

## How to Maximize the Economic Impact of Mobile Communications: The Four Waves

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Ever since man hunted the mastodon, the ability to communicate over ever-expanding distances has been a key element of human success and advancement. But the modes of communication available and the power of the telecommunication technologies that people utilize have increased dramatically in the last 150 years with the advent of telegraph, telephone service, and now wireless (mobile) networked telecommunication services offering applications such as email and Internet access, and the ability to ignore geographical limitations in the organization of economic and social interaction. Further, progress in telecommunications has been neither linear nor even. The pace of development and innovation has increased in the last 25 years, resulting in an increasingly boundary-less world. Many of these developments have become an integral part of our daily lives—wireless telephony, Internet usage, and email—and yet just 15 years ago, these were “early stage” technologies, at least from a consumer perspective.

The first submarine telephone cable was laid in 1956, just 52 years ago. TAT-1, the joint venture of the UK government and AT&T—a project that was worth £120 million—was one of the three engineering marvels of the 1950s (the other two were Sputnik and the TransCanada Gas Pipeline). TAT-1 had a capacity of 83 simultaneous voice signals. Prior to TAT-1, international calls from New York to London were wireless! (The calls were made via radio waves bounced off the stratosphere.) In 1970, according to the International Telecommunication Union (ITU), there were just 8 telephone lines per 100 inhabitants in France, a number that rose to 30 by 1980, and, with the advent of mobile telephones, 141 lines (fixed and mobile) per 100 inhabitants by 2006 (see Table 1). Today we take relatively affordable and reliable long-distance services and near-universal mobile and fixed telephony for granted in the developed world. Yet these examples demonstrate just how recent the modern telecommunications environment is, even in an affluent country such as France.

In the developing world, the modern telecommunications environment has largely been created by mobile telephony. Malaysia went from having 1 fixed telephone line per 100 inhabitants to 9 fixed lines per 100 inhabitants in 1990, to 92 lines per 100 in 2006, with a mobile penetration rate of 75 per 100. Even more tellingly, Nigeria achieved a teledensity of 25 lines per 100 inhabitants in 2006; 24 of these are mobile telephones. As a result of mobile telephony, teledensity in Nigeria today is at levels similar to that of France in the late 1970s, a remarkable achievement. As Mo Ibrahim, the founder of Celtel, has written, “Fixed lines can never connect Africa: less than 1% [of the population] in Sub Sahara Africa [were connected] 100 years after development of the phone.”<sup>1</sup>

Three questions immediately come to mind: first, what has been the impact of the significant increase in teledensity on economic output and welfare; second, if

**Table 1: Evolution of total telecommunications penetration, selected countries**

Country	Year	Fixed penetration	Mobile penetration	Total telecommunications penetration
China	1970	n/a	0	n/a
	1980	0	0	0
	1998	7	2	9
	2006	28	35	63
France	1970	8	0	8
	1980	30	0	30
	1998	58	19	78
	2006	56	85	141
India	1970	0	0	0
	1980	0	0	0
	1998	2	0	2
	2006	4	15	18
Malaysia	1970	1	0	1
	1980	3	0	3
	1998	20	10	30
	2006	17	75	92
Nigeria	1970	n/a	0	n/a
	1980	n/a	0	n/a
	1998	0	0	0
	2006	1	24	25
Sweden	1970	45	0	45
	1980	58	0	58
	1998	72	46	119
	2006	61	106	167
United Kingdom	1970	17	0	17
	1980	32	0	32
	1998	55	25	81
	2006	56	117	173
United States	1970	34	0	34
	1980	41	0	41
	1998	65	25	90
	2006	56	80	136

Source: ITU, 2008.

telecommunications are so important to the economy, why is Nigeria still vastly poorer than France was in the 1970s; and third, how do we maximize the social gains from telecommunications?

One of the main ways in which modern telecommunication networks affect economic output and welfare is through their effect on how rents are captured and distributed. Picture a remote village in Indonesia today. That village and its inhabitants cannot easily take part in a market economy. Agriculture tends to be subsistence—not because farmers want to tend small lots, but because little information and few market opportunities are present. For example, farmers cannot easily gather information about prices that prevail for their produce at nearby markets. Nor can they easily gather information about the prices of inputs such as fertilizer and feed that they need for their farms. The simple fact of owning a mobile telephone can transform their intelligence-gathering capabilities, and with it the

distribution of bargaining power among farmers, middlemen, and sellers is also transformed.

Hence, modern communications in the developing world today—principally wireless communications—lowers transaction costs and redistributes rents by reducing the market power that arises from asymmetric information. This is best seen in Jensen's research, which describes the impact of mobile telephony in changing a situation in which the primary reason that rural producers (fishermen, in this case) earned lower profits and consumers paid higher prices was the distribution of information on demand and supply conditions. Without mobile telephones, fishermen and traders typically knew only the price of fish in a handful of nearby villages or the nearest town. Fuel costs limited the markets at which a fisherman could dock; little storage capacity was available, and ground transportation costs were high. "The inefficiency is clear," Jensen writes. "While at Badagara there are eleven fishermen dumping their catch unsold, there are twenty-seven buyers within fifteen kilometers who are about to leave without purchasing any fish."<sup>2</sup>

Following the introduction of mobile telephony between 1997 and 2001, prices for consumers fell by an average of 4 percent, and fishermen's profits rose by 8 percent. Middlemen who previously earned rents through their control of information and resources related to the dissemination of information lost out. Jensen found that profits rose even for fishermen who did not use mobile telephones. The study by Jensen is a powerful example of the fact that mobile telephones are very much an information technology, and that these information technologies affect economic life in very basic and intuitively understandable ways.

At a macroeconomic level, Waverman et al. found—based on the then-available evidence—that an increase in mobile telephone penetration had a positive and statistically significant impact on the rate of long-term economic growth.<sup>3</sup> Mobile telephones were a vital aspect of social overhead capital to the extent that an increase of 10 lines per 100 inhabitants was associated with an increase of 0.6 percentage points in the long-term rate (20 years) of economic growth.

The Jensen paper and the earlier paper by Waverman et al. both estimate the value of *access* to mobile telephones, since they examine the impact of the increase in the availability of the number of telephones themselves (see Appendix A for a more detailed review of the literature on the subject). However, the effects described in detail by Jensen and implicitly captured in Waverman et al.'s aggregate-level analysis are the effects of not merely having access, but of *usage* of modern telecommunication networks. But these approaches and others do not, in their statistical analysis, examine the contribution to economics and society from modes of use. Thus a next step would be to examine how access and usage contribute to society.<sup>4</sup>

The existing research does, nevertheless, at some level answer the questions surrounding the value to society from modern telecommunication networks. However, one needs also to consider (1) whether factors such as taxation, regulation, social customs, and the like enhance or moderate the value that individual societies derive from investment in modern telecommunication networks, chiefly mobile networks in developing nations; (2) to what extent investment in mobile telecommunication networks requires complementary investment in education, other basic infrastructures, and the like; and (3), to drive productivity growth beyond the huge effects of simple access, how do these complementary investments in assets and skills boost the “bang for the buck” that mobile investment might provide?

Answering these questions will explain both why Nigeria today is poorer than France in the 1970s despite having similar teledensity levels, and also what Nigeria might need to do to boost the impressive strides that the mobile telecommunications sector has made in that country. Literacy rates in France in the 1970s were far higher than they are in Nigeria today, roads were better, and health care was better. Clearly the simple addition of more mobile telephones cannot in itself cure the deep-rooted problems that countries such as Nigeria face. There is no magic bullet solution for economic development, but mobile telecommunications has indeed a “positive disruptive” impact on life in many developing economies, especially in rural areas, where the mere availability of information poses a significant challenge to established ways of doing things. Further, the mobile telecommunications sector provides a significant example of an industry that has survived, thrived, and proliferated even in the seemingly most unpromising environments.

### The four waves of communications

Indeed, one might argue that there are roughly four stages of development of an information society, which one might call the *four waves of communication technologies*:

- simple access,
- universal service,
- usage, and
- provision of complementary skills and assets.

*Simple access*: a telephone in a village, for example, provides huge social and economic benefits. As shown by the example of Jensen above,<sup>5</sup> the ability to make or take a call diminishes the asymmetry of information control. The literature generally illustrates the enormous benefits of access. One line per village might well then have huge social payoffs.

*Universal service* was and is the policy driver for much of North America and Western European telecommunications policy. Because the technology at

that time was fixed lines, a connection to every household provided universal service. Policy was devoted to ensuring that each household had access to the telephone system. Mobile telephones change the notion of universal access from one telephone per household to one telephone per person.

*Usage*, as discussed above, is the means through which the productivity and economic benefits of communication networks are manifested. Usage of mobile telephones is affected by the cost of calls (here taxes are important as an obstacle to usage) as well as by institutional arrangements such as the sharing of costs between the calling and receiving party. If (as the econometric research on fixed-line telephony suggests),<sup>6</sup> demand for calls or usage is significantly more elastic than demand for access, then high levels of taxation on mobile telephones might lead to significant “deadweight loss” (loss of welfare) as well as reduce the potential growth and productivity benefits derived from the infrastructure in place.

Insufficient attention has been paid to the impact of institutional arrangements. Penetration appears to be somewhat lower in some “receiving-party-pays” countries (countries where the receiving party is charged for receiving a call on a mobile telephone) than in “calling-party-pays” countries (where the receiving party makes no contribution to the costs of the call). Penetration of mobile telephones also appears to be lower in countries that utilize multiple standards (Global System for Mobile communications, or GSM; Code Division Multiple Access, or CDMA; etc.) relative to countries that utilize just the GSM standard. Crucially, however, the same is certainly not true for data on minutes of use—usage is higher in countries with multiple standards as well as in countries where the receiving party pays part of the costs of a call. Increased competition emanating from the institutions may be the answer; more research is needed.

Finally, *complementary skills and assets* refers to the concept that productivity growth today emanates not just from simple access, universal service, and usage, but also from what one might term the “quality of usage” or “smart usage.” Using firm-level data allows one to address some quite targeted hypotheses regarding, for example, the impact of particular technologies, managerial practices, and public policies on firms productivity, output, and efficiency, while being able to control for the other characteristics of firms that also effect productivity, output, and efficiency.

Although we are aware of no specific research on the productivity impact of mobile telephones conducted at the firm level, there is a significant body of literature that looks at the impact of information and communication technologies (ICT) on firms. The findings from this literature are deeply informative: papers by several noted authors, including Brynjolfsson and Hitt,<sup>7</sup> suggest that the payoff to firms from investing in ICT is highest

when firms have the freedom and willingness to reorganize themselves around the ICT that is in place. Other research finds that the impact from investment in ICT may not materialize unless and until there is a significant amount of investment in “complementary capital”—such as worker training, for example.

The findings from this literature are relevant to any future research agenda for studying the economic impact of mobile telephones—which are the most widely diffused form of ICT hardware in most developing nations. One would expect that the impacts of mobile telephony, or ICT more generally, are highest in nations that have a cultural and regulatory climate that welcomes change, and where firms and individuals are most free to reorganize their work habits to make optimal use of technology. While it may seem obvious and intuitive that this is the case, the reality is that the literature on mobile communications and telecommunications generally has not, to date, looked in sufficient detail at factors beyond penetration.

We suggest that only when a country has evolved through all four waves described above is it able to make the fullest use of technology. The literature and policy debate that we have experienced has to date concentrated essentially on the first two waves. In part, this emphasis is an artifact of data availability. To truly study the impact of usage and complementary capital in a manner similar to the research that has been conducted for the impact of ICT in developed economies, one would have to collect detailed firm-level and consumer-level data, which requires a patient and costly research program. However, some initial studies of consumer-level demand patterns are being conducted for countries such as South Africa.<sup>8</sup> Clearly, the development of such research should be of paramount importance, as only when we understand the role of usage and complementary capital in governing gains from ICT in a developing-country context can we provide policymakers with a truly robust assessment of the policies that will enable them to maximize the returns from ICT investment.

We have used these concepts to produce a new method to measure the “connectedness” of countries. This *Connectivity Scorecard* adds to the literature, in a way similar to that of the Networked Readiness Index in this *Report*, by providing novel ways to incorporate infrastructure, access, and usage into measures of communication systems importance.<sup>9</sup>

The remainder of this chapter provides some recent estimates of the welfare loss from high mobile taxation in developing nations. We then conclude by drawing some lessons from the literature that might be used to evaluate arguments regarding the appropriate role of government intervention and regulation in the current challenging economic environment.

Finally, it is worth mentioning that 3G or wireless mobile telephony could have a particularly important impact in the developing world. 3G and other modes of

broadband wireless access may represent the most cost-effective way to bring broadband or even Internet access to the masses. Further enabling the introduction of mobile broadband is likely to stimulate inter-platform competition in the broadband market in these countries, with the main different platforms likely to be public switched telephone network (PSTN) for digital subscriber line (DSL) access, fixed wireless (technologies such as WiMax), and wireless (3G and 4G technologies). Developing countries are likely to enjoy the benefit of adopting 3G+ technology at a time when devices and applications relevant to enhancing the mobile broadband experience are entering a mature developmental phase; thus one can expect relatively rapid diffusion of 3G technology in these emerging markets.

### Some policy considerations

Despite the fact that many governments and mobile network operators are in total agreement regarding the growth benefits of mobile telephony, several aspects of government policy in developing countries actually affect the mobile sector in adverse ways. Two areas of policymaking where governments in developing nations (particularly) would be well served by taking a broad view of the mobile telecommunications sector as a potential catalyst for growth, rather than as a ready revenue source, are taxation and licensing. Below, we discuss these policy aspects briefly.

### Consequences of asymmetric taxation on mobile usage

The GSM Association has prepared several papers documenting the incidence of taxation on the mobile sector. In some countries, such as Turkey, taxes represent as much as 44 percent of the cost of owning and operating a mobile telephone. The impact of taxation on usage (e.g., the taxes that some countries levy as a proportion of a subscribers’ bill that includes usage and line rental charges) might be particularly significant.

Although there is little detailed econometric research on the issue, it is likely that the price elasticity of demand for “calls” or “minutes” is at least somewhat higher than the price elasticity of demand for “access” (or owning a telephone). Thus, taxes are likely to be a bigger barrier to utilization of mobile telephones than they are to ownership of a mobile telephone.

Hausman provides a relatively simple method for evaluating consumer welfare gains from introducing mobile telecommunications and for assessing the deadweight loss caused by taxation of mobile telecommunications.<sup>10</sup> Hausman’s papers suggest that the deadweight loss is likely to be significant when (1) demand is relatively elastic and (2) when an industry has relatively high fixed costs and relatively low marginal costs (i.e., gross margins are high).

Using sensible values for elasticity and gross margins, we recently calculated that the annual deadweight loss

caused by mobile telecommunication taxation on the usage of mobile telephones in Turkey was over US\$2 billion, or more than 60 cents for every dollar raised in tax revenues.<sup>11</sup> By contrast, the typical deadweight loss from general taxation is around 20 to 30 cents per dollar of tax raised. That is, Turkey would raise economic welfare and economic growth by shifting taxes from mobile use to other goods and services.

The mobile sector provides an attractive target for exchequers in developing nations—mobile operator revenues are relatively easy to record, and most operators are large companies that happen to be good corporate citizens. Absolutely no economic theory of commodity taxation supports the notion that mobile telephones should bear an especially high tax burden. Mobile telephone usage is not a “sin” that merits a sin tax, it does not have negative externalities meriting a Pigouvian tax designed to reduce usage of mobile telephones (perhaps the opposite can be argued to be desirable), and mobile telephones are not what economists would describe as complements to leisure. Mobile telephones are not a luxury good, and high mobile telephone taxation may particularly discourage usage by less affluent sections of society whose ability-to-pay is relatively low. Thus high mobile telephone taxation is iniquitous and regressive in its nature.

There is another impact of taxation besides the efficiency or static welfare losses described above. Taxation may dampen investment and entry in the mobile telecommunications sector. Given the likely high social rates of return on telecommunications investment, lower investment is likely to translate into lower economic growth. Further, given that the “broadband for the masses” may largely be a mobile-driven story in at least some developing markets, and that entry by mobile or wireless broadband operators into the broadband space has a key role to play in providing sufficient investment and competitive incentives for other players in the broadband sector (fixed PSTN, and fixed wireless), one may have reason to believe that the economic impact of mobile taxation may affect large swathes of the economy in an adverse fashion.

#### Licensing and auctions policy

Besides taxation, it may also be tempting for governments to use licensing policy solely as a means to raise revenues or (worse) to orchestrate industry outcomes and favor particular players, technologies, or market outcomes over others. Although we believe that auctions are certainly the theoretically preferred way to allocate valuable spectrum in most circumstances, there are a variety of other considerations that licensing policy ought to take into account:

- Frequent revisions and lack of clarity in the licensing process sow uncertainty and confusion in the minds of industry players. In particular, uncertainties

may make it harder to attract international capital to the table; at the margins, international capital may be migrated to other, more attractive and more certain environments. In the current challenging economic environment, capital is no longer plentiful and marginal differences will assume especial importance. Thus the rules of the game have to be made clear and transparent, and they need to be fair rules.

- Although economists would prefer auctions over taxation as a means to raise government revenues (as taxation is more distorting), the valid goal of raising revenues should not become the only goal of the auction, or indeed the *raison d'être* for licensing policy. Recently there have been growing calls for regulators in the United Kingdom and elsewhere in Europe to consider “speed for spectrum” swaps—that is, to give away spectrum in return for commitments by successful licensees to commit to invest in faster broadband access networks.<sup>12</sup> While we continue to think that the market-oriented regulatory approach that has emerged in Europe and North America over the last 20 years remains the best way to promote efficient investment and that within such an approach auctions will remain important, the auction process should take into account not just revenues and competition policy concerns (preventing collusion and market manipulation), but also long-term economic development goals. There may not necessarily be tradeoffs involved between these different goals (indeed, the primary designer of the UK auctions, Professor Klemperer, would insist that there are no tradeoffs involved), but to the extent that there are tradeoffs, licensing policy should take them into account.<sup>13</sup>
- Today, if cash-strapped operators are forced to delay their investment in actual network assets, or, alternatively, if successful licensees have the luxury of limited competition that allows them to wait until the *private benefits* from network rollout are maximized, then there could be a significant loss in consumer welfare.<sup>14</sup> Delaying licensing or spectrum availability to take into account the possibility that handset prices and thus ownership costs for consumers may fall may also not constitute sensible policy. For example, even at today’s prices a significant segment of consumers in India and similar developing nations is willing to pay for advanced wireless services (i.e., there is a significant consumer surplus from introducing services today). If services to such consumers are held up by government or regulators for two years, say, then the entire consumer surplus that could have been realized over these two years is lost.

- Unlike Europe, the developing countries have the benefit of introducing 3G technologies at a time when the demand for such technologies, and the applications and devices that enhance the value of 3G networks, are significantly well developed. This is one more reason to believe that it is in national regulators' interest to make it attractive for operators to invest in actual physical network assets sooner rather than later. The long-lived and durable nature of these telecommunications assets is likely to generate significant consumer and business benefits well into the future, and the higher economic growth that results should be factored against the short-term boost to government finances from auctions designed only to maximize revenues.<sup>15</sup> We are not condemning auctions—they are the mechanism of choice; however, their design should not have governmental revenues as their sole objective.

### Conclusion

We do not pretend that mobile telecommunications or ICT is a magic remedy for economic development, or that the financing of government activities in such challenging times as the present credit crisis is at all a simple task. However, we stress the crucial importance of investment in socially valuable infrastructure such as mobile telecommunication networks, and thus the value of policies that enable such investment to be made efficiently and on a timely basis.

The discussion above addressed some simple points:

- the massive and entirely unforeseen success of telecommunications and, in the last decade, of mobile telecommunications in the developing world;
- the positive impact on economic growth and welfare of the initial wave of network rollout in the developing world;
- the still inchoate nature of the research on mobile telecommunications and their impact on economic growth, particularly with respect to the distinctions that we draw between access on the one hand and usage and complementary capital on the other; and
- the role of taxation and the licensing process in ensuring adequate investment and consumer benefits in the mobile sector.

We think that the world, particularly the developing world, has seen only a glimpse of the potential economic and social value from investment in mobile telecommunication networks. However, until there is further research on the key areas of usage and complementary

investment, we are still lacking a true understanding of how the benefits from mobile network investment can be maximized. We are also lacking an understanding of which policy and monitoring targets should be chosen—for example, in many countries the penetration rates of mobile telephones are incorrectly measured and overstated because of the incidence of multiple subscriber identity module (SIM) cards among pre-paid customers. On top of this, penetration may not translate into higher usage if market or regulatory factors cause prices to be higher than they might otherwise be. In such circumstances, it may not be adequate to monitor merely penetration rates as a measure of telecommunications development.

Additionally, the early development of 3G mobile networks may have significant potential in the developing world. As was the case with the first wave of 2G mobile network deployment, those who argue that the demand for mobile broadband and what they deem as “high-end” services is limited may be underestimating the thirst for technology in the developing world as well as the demonstrated ingenuity of consumers and businesses in the developing world to put technology to good use. Again, the relative infirmity of fixed-line networks could make 3G mobile broadband (and its successors) the best path forward for making mass-market consumer broadband a reality in many developing nations. It would thus be unfortunate if government policies on taxation and licensing interfered with the timely development of 3G networks.

### Notes

- 1 Ibrahim 2005.
- 2 Jensen 2007, pp. 882–83.
- 3 See Waverman et al. 2005.
- 4 For instance, we are not aware of studies that capture the differential impact of mobile telecommunications or even fixed lines in countries where usage levels are high relative to where usage levels are low. For instance, the United States has a much lower reported mobile penetration rate than Italy, but much higher minutes of use (even when one considers just outgoing minutes). In which country does mobile telephony have a larger economic impact? These sorts of questions in fact assume that it has an even greater importance in developing nations. Similarly, there are few data and little systematic analysis on the impact of usage of mobile data services, although this is a function of the relative newness of such services.
- 5 Jensen 2007.
- 6 See Perl 1983 and Taylor 1994.
- 7 See Brynjolfsson and Hitt 2000.
- 8 See Gasmi et al. 2008, for example.
- 9 The *Connectivity Scorecard* is an index that looks at ICT usage and infrastructure, and links it to the prosperity of 25 countries. See Waverman 2009.
- 10 See Hausman 1997, 2000.
- 11 Waverman 2008.

- 12 See, for example, Bailey 2009. One catalyst for the recent proposals for a "public sector" type approach to licensing appears to be the UK government's newfound willingness to reconsider the idea of significant public intervention in developing next-generation broadband.
- 13 As an example, too low a reserve price might encourage collusion. However, in the current instance of the Indian spectrum auction, too high a reserve price might drive away potential international bidders. Further, there have been complaints that the licensing process already favors established domestic players. In such cases, one must take into account the actual likelihood of collusion as well as the nature of the players that may or not be affected by how the reserve price is set. The fact that capital is very scarce at the moment may also be worth considering in setting auction terms (i.e., look at the ability to pay of different parties). Finally, the fact that parties may not actually have a realistic idea of the real value of their spectrum (as appears to have been the case with some past 3G spectrum auctions) means that they may end up paying "too much" for spectrum. While one might say that this payment is sunk, and will thus not affect their future investment decisions, in practice the cost of capital could be affected by the perception that firms have paid too much for spectrum. Pindyck (2004) provides a good discussion of how one should properly think of "sunk" costs.
- 14 Here one must take into account the fact that operators are typically unable to capture all the benefit from their investment in socially valuable infrastructure such as telecommunication networks, and that there may be a difference in the privately optimal level and timing of investment and the socially optimal investment schedule.
- 15 One might argue, again, that the short-term boost to government finances looms large in any net present value type of calculation. Further, the government could re-invest the revenues raised in other sectors and activities. However, against this argument one must consider the finding of DeLong and Summers 1991 that suggests that investment in equipment, machinery, and infrastructure yields especially high returns for society, but also that the returns are highest where the investment is market-conforming (i.e., privately made) rather than market-replacing (government-led).
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## Appendix A: Details of previous studies

Waverman L., M. Meschi, and M. Fuss. 2005. "The Impact of Telecoms on Economic Growth in Developing Countries, Africa: The Impact of Mobile Phones." *Vodafone Policy Paper Series 2*, March.

- Waverman et al. employed two different approaches to estimate the impact of the rollout of mobile telephones on economic growth—the annual production function (APF) approach following the work of Röller and Waverman and the endogenous technical change (ETC) approach similar to the work of Barro.<sup>1</sup>
- Barro provided the more robust and sensible estimates of the impact of mobile telephony on economic growth. Data on 92 countries—high income and low income, from 1980 to 2003—were used and Waverman et al. tested whether the introduction and rollout of mobile telephone networks added to growth.
- The finding was that mobile telephony had a positive and significant impact on economic growth, and this impact was twice as large in developing countries as in developed countries. This result concurs with intuition, since developed economies by and large had fully articulated fixed-line networks in 1996, while developing countries had little telecommunication infrastructure of any kind.<sup>2</sup>
- The growth dividend of increasing mobile telephone penetration in developing countries was estimated to be substantial. All else equal, the Philippines (with a penetration rate of 27 percent in 2003) might enjoy annual average per capita income growth of as much as 1 percent higher than Indonesia (with a penetration rate of 8.7 percent in 2003) owing solely to the greater diffusion of mobile telephones, were this gap in mobile penetration to be sustained for some time. Overall, the Waverman et al. paper found that the long-term average growth rate of a developing country could be boosted by 0.59 percentage points per annum for every 10 mobile telephones per 100 inhabitants added.
- However, the Waverman et al. paper explored the impact of mobile telephones at a time when the development of mobile telephone networks was still very much in progress in the developing world. Further, the paper (in common with the approach utilized by Röller and Waverman) used the mobile penetration rate as an embodiment of the diffusion of the telecommunication capital stock through the wider economy. It would be a potentially

fruitful exercise for governments, operators, and professionals alike in the development field to examine whether a longer time-series of data, combined with an attempt to incorporate more explicit measures of usage (i.e., to look at not just diffusion but also utilization of the telecommunication capital stock) would yield results that are similar or provide other relevant insights regarding the growth effect of mobile telecommunications.

Jensen, R. 2007. "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector." *Quarterly Journal of Economics* 122 (3): 879–924.

- Jensen provided the first microeconomic study that looked at the impact of mobile telecommunications on the distribution of information in a rural, developing-economy setting; further, unlike the numerous case studies that preceded his effort, Jensen uses rigorous economic techniques to quantify the impact of mobile telecommunications on the relative well-being of different actors (fishermen, consumers, and middlemen or agents) in the rural economy.
- Jensen finds that the introduction of mobile telecommunications had a significant impact on the fishing economy in rural Kerala, India. The main effect that he describes is the redistribution of information, which enables significant gains in what economists would term *allocative efficiency*. Simply put, mobile telephones enabled fishermen to determine where there was demand that matched their supply, and at what price they could sell their produce. Mobile telephones greatly reduced the role of human "market-makers" such as middlemen, and reduced the rents available to these middlemen. Interestingly, the introduction of mobile telecommunications resulted in a reduction in the dispersion of prices for the fishermen's produce.
- As discussed previously, Jensen found that fishermen increased their profits by 8 percent, whereas consumers on average paid 4 percent less for their fish (a staple of the diet in Kerala).
- Jensen's findings do not mention the term *GDP* anywhere. But they provide truly robust evidence to support the findings of Waverman et al. In the developing world, mobile telephones have a "market-making" effect—that is, they have the effect of transforming an inefficient, restricted market characterized by huge asymmetries in the distribution

of information into something resembling the efficient well-functioning markets in which one can expect the classical results of welfare and general equilibrium economics to hold. Thus there is a fundamental and transformative impact of mobile telephones on the very nature of the economy under consideration; in the developing world, mobile telephones are truly a disruptive technology, but this disruption is beneficial since it shakes out the inefficiencies and limited opportunities associated with economies in which communication is difficult and information is asymmetric. In the developed world, while mobile telephones may help markets to function better, the effect is fundamentally an incremental or augmentative one, rather than a transformative one.

### Notes

- 1 See Röller and Waverman 2001 and Barro 1991.
- 2 The addition of mobile networks had significant value-added in the developed world, reflecting not just the mobility value of the new technology but also the inclusion of disenfranchised consumers through pay-as-you-go plans that were not available for the fixed-line network.