Telephony: A Critical Enabler of Networked Readiness?

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Mobile telephony occupies a special place among the various information and communication technologies (ICT) that have emerged in recent decades, in terms of both its stellar diffusion and its impact on economic growth and poverty reduction.

In particular, mobile communications penetration has boomed in developing countries, helping them to compensate for an often underdeveloped and flawed fixed telephony infrastructure and offering a promising tool to increasingly lift their citizens out of poverty and improve the efficiency of their markets and economies. The total number of mobile telephone subscribers in the developing world is more than twice that of advanced economies.¹ This, as pointed out by Kalil,² can be explained by a number of factors, including the relative ease of deploying mobile infrastructure versus land-line phones; a more liberal regulation of mobile service provision in most countries, favoring competition; the decreasing cost of mobile handsets; and the possibility of sharing phones and buying pre-paid cards.

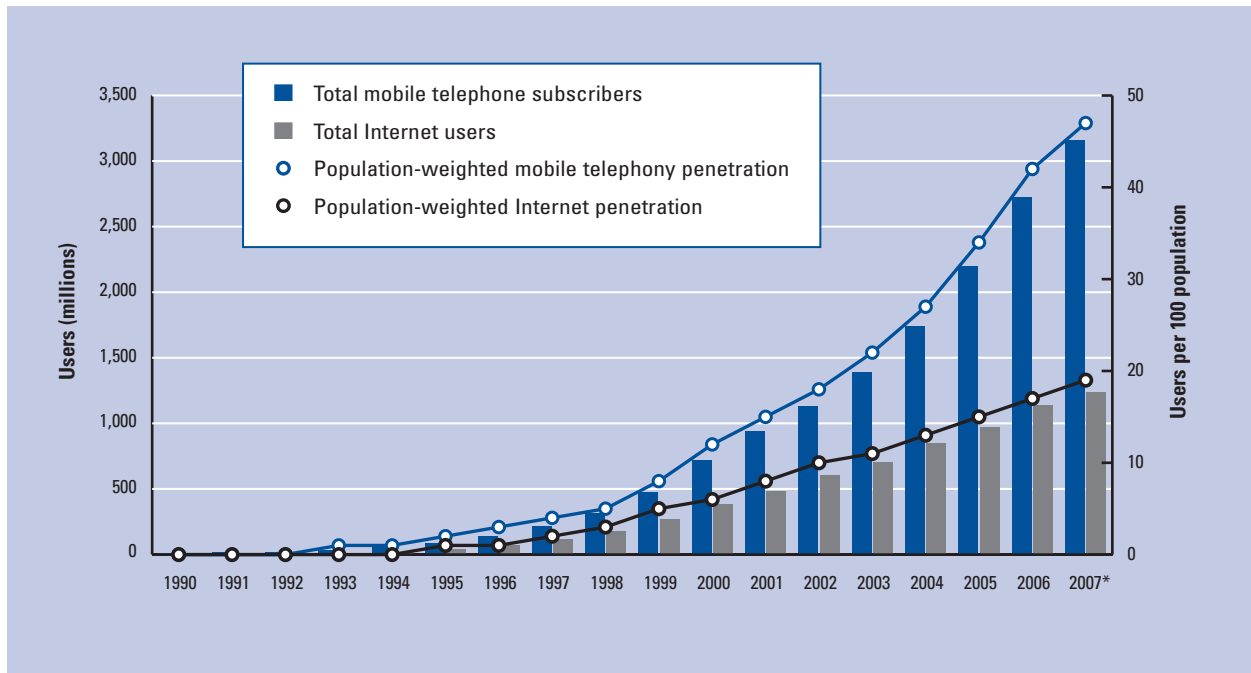
The above trend bodes well for reducing the digital and economic divide between developing and developed economies, given the extensive body of literature and the evidence pointing to the economic and social benefits of mobile telephony.

In line with the theme of mobility, this chapter aims to further explore the connection between mobile telephony and economic growth and development, as well as identify the impact, if any, of mobile technologies on countries' networked readiness, as captured by the Networked Readiness Index (NRI) featured in this *Report*. Does mobile penetration, used here as a proxy for "mobile readiness," affect general networked readiness and, if so, does it do so equally for all countries, regardless of their development level?

After a brief overview of the evolution of mobile penetration in recent years, the chapter will focus on mobile telephony and its impact on GDP and networked readiness.

Mobile penetration across the world: A remarkable success story of our day

There is no doubt that mobile telephony has been not only among the most revolutionary technologies of the last couple of decades, but also among the most adopted and rapidly spreading in the developed and developing world. A comparison with Internet diffusion is quite telling. Although often the Internet is mentioned among the fastest-growing technologies worldwide, a glance at Figure 1 shows that Internet penetration has indeed expanded over the last 20 years, but not as fast as mobile telephony. Using ITU data, we estimate that the number of mobile telephone users increased from 11.1 million in 1990 to 3.2 billion in 2007. The number of Internet users went from 2.6 million to 1.2 billion over the same period.

Figure 1: Mobile telephony penetration and Internet usage, 1990–2007

Source: Authors' calculations, based on ITU, 2008.

*Preliminary data

Figures 2 to 4 complement Figure 1, providing more detailed information on the growth of mobile telephony penetration across the world and by income group.³ These figures also illustrate how the growth has been particularly impressive in low-income countries.

Figure 2 describes the evolution in absolute mobile telephony penetration by income group. It shows notably that the group of low-income countries has increased the most: between 1995 and 2006, the number of subscribers grew by an average 90 percent annually, compared with an annual average of 26 percent and 36 percent for OECD and non-OECD high-income countries, respectively. This is a very positive trend, although these data should be taken with some precaution: low-income countries started from a much lower penetration basis than high-income ones and, as shown in Figure 3, the story told by population-weighted average penetration rates is rather less rosy, with a penetration still limited to 18 percent of the population in low-income countries in 2007 versus 107 percent and 114 percent for OECD and non-OECD high-income countries, respectively.⁴

Another way to gauge the growing importance of mobile telephony globally is to analyze the share of mobile subscribers in total telephone subscribers since 1990. As Figure 4 illustrates, not only has this share risen globally from 2.1 percent in 1990 to 77.3 percent in 2007, but, quite predictably, the most marked rise has come from low-income countries, where it has gone from 0 percent in 1990 to 86.3 percent in 2007.

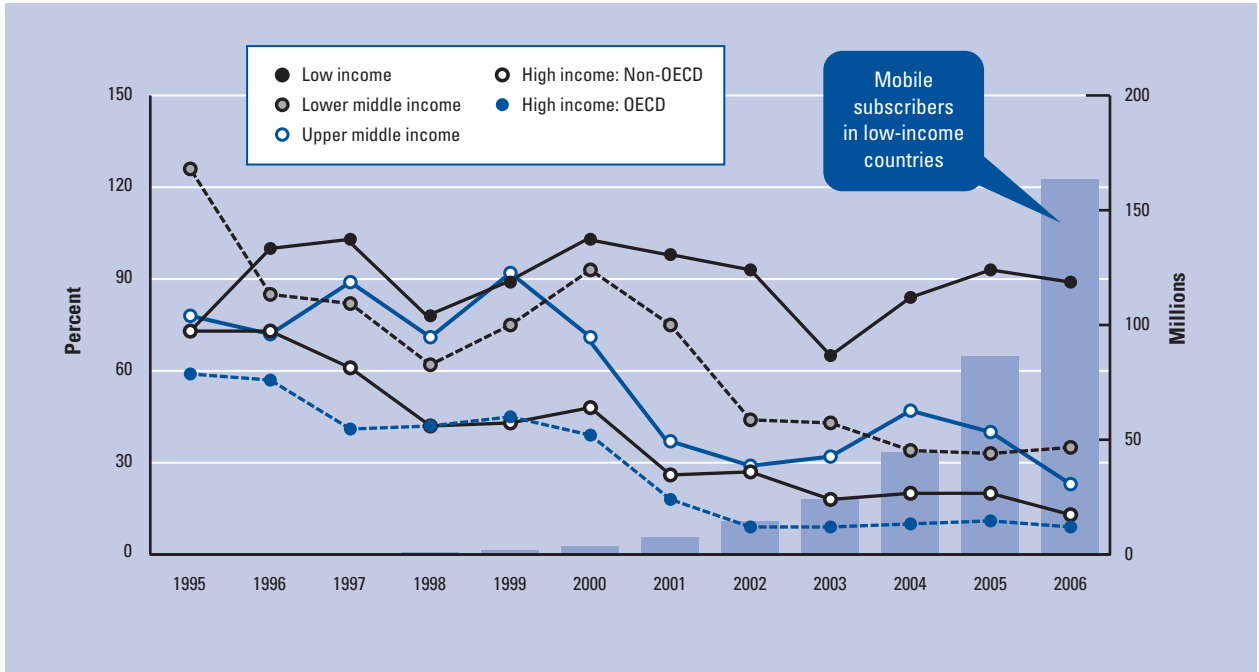
This is partly explained by the fact that mobile technology has allowed many developing countries to leapfrog the lack of fixed infrastructure and thus provide access to telephony services to a much larger portion of their citizens.

Mobile technology's relative simplicity for being deployed and used, together with its versatility and the diminishing costs of both handsets and calls, have been some of the key enablers in its impressive diffusion.

In terms of versatility, even without considering the most advanced—and expensive—mobile applications being constantly developed and adopted in the rich part of the world, there are plenty of examples that illustrate how mobile phones can facilitate business and enable access to markets and to services, not to mention social life. According to the United Nations Conference on Trade and Development (UNCTAD), for example, mobile phones have become the most widely used form of ICT by African businesses to deal with their clients and providers.⁵ More generally, m-commerce is becoming an important modality of selling and buying goods in the developing world, which is also facilitated by banking and payment via mobile phones.

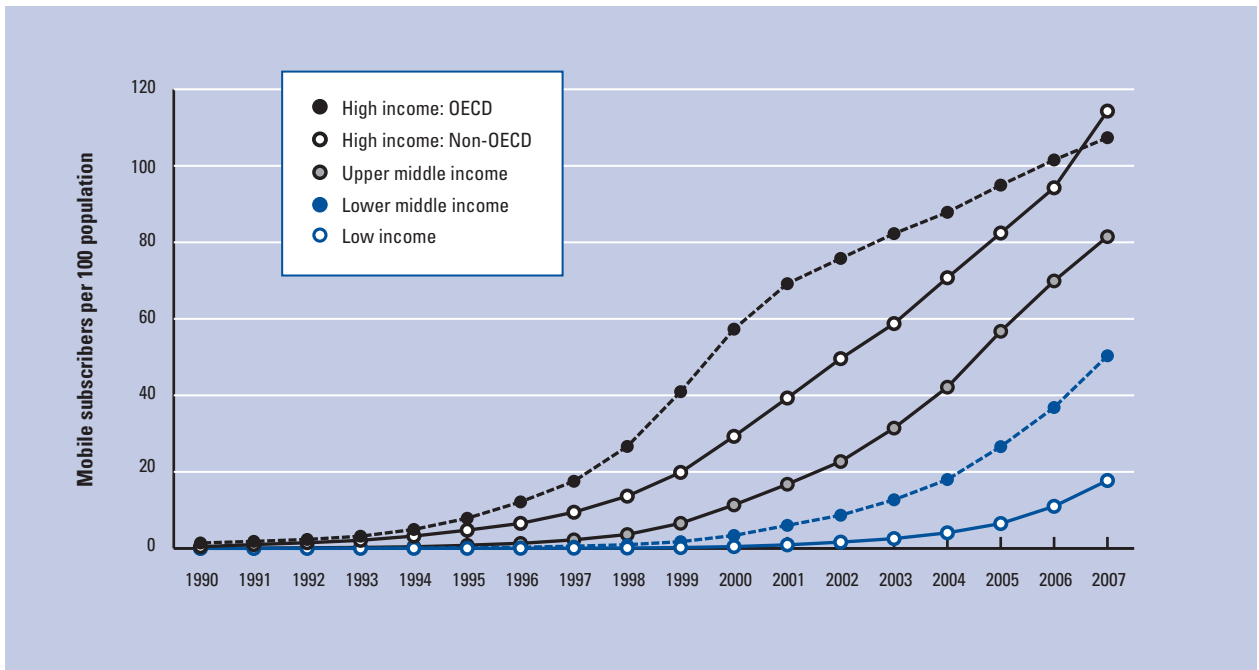
Regarding costs, Figure 5 shows the evolution in mobile call costs in basis points (hundredths of percentage points) of GDP per capita since 1995. Despite large fluctuations, partly attributable to data availability issues, telephony costs have been declining not only for developed countries but also for low-income ones. This trend is reinforced and complemented by a dramatic reduction

Figure 2: Growth of mobile telephony penetration rate, 1995–2006

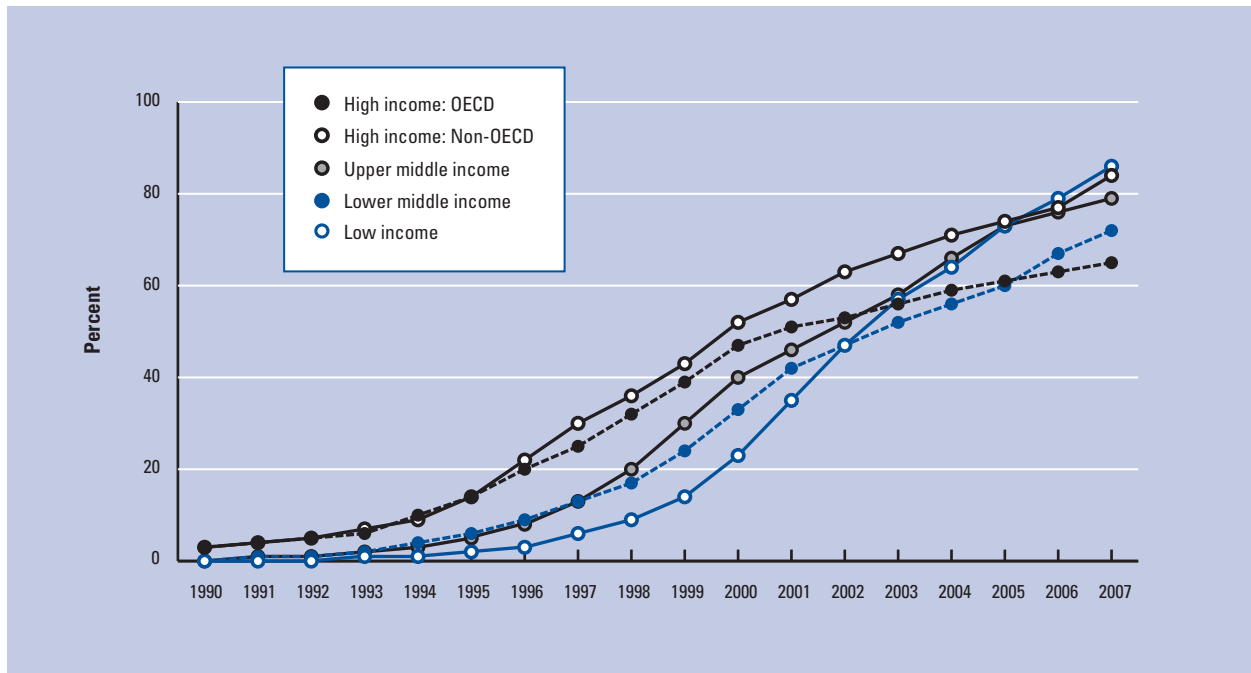


Source: Authors' calculations, based on ITU, 2008.

Figure 3: Population-weighted average mobile penetration rate, 1990–2007



Source: Authors' calculations, based on ITU, 2008.

Figure 4: Share of mobile subscribers in total telephone subscribers, 1990–2007

Source: Authors' calculations, based on ITU, 2008.

in the cost of handsets, which have come down to as little as US\$15 in some developing countries.

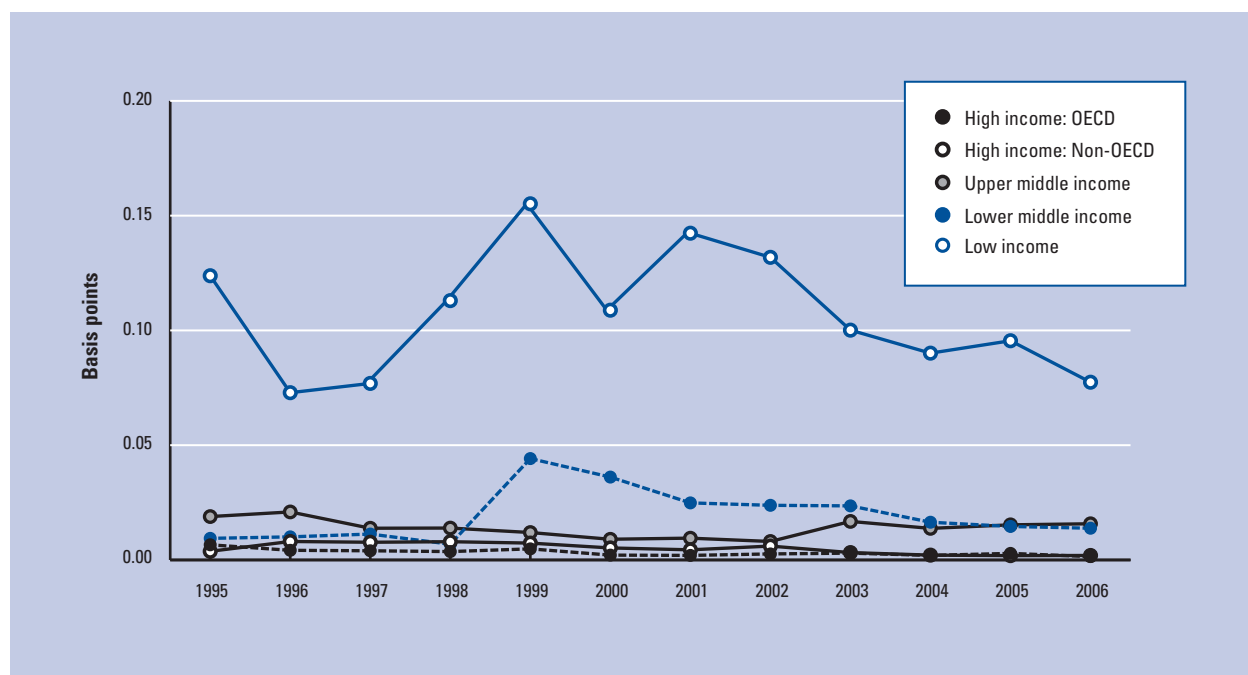
The costs for the poorest segment of the population in developing countries could be further reduced with some relatively simple changes in billing practices. For instance, Barrantes et al. found that access to mobile services would be greatly expanded in Latin America if the mobile phone operators would allow billing practices per second or “mini-recharges” of the pre-paid cards.⁶

Mobile technology: Impact on GDP growth and countries' networked readiness

There is extensive literature and much evidence about the economic and social benefits associated with mobile telephony. In particular, a number of studies have demonstrated the positive impact of mobile penetration on economic growth and development,⁷ which also has an important bearing on poverty reduction and on bridging the digital divide.

This impact on economic growth takes a variety of forms, which can be grouped into a number of sub-categories. These include:

- *Improvement of market and business efficiency.* The introduction and usage of mobile telephony can provide economic operators with better access to the goods markets and information they need to manage their business more effectively. This is even more the case for industries and sectors intensive in information.
- *On a similar note, mobile phones can be used to send personalized job listings to job seekers, thus improving the functioning of labor markets.*
- *Larger access to financial services.* Mobile banking and mobile payments represent a cheap alternative for the poor in developing countries to gain access to the formal financial market and consequently to credit, insurance, and money transfers. In particular, mobile telephony facilitates remittances to developing countries, making them easier and cheaper. This has a special relevance for growth, since remittances nowadays represent more than double the amount of foreign aid to the developing world and are therefore among the most important sources of finance in many countries.⁸
- *Job creation.* Investment in mobile network infrastructure and related services directly and indirectly generates employment opportunities.
- *More efficient provision of health-care services.* Mobile phones have proven to be a very helpful complement in the collection of health data, and they are key for better health-care provision and the treatment of patients (for instance, in reminding patients via short message service (SMS) of the medication they need to take).

Figure 5: Mobile call cost as a share (basis points) of GDP per capita, 1995–2006

Source: Authors' calculations, based on ITU, 2008.

Note: A call is a three-minute call during peak period. Country groups' average costs are weighted by country population.

These illustrations seem to suggest that mobile telephony and its applications have a greater impact in the developing world, where their deployment can yield enormous productivity gains. For advanced economies, which are approaching the technological frontier, such gains will necessarily be smaller. Enhanced productivity, in turn, is a major source of economic growth and, hence, increased prosperity. The relationship between mobile telephony usage and economic prosperity should therefore be stronger for the least-developed countries.

Figure 6 plots mobile telephony penetration, which we use as a proxy of mobile readiness, against the log of GDP per capita (valued at purchasing power parity) to explore whether the above hypothesis is correct.

As can be seen from the figure, the relation between mobile penetration and GDP per capita is a positive one. A simple regression of GDP per capita on penetration rates yields a high R^2 of 0.76.⁹ Yet as wealth increases, the relation gets looser. It totally breaks down for advanced economies. When considering only the 88 developing countries that belong to the low-income or middle-income groups, the R^2 is 0.70. For the 44 high-income countries, the R^2 is almost zero (0.03).¹⁰

These findings appear to corroborate the fact that mobile penetration is particularly relevant for developing countries as an enabler of increased growth, while it becomes less crucial as a country evolves to higher stages of development.

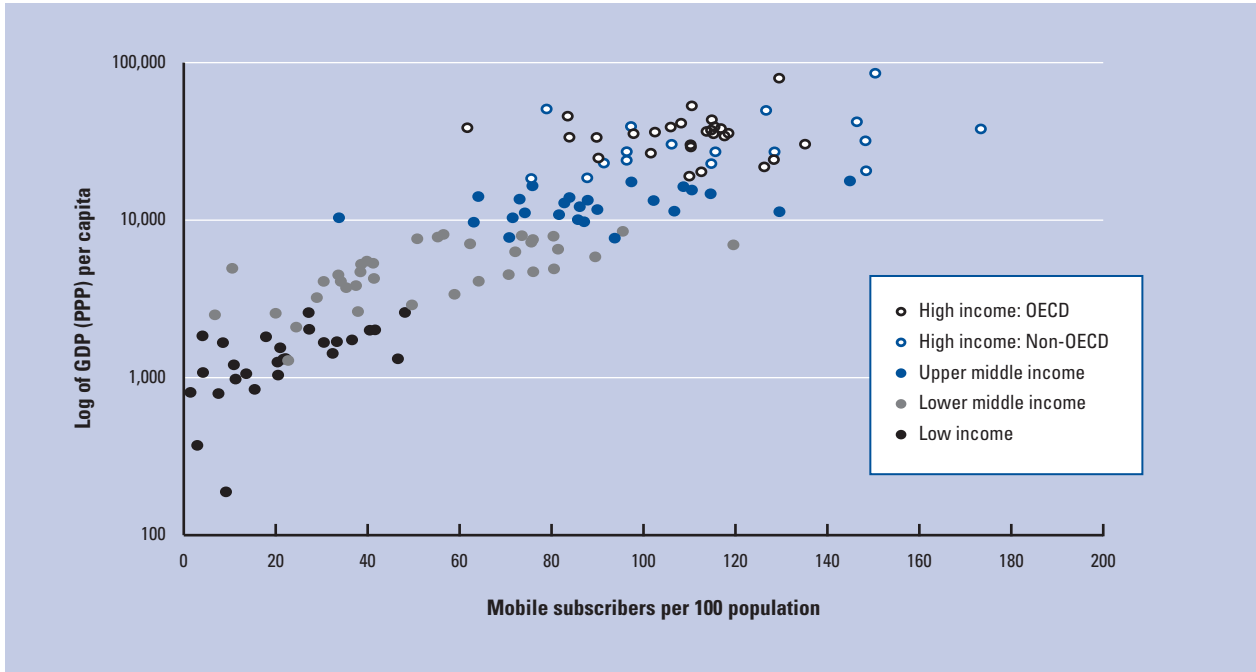
Mobile telephony and networked readiness

After having explored how mobile telephony contributes to economic growth, the relationship between mobile telephony and networked readiness is examined—that is, countries' capacity to leverage ICT for development. To what extent do the spillovers generated by the usage of mobile telephony translate into enhanced networked readiness as captured by the NRI?

One straightforward way to analyze the relation between mobile telephony diffusion and the NRI is to simply compute the correlation between the 2007 mobile telephony penetration rates for the 134 countries covered in this *Report* and their respective scores on the NRI 2008–2009.¹¹ This generates an R^2 of 0.75, since countries with high mobile penetration rates tend to score well in the NRI, although the high correlation does not necessarily entail a causality link at this stage.

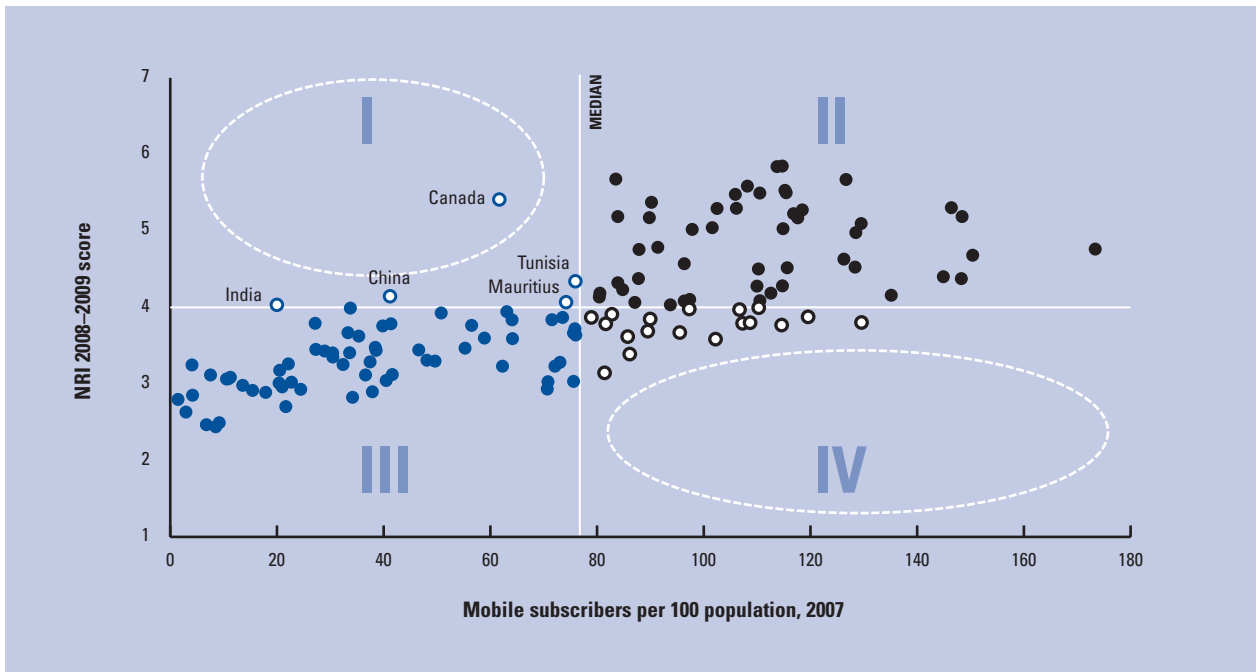
Furthermore, the basic scatter plot presented in Figure 7 reveals the existence of a “glass ceiling” in terms of networked readiness (Y-axis) around the middle score of 4.0. Only countries with penetration rates higher than the median rate of 73.2 mobile subscribers per 100 population seem to break through this ceiling. There are very few exceptions. Out of 134 countries, only five (4 percent) combine an NRI score *above* the middle score and a penetration rate *below* the average rate. Among these, Canada is in a league of its own. The country ranks 10th in the NRI, with just 61.7 mobile subscribers per 100 population, largely below the median rate. The other four countries are located either at

Figure 6: GDP per capita and mobile penetration rate, 2007



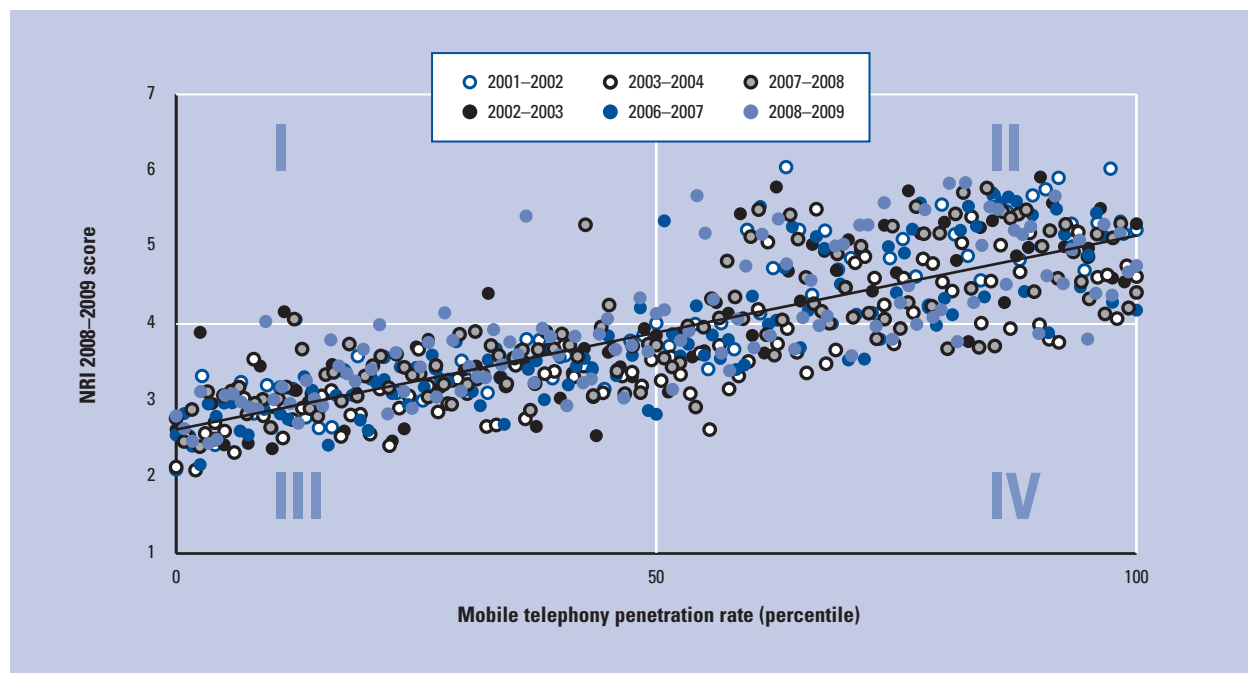
Source: ITU, 2008; IMF, 2008.
 Note: Montenegro and Puerto Rico not included due to limited data availability.

Figure 7: Mobile penetration and networked readiness, 2007



Source: World Economic Forum; ITU, 2008.

Figure 8: Mobile telephony and networked readiness over time



Source: World Economic Forum; ITU, 2008.

the very bottom of panel I, such as India (with an NRI score of 4.02 and 20 subscribers per 100 population) and China (4.15 and 41), or at the very right of the panel, such as Mauritius (4.07 and 74) and Tunisia (4.34 and 76).

We also carried out a similar analysis with historical data. We compared NRI scores from six of the eight editions of the NRI, including the earliest and the latest, and the mobile penetration rates for the corresponding years.¹² This represents 638 pairs of scores and penetration rates. In order to deal with the increase in penetration rates, for each year we convert penetration rates into percentile rankings. For each year a percentile rank of 0, 100, and 50 corresponds to the lowest, highest, and median penetration rate, respectively, within the sample of countries for that year. This way we can overlay on one single chart the results of several editions.

The same transformation is not necessary for the NRI scores. The NRI overall score is an average of *relative* scores.¹³ Hard data indicators are normalized so that the best- and worst-performing countries in the sample receive a relative score of 7 and 1, respectively.¹⁴ The absolute scores of the other countries are rescaled linearly so that the distances between them remain proportional. The normalization is redone every year and considers only the value of the current year. This is why NRI scores do not increase from year to year even if the underlying indicators' values do. They always range between 1 and 7.

The results are represented in Figure 8, which looks very similar to Figure 7. North of the 4.0 value on the Y-axis and east to the median rate on the X-axis, the northwest quadrant (Panel I) appears very scarcely populated. As a matter of fact, out of the 638 considered data points, only 20, or 3 percent, belong to that panel. This is a remarkable result considering that, over this eight-year period, mobile telephony diffusion increased, depending on the region, anywhere from 2 to 40 times. All countries, including the least advanced, have seen mobile telephony usage grow dramatically. Yet the ceiling has not disappeared. Only a handful of countries have managed to move from Panel III to Panel I over the past eight years—that is, to overperform in the NRI with a mobile penetration below the median rate. These are China, India, Jamaica, Mauritius, and Thailand. Four other countries—Canada, Italy, Netherlands, and Barbados—continue to overperform in the NRI with respect to their mobile penetration despite falling behind in terms of mobile telephone usage. Finally, Puerto Rico and Tunisia have remained in Panel I since their first inclusion.

Out of the 20 combinations inside Panel I, the biggest outlier is Canada—both in 2007–2008 (43rd percentile for mobile penetration rate and NRI score of 5.29) and in 2008–2009, as discussed above. All the other cases are relatively close to the frontier with the other quadrants.

Although a low mobile penetration rate (i.e., below the median rate) seems to virtually disqualify a country

from reaching the top positions in the NRI rankings, the converse is not true. High mobile telephony diffusion does not necessarily lead to a high level of networked readiness. Returning to the NRI 2008–2009 results and 2007 penetration rates (displayed in Figure 7), we see that 18 of the 67 countries with penetration rates above the median rate score 4.0 or lower in the NRI.¹⁵ The same pattern holds true when one takes into consideration the results from all editions of the *Report* (reference is made to Figure 8). Out of the 307 combinations with a penetration rate above the median (Panels II and IV), 78, or 25 percent, have an NRI score lower than 4.0.

Another interesting observation is that, although clearly positive, the relationship between mobile telephony usage and networked readiness gets looser as usage increases. This can be clearly seen in Figures 7 and 8, and the correlation coefficients provide further evidence. Considering only the points inside Panel III in Figure 7, the correlation between the two series is 0.58. For points inside Panel II, the correlation is only 0.13. Again, this observation continues to apply when considering the historical data. Correlation for the sample of points inside Panel III (311 points) of Figure 8 is 0.60 while it drops to 0.20 for the 229 points inside Panel II.

Conclusion

Building on the overall theme of this *Report* and previous studies on the impact of mobile telephony on economic growth, this chapter is an attempt to provide some clarity on the relationship and interrelations existing between mobile telephony diffusion and the capacity of countries to use ICT to improve their competitiveness, as measured by the NRI. One would logically expect that mobile readiness has a strong impact on overall networked readiness of countries and therefore on sustained economic growth and development. Our analysis shows that this supposition is true, but only to a certain extent. While the latest data as well as historical data demonstrate that only a handful of countries with low mobile telephony penetration rates achieve above-average networked readiness levels, we found that high mobile telephony penetration is not inevitably synonymous with high networked readiness. Mobile telephony usage, therefore, appears to be a necessary but not sufficient condition of enhanced networked readiness. We also observed that the relation between mobile telephony usage and GDP per capita is clearly positive, but is about three times as strong among low- and lower-middle-income countries. This suggests that the booming mobile phone penetration rates observed in poor countries in recent years can indeed help them reduce poverty and foster economic performance.

Notes

- 1 According to ITU data, in 2007 there were some 2.4 billion subscribers in the developing world (low-income, lower-middle-income, and upper-middle-income countries) as opposed to 920 million in high-income countries.
- 2 See Kalil 2008.
- 3 In this chapter, we use the World Bank's "World by Income" country classification (as of December 2008). The classification is based on 2006 gross national income (in US dollars) per capita. The four income groups are defined as follows: Low income: \$905 and less; lower middle income: \$906–\$3,595; upper middle income: \$3,596–\$11,115; high income: \$11,116 and more.
- 4 Population-weighted average penetration rates are calculated using estimates based on 164 countries for which 2007 data were available.
- 5 UNCTAD 2007.
- 6 Barrantes et al. 2007.
- 7 For a review of the literature in question, see De Silva and Zainudeen 2007 and Chapter 1.4 of this *Report*.
- 8 See Kalil 2008, p. 10.
- 9 Only the countries covered in this *Report* were considered. Though covered, Puerto Rico and Montenegro were not included because of the unavailability of PPP estimates for these countries. GDP data are from 2007 for all countries. Mobile telephony data are from 2007 for 119 countries, from 2006 for 10 countries, and from 2005 for 3 countries.
- 10 Admittedly, the number of observations affects the coefficient of determination, yet it cannot alone account for this huge difference.
- 11 Mobile telephony penetration, measured by the number of mobile telephone subscribers per 100 population, is one of the 68 indicators entering the NRI, but that by itself is not enough to draw any conclusion as to the nature of the relationship. Given the very small implicit weight of each indicator—mobile telephony penetration accounts for 1.2 percent of the overall score—this is unlikely to cause an endogeneity problem that would make the analysis spurious.
- 12 We included in the analysis the 2001–2002, 2002–2003, 2003–2004, 2006–2007, 2007–2008, and 2008–2009 editions of the NRI. The 2004–2005 and 2005–2006 editions use a different methodology for score computation and the results are not on the traditional 1-to-7 scale. For the 2001–2002 edition, we used penetration rates from 2000; for 2002–2003, we used 2001, and so on.
- 13 Unlike percentile ranking, which is an ordinal measure (only the order of the values of the underlying data matters), the normalization of the hard data yields a cardinal measure (both the order and the value of the underlying data matter).
- 14 The general normalization formula is:

$$6 \times \left(\frac{\text{country score} - \text{sample minimum}}{\text{sample maximum} - \text{sample minimum}} \right) + 1$$
- 15 Yet only the upper right corner of quadrant IV in Figure 7 is populated, meaning that no country with above-median penetration rates appears in the bottom tier—a score less than 3—of the NRI ranking.

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