PUBLICATION

The Global Adoption and Diffusion of Mobile Phones

Kas Kalba

December 2008

Program on Information Resources Policy

Center for Information Policy Research

Harvard University

The Program on Information Resources Policy is jointly sponsored by Harvard University and the Center for Information Policy Research.

Kas Kalba, Ph.D., is co-founder and president of Kalba International, Inc., a management consulting and research firm. After building the firm's initial government practice, he went on to develop commercial sector and international practices. He has recently returned to academia, teaching a course on the globalization of communications at Yale University.

ISBN 0-9798243-0-3 P-08-2

Table of Contents

Executive Summary

This report assesses the drivers of mobile phone diffusion and adoption across the world.[1] It addresses demand- and supply-side factors and provides an outlook on the diffusion process going forward, as mobile networks may accommodate 2 or 3 billion more users in addition to today's 3–4 billion subscribers and users.[2] While offering a general analysis, the report attempts to explain why mobile penetration has been higher in Western Europe than in the United States, in China than in India, and in Eastern Europe than in Latin America. Inputs to the report have included two cross-country databases (compiled by Merrill Lynch and ITU [International Telecommunications Union]), the author's field studies of mobile adoption in more than twenty countries, and the comments of reviewers of earlier drafts.[3]

On the demand side the report addresses the role of disposable income, legacy phone service (wireline), demographics, and adoption "observability," among other factors. It shows that a country's income level is more closely associated with its mobile adoption level in emerging markets than in developed ones. It also documents the close association of legacy phone connections and mobile phone adoption in emerging markets, including low-income African countries, a finding that runs contrary to common assumptions. The report proposes an "income distribution" explanation of why countries such as the United States and those of Latin America experienced higher mobile penetration in the early stage of the market and why more egalitarian countries, including most of those in Eastern Europe, have had higher adoption levels in the mass market phase. In addition, the report reviews the adoption effects of demographic factors in China, India, and other markets, particularly the role of household size, pointing to China's smaller households in explaining the relatively fast adoption of mobile phones compared to India.

The report also looks at mobile phone usage levels across countries. It concludes that mobile talk time is largely determined by usage prices and not by communication culture, notwithstanding common assumptions to the contrary. Mobile phone users in a culturally mixed group of countries that includes the United States, India, Finland, and Israel—all with very low per-minute usage rates—exhibit the highest usage levels. At the same time, the report recognizes the role of cultural norms and taboos in fostering product innovation, such as i-mode in Japan and SMS [Short Message Service] in the Nordic countries. In addition, it discusses the generally

---

[1] The author wishes to thank Gustave Barth, Rick Costello, Ken Engelhart, James E. Katz, Yasuhiko Kawasumi, Markku Kivinen, Warren Lavey, John LeGates, Wolter Lemstra, Richard Ling, William Melody, Roger Noll, W. Parish, Hector Salgado, F. M. Scherer, Mike Short, Thomas Ronai, and Dimitri Ypsilanti for commenting on earlier versions of this report.

[2] This is a general estimate. See **Chapter Two** for a discussion of issues surrounding the definition and measurement of the number of mobile phone "adopters" at the global level.

[3] See footnote 1 above.

unrecognized role that climate differences may have played in the early stages of mobile phone adoption.

On the supply side, the report reviews the role of technology development and entrepreneurial investment as underlying factors in the diffusion of mobile phones and associated services. It recognizes in particular the role of prepaid technology (originally introduced in Mexico) in the diffusion of mobile communications in both developed and emerging markets. The report concludes that prepaid has been the most fundamental product innovation that the mobile communications market has experienced since the initial introduction of the mobile phone and its supporting cellular infrastructure. Prepaid has made mobile communications accessible to nonsalaried individuals, who on a worldwide basis outnumber people with automobiles and people with fixed salaries—the targets of the first two waves of mobile adoption.

The report also assesses the impact on mobile penetration of different numbers of mobile operators, offering comparisons across Organisation of Economic Cooperation and Development countries as well as several sets of emerging markets. From an adoption standpoint, the positive effects of competition seemingly decline in markets with more than three or four competing operators. Similarly, the report examines the impact of geography, market size (including apparent diseconomies of scale), technical standards, spectrum availability, and tower permits on mobile phone diffusion. U.S. communities have been more tower-resistant than European ones—in stark contrast to the case of genetically modified foods.

The report ascribes the relatively low mobile penetration level in the United States (compared to Europe and a growing number of emerging markets) to the slower diffusion of prepaid products, the large size of the market, the greater number of operators, and the high number of fixed lines—an indicator on which the United States leads the world by a wide margin. It also shows that the expensive 3G [third generation] spectrum auctions held in several European countries have not stymied those countries' subscriber growth rates.

In assessing mobile phone adoption in low-income regions such as Sub-Saharan Africa, India, and Bangladesh, the report emphasizes the combined effect of low-cost prepaid phones, calling party pays billing, and asymmetrical interconnection rates.[4] This combination of product innovation, billing software, and regulatory formulation and the resulting pricing framework has played a major role in mobile phone diffusion, approaching that of the more obvious cost-reducing technological advances generally cited by industry observers and analysts. The report also acknowledges the important role of low-cost handsets (already under $30.00 in many

[4]An overlapping companion paper on "The Adoption of Mobile Phones in Emerging Markets" delves into some aspects of mobile adoption in developing markets in greater detail. The paper was initially presented at the 6th Annual Global Mobility Roundtable, Center for Telecom Management, Marshall School of Business, University of Southern California, Los Angeles, June 2, 2007, and is available at http://www.marshall.usc.edu/assets/006/5577.pdf (last accessed 14 August 2008). A revised version of the paper is scheduled to appear in the *International Journal of Communication*.

markets), mobile payphones, and the shared use of mobile phones in stimulating adoption and usage in emerging markets.

The relationship between prices and adoption is far more complex than the direct relationship between usage prices and talk time. Some markets (e.g., Greece, Italy, and Portugal) have reached high mobile adoption rates with high prices and prepaid products, while others, notably in Asia, have achieved the same results with limited reliance on prepaid products and billing and with low prices. Similarly, markets with low mobile penetration reflect different pricing levels. These diverse results suggest that nonprice factors, including legacy infrastructure and product "observability," may play a significant role in the diffusion process.

Looking to the future, the report addresses the major challenges the mobile industry faces in extending mobile networks to rural regions in Africa, Asia, Latin America, and elsewhere. It questions whether the market will be able to reach most individuals at the "bottom of the pyramid" in the next few years or whether subsidies will be required to ensure such coverage, and notes the emerging use of infrastructure sharing and output-based subsidy schemes to foster deployment of rural networks.

Chapter One

Introduction

Mobile phones are spreading ubiquitously across the planet. They are considered a common manifestation of the latest phase of globalization, along with Chinese consumer goods and Indian information technology services. With about 3.5 billion subscribers and users worldwide,[1] mobile phones have out-diffused virtually every prior technology, including bicycles, radios, television (TV) sets, wallets, wireline phones, and wristwatches, and have done so in twenty-five years.[2]

The sheer numbers and the rapid diffusion rate are two reasons why mobile phones merit attention as *globalization* phenomena. Another, however, is the baffling degree of variation in how they have been adopted in different parts of the world. Mobile "penetration" rates vary substantially, from Luxembourg's 154.83 subscriptions per 100 persons to Papua New Guinea's 0.44 level (roughly 1 subscription per 200 persons).[3] On a continental basis the levels range from Europe's 84.53 to Africa's 15.03.[4]

Some of the variation is to be expected, given differences in economic and operating environments as well as different mobile service initiation dates. Some is highly unexpected. For example, Jamaica and Lithuania are at the 100+ level along with Hong Kong, Israel, Italy,

---

[1] This is a general estimate meant to cover unique subscribers as well as users who share the former's phones, including family members and friends. Informa Telecoms & Media, a UK-based industry research group, estimated 3.3 billion subscriptions (equivalent to half the world's population) in November 2007; see "Global Mobile Penetration Hits 50 Percent Today," November 29, 2007; URL: http://www.mformation.com/mformation-news/industry-news/telecoms-com-global-mobile-penetration-hits-50-percent (accessed 19 November 2008). **Chapter Two** of this report provides a discussion of issues surrounding the definition and measurement of the number of mobile phone "adopters" at the global level. The number of mobile phones in people's hands and desk drawers is harder to estimate but is probably about twice the above number, causing a growing concern in terms of battery and device disposal.

[2] For example, landline phone connections have fallen far behind. They stood at 1.26 billion at the end of 2005, up from 979 million in 2000; see International Telecommunications Union (hereafter cited as ITU), ICT [information and communications technology] Statistics, available at http://www.itu.int/ITU-D/ict/statistics/ (accessed 19 November 2008). As for bicycles, there appears to be no authoritative data source; when the author contacted the International Bicycle Fund last year regarding the number of bicycles in use in the world, he was told that 2 billion was a good guesstimate (with the two largest markets being China and India). About 100 million bicycles are sold a year vs. about 1 billion mobile phones.

[3] ITU, Mobile Cellular Subscribers, 2005 data. The ITU is one of the two principal data sources relied upon in this report. The other is Glen Campbell and Flora Chen, *Global Wireless Matrix 4Q06* (New York: Merrill Lynch, March 28, 2007). This latter source is limited in terms of the countries covered but provides more detailed information, such as prepaid subscriber shares, minutes of use (MOU), revenues per minute, and so on.

[4] Still another reason why it is important to understand the mobile phone diffusion process is that mobile phones can provide access to newer technologies such as the Internet. Vinton Cerf, one of the founding fathers of the Internet, recently acknowledged the greater connectivity of mobile phones compared to the Internet (currently accessed on a fixed basis by about 1 billion users) and projected the future growth of the Web through mobile devices. See "Cerf catches mobile wave," telecom.com, February 21, 2007.

Norway, Singapore, the United Arab Emirates (UAE), and the United Kingdom (UK). Most African countries are below the 10 percent level yet three, including South Africa, are above 70 percent, which places them above the comparable United States level of 67.62 percent but below Russia's 83.62.[5] Equally wide disparities exist with respect to talk time, which averages from less than 25 to more than 800 minutes per month on a subscribing unit basis.[6]

This report addresses a number of questions related to the global diffusion of mobile phones:

1. Has the worldwide spread of mobile phones involved a single diffusion and adoption process or multiple ones, given the different product and technologies involved? In this context, how important was the role of prepaid phones and Subscriber Identity Module (SIM) cards?
2. In addition to income per capita and fashion, what less obvious factors have driven the demand for mobile phones and service? To what extent do culture, climate, demographics, or the availability of legacy phones and connections play a role?
3. What has been the role of supply-side factors, such as competition, technical standards, population density, interconnection charges, and spectrum availability? Does market size make a difference?
4. To what extent do mobile service prices drive adoption and usage? Are low prices responsible for the high adoption rates in developed and emerging markets?
5. How and when will the rest of the world's population of 6.7 billion adopt mobile phones? Will mobile diffusion hit a *rural* wall in Africa, India, and elsewhere?

The report addresses these issues as well as some of the perceived anomalies of mobile phone penetration: for example, why Europe is ahead of the United States, why China has outpaced India (though India is catching up), and why aging Eastern Europe is well ahead of youthful Latin America. Correspondingly, it examines why laconic Finns and other Nordics out-talk ostensibly garrulous Italians, Spaniards, and Portuguese.

1.1 Note on Methodology

The methodology underlying this report follows a more traditional path than much of the recent research on adoption, which typically relies on microeconomic theory, regression analysis, and commonly available databases. By contrast, the author's analysis of mobile phone adoption began in the United States in the early 1980s in the context of survey research and demand forecasting for this new communications service. This was followed over the next twenty years

---

[5] ITU, op. cit.

[6] Some reports on MOU indicate even greater differences. However, these do not always adjust for differences in reporting among countries. In some countries with CPP (calling party pays) only outgoing minutes may be reported; in others, such as the United States, Canada, and the United Kingdom, both outgoing and incoming minutes may be included, consistent with local billing practices. There is also the issue of users with multiple SIMs and subscriptions.

by field studies in both developed and emerging markets, combining survey research, statistical analysis, and international benchmarking.[7] The resulting "natural history" and comparative geography of mobile phone adoption underlie the current report.

This earlier phase of analysis largely validated the importance of income per capita, competition, and pricing factors in understanding differences across countries. At the same time, it fostered a growing sense that a wider range of variables—such as interconnection fees, demographics, population concentration (or lack thereof), climate, legacy phone use, and associated regulatory frameworks— merited consideration. As more countries joined the *mobile revolution*, still more variables came into play, including the challenges of rural coverage (costs, terrain, power sourcing, equipment security, et cetera), disposable cash (as opposed to barter and other forms of exchange), wealth and income distribution, migration effects, and so on.

Still other questions came to the fore as markets with early leads in mobile penetration, notably the United States, began to lose their mobile buoyancy, while early laggards such as France and Spain caught up and even moved ahead. Given that mobile prices were generally higher in Europe than in North America, what could explain this development? Was it primary usage context (public spaces in Europe vs. private automobiles in the United States), unitary vs. multiple technologies (GSM [Global System [for] Mobile Communications] vs. the three U.S. digital standards), or calling party pays (CPP) and prepaid billing? Similarly, the surge in mobile adoption in many countries in Asia, Africa, the former Soviet Union, Latin America, and the Caribbean raised a new set of competing explanations of penetration drivers in addition to income, including demographics, regulatory policy, the effects of new products and services (such as prepaid, Short Message Service [SMS], et cetera), and shared access to mobile phones.

The range of variables involved and the varying states of appropriate cross-national data sources suggested the need for a hypothesis-building and -screening methodology. Accordingly, this report aims to provide a first-cut screening of the broader set of variables mentioned above. In the process it offers elements of a natural history of the global diffusion of cell phone technology. It also attempts to provide a multidisciplinary framework for theory development and subsequent validation through regression-based and other approaches.[8]

---

[7] As a consultant, the author directed and advised on mobile adoption and deployment studies in Australia, Belgium, Brazil, Canada, Chile, China, the Czech Republic, Egypt, Germany, Hong Kong, Hungary, India, Indonesia, Japan, Kenya, Korea, Mexico, Poland, Singapore, South Africa, Ukraine, the United Kingdom, the United States, Venezuela, Vietnam, and other countries during 1982–2001. In the process he worked with Yale Braunstein, R. K. Burns, John Kaufman, Frank Robert, Andrew Simpson, Mathew Sorell, Beverly Spencer, Weston Vivian, Richard H.A. Wolfe, and other colleagues.

[8] Several reviewers of the current report have called for regression-based testing of preliminary conclusions reported in the report. This could certainly be undertaken in a future phase, on the basis of a wider theory of adoption than is generally assumed. The aim here is to indicate the need for such a theory and to suggest some of its elements. Meanwhile, many overly simplistic, even erroneous, assumptions continue to be made about the "universal" properties of mobile phones: for example, that they proliferate most rapidly where there are few fixed phones, that their short-term

1.2 Structure of the Report

Chapter Two examines some of the definitional and measurement issues surrounding the study of mobile phone penetration levels across countries. **Chapter Three** describes phases of mobile diffusion. **Chapter Four** analyzes economic, social, cultural, and environmental factors affecting the adoption of mobile phones, while **Chapter Five** explores supply side issues such as competition, pricing policies, and spectrum availability. **Chapter Six** discusses limitations on cell phone adoption and suggests strategies for expanding diffusion in the future. **Chapter Seven** reviews the major findings of the report, highlighting topics for further research, and **Chapter Eight** presents a concluding perspective.

---

adoption is driven by handset subsidies, that differences in usage levels are due to cultural differences, that large markets have higher penetration levels than smaller ones (due to economic efficiencies), and so on.

Chapter Two

Defining and Measuring Adoption

Mobile phones cannot be used without the underlying wireless connections and associated infrastructure and service provision, including interconnection that allows them to be connected to each other and to the public telephone network. In short, any study of mobile phone adoption depends on the underlying availability of the infrastructure, which itself involves a complex diffusion process. This process brings together investors, technology, government, and management with the common aim of allowing individuals and businesses to make calls "on the go" (or at least from wireless devices) for a wide range of purposes and in a variety of places.

2.1 Scope of the Report

The main purpose of this study is to explain the factors that affect the initial diffusion and use of mobile phones, primarily for voice communications, and how the indicators of mobile phone diffusion, mostly at the country level, reflect the interplay of these factors. However, the report does not focus to any significant degree on how mobile phones are used, how they contribute to worker productivity, how they affect social relationships and integration, and how they are evolving from their initial function of executing voice calls to the provision of "data" applications.[1] A broader definition of "adoption" would encompass such usage as well as social—even symbolic—aspects of the mobile phone. These are possible follow-on topics, and some have been covered in other studies.[2]

The current study also does not devote much attention to the intermediate level of diffusion, but does consider it where developments at this level help explain the degree of end-user adoption of mobile phones. Neither does it address the process by which mobile phones are designed, manufactured, and distributed. Similarly, the discussion does not examine the conventional strategies of specific companies in stimulating the diffusion of mobile phones. Such strategies, which marginally differentiate one operator from another on the basis of price, coverage, service quality, brand, or other factors, are highly relevant to mobile operators seeking competitive

---

[1] However, these two functions can no longer be completely separated. As an early reviewer of the report has noted, some of the adoption statistics represent mobile phones used exclusively or primarily for data services, including machine-to-machine applications; email message to the author from Michael Short, January 27, 2007.

[2] For example, on mobile phone implications for social contact in different cultures, see James E. Katz and Mark Aakhus, eds., *Perpetual Contact: Mobile Communication, Private Talk, Public Performance* (New York: Cambridge University Press, 2002). For a multidimensional approach to mobile phone adoption, see Werner Wirth, Thilo von Pape, and Veronika Karnowski, "An Integrative Model of Mobile Phone Appropriation," paper presented at the 2007 ICA Conference, May 2007, San Francisco, Calif.; also Mary Bina, Dimitrios, and George Gigalis, "Investigating Factors Affecting Actual Usage Patterns of Mobile Data Services, paper presented at 6th Annual Global Mobility Roundtable, June 2007, Los Angeles, California. For a broad philosophical argument that the evolution from mobile phones to mobile devices is increasingly rendering communications a process of systems integration versus social integration, see George Myerson, *Heidegger, Habermas and the Mobile Phone*, (Duxford, UK: Icon Books, 2001).

advantage versus other operators and can have a short- to mid-term impact on how rapidly a market develops.[3]

The study also does not focus on how the design and ergonomic qualities of mobile phones contribute to the adoption of the "mobile phone" habit, except at the aggregate level of the role of phones as fashion accessories in some countries and the general contribution of wider choices in phone models on market growth.[4] Nor does it explore "meta theories" of media adoption, such as those of McLuhan.[5]

2.2 Defining Penetration Levels

The principal indicator of mobile diffusion is the "penetration" level of a country or other area. This level is usually calculated from statistics provided by mobile operators based on their subscriber counts. These counts do not generally reflect individual users, but rather individual subscription accounts, so there is some degree of double counting.[6] The double counting problem only escalates as the "subscriber" figures of multiple operators are combined, as consumers often subscribe to two or more services[7,8] because of call pricing and discounting differences between

---

[3] The author has prepared (with colleagues, as indicated in parentheses) a number of case studies on the competitive market strategies of mobile operators in Chile (R. Wolfe), China (R.K. Burns), Germany (L. Hendrickson), Hong Kong, Malaysia, United Kingdom, Venezuela, and three U.S. markets: Atlanta (F. Robert), Chicago (W. Vivian), and Los Angeles—highlighting the role of marketing, technology, and management factors in securing market growth and a high share of the subscribers.

[4] While the industry press (not to mention advertising) implicitly, if not explicitly, supports the notion that particular phone designs or models increase mobile phone subscriber levels, the author is not aware of any systematic research on this topic. This does not mean that Motorola's introduction of the RAZR or earlier clamshell phones did not coincide with increases in U.S. subscriber growth or that Nokia's concentration on India's market has not contributed to the recent market explosion there.

[5] McLuhan's theory of "hot" and "cool" media may have some applicability in that the combination of oral and tactile qualities makes the mobile phone a very cool medium in McLuhan's lexicon. See Marshall McLuhan, *Understanding Media: The Extensions of Man* (Cambridge, Mass.: The MIT Press, 2001); also Kas Kalba, "Understanding McLuhan's Media: 40 Years After," *InterMedia* (International Institute of Communications, London) **32**, 3, September 2004.

[6] Different operators also have different standards for counting active subscribers, in part based on their accounting and billing systems and how much they lag subscriber activations and deactivations. In prepaid environments this is a key issue, in that some operators allow prepaid subscribers to use their initial account for periods exceeding a year while others impose limits of sixty or ninety days; in some cases these limits are determined by industry associations or regulators, but often they are discretionary.

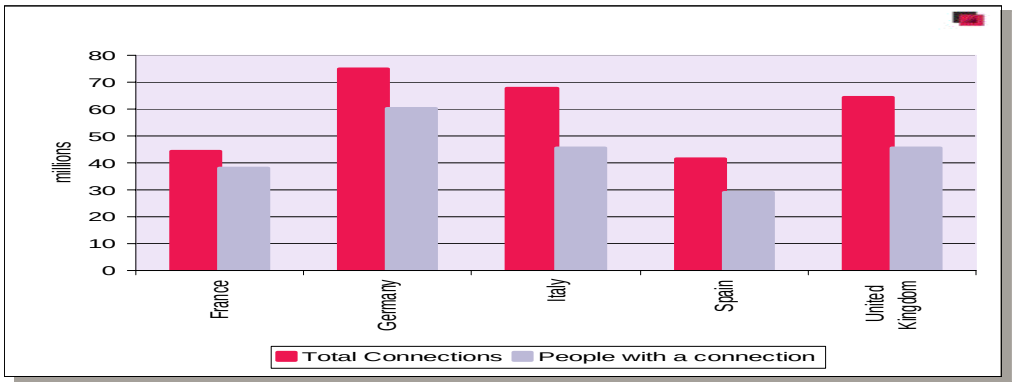
[7] The author is reminded of a taxi ride in Stockholm in the early nineties. When asked about his mobile service, the taxi driver responded, "Which one?" It turned out he subscribed to three—one for his taxi business, one for personal calls, and one for his boat. This last plan had no monthly charge but a very high per-minute charge, which driver and passenger agreed would be well worth paying in an emergency. More recently, the author has met individuals who travel internationally and have as many as six SIMs, and he has had to buy three mobile phones in the past two months because of blocked roaming and SIMs while traveling.

[8] The GSM Association has developed separate subscription ("Total Connections") and subscriber ("People with a Connection") estimates for some countries, as reflected in the following figure:

operators or plans, coverage differences, lack of interoperability (e.g., SMS), high roaming charges, SIM and/or roaming blockage, expense tracking (e.g., personal vs. business use), functionality (data vs. voice), backup service, anonymity, et cetera

This conflation of the penetration numbers makes it difficult, if not impossible, to determine the number of mobile adopters (i.e., those subscribing to or using an initial mobile service) versus the number of adopters with two or more subscriptions.[9] In fact, multiple subscriptions can be driven by a number of considerations, including the use of different types of wireless devices (e.g., a call-making and/or –receiving phone, a Blackberry, an iPhone or third generation (3G) multimedia phone, et cetera) or of multiple SIM cards to arbitrage calling rates or to reach different subscribers because of coverage differences or interoperability limitations across services. In short, the "subscriber" numbers potentially lead to over-counting the number of unique mobile phone adopters significantly.

Future studies should address this issue of multi-phone and -SIM adoption in a number of contexts, including mobile connections for young children (with a preset number for calling home and GPS [Global Positioning System] tracking), as well as to pets, automats, robots, vehicles, and



(Source: Rick Costello, Commercial Director – Market Information Services, GSM Association, September 6, 2007, Wireless Intelligence 2007). It shows that the ratio of connections to users varies considerably, even within major countries in Western Europe, with the presence of prepaid being a major factor. Wireless World Forum, a market research and networking entity, has also sought to take into account multiple subscriptions per user and has developed adjusted national subscriber (i.e., user) numbers; see http://www.w2forum.com. (WWF has not responded to a request for an explanation of the methodology underlying its adjusted figures.)

[9] A reviewer of a previous version of this report suggested that in fact two separate issues should be addressed: "1. What are the factors leading to full penetration (i.e., 80 percent of the people in a country have a phone) and 2. What are the factors that cause full penetration countries to have multiple vs. single subscriptions?" (Ken Englehart, email to the author, January 10, 2008.) This is entirely valid, except for the lack of data on first subscriptions and subsequent ones. At the same time some methodologies are based on the assumption that any subscriptions above a certain penetration level (e.g., 80 percent) should incorporate an adjustment factor for local demographic differences. This is especially true when comparing developing markets (usually a high percentage of very young people) with developed ones; or the minority of developing markets with aging populations (e.g., Eastern Europe) with other developing markets.

other "users."[10] Most of these will not be voice connections, although the "oral" tradition of the human species is likely to remain powerful for the indefinite future. In the long run the potential number of *subscriptions*—and the associated gross penetration level—could be several times the planet's population. In short, the over-counting of adopters could become rampant.

At the same time, the reverse issue of *undercounting* adoption and usage can skew calculations of penetration. If spouses, co-workers, or teenage friends share a mobile phone, are they not all "adopters?"[11] This sharing practice is especially prevalent in countries and households where mobile phones have become the dominant instrument of communication, surpassing the landline count by as much as eight or nine to one. In many cases the mobile phone remains in a designated spot in a home and is used as a fixed line, except on special occasions when it is taken outside the home. Among teenagers in the Middle East a young male may hold a double subscription: one for himself and one for his girlfriend whose parents forbid their daughter to subscribe herself.

In fact, recent research has revealed that access to mobile phones in low-income countries is more extensive than previously thought.[12] Informally the access occurs through use of household members' phones and of the phones of friends and acquaintances. In some cases this access operates on a barter basis (yes, fruits and vegetables for mobile minutes) but often through looser kinship- or friendship-based forms of sharing and exchange. There is also a growing number of formal channels for accessing mobile phones and mobile phone service on a temporary basis. They involve different types of resellers of mobile service, from traditional distributors (e.g., where mobile phones are sold and prepaid minutes are topped up) to village entrepreneurs backed by microcredit. While this report uses standard penetration figures, it is important to keep in mind that "penetration statistics" and diffusion or adoption levels are not equivalent.[13]

---

[10] See ITU, *The Internet of Things*, 7th Edition (ITU Internet Reports: Geneva, 2005) for an early preview of automated connectivity, which is bound to grow if Internet access converges with mobile communications, as many predict..

[11] In addition, former subscribers have dropped out of the market for economic, utility, coverage, or other reasons, and are no longer included in the statistics.

[12] See, for example, D. Souter, N. Scott, C. Garforth, R. Jain, O. Mascarenhas, and K. McKemey, *The Economic Impact of Telecommunications on Rural Livelihoods and Poverty Reduction: a Study of Rural Communities in India (Gujarat), Mozambique and Tanzania* (Commonwealth Telecommunications Organization for UK Department for International Development, 2005); also the growing number of surveys of mobile phone users in emerging markets in Africa, Asia, and elsewhere, such as reported in Rohan Samarayiva and Ayesha Zainudeen, eds., *ICT Infrastructure in Emerging Asia* (SAGE and IDRC, 2008), covering India and Sri Lanka, and *Africa: The Impact of Mobile Phones,* the Vodafone policy paper series, Number 3, March 2005, covering various African markets..

[13] According to a recent French study the sharing of mobile phones is a practice also encountered in mature markets too; however, most of the sharing may involve individuals with their own handsets (e.g., allowing a friend to use a special feature or minutes that would otherwise be wasted) rather than adopters who would otherwise not be reflected in the subscriber statistics. See Association Française des Opérateurs Mobiles, Discours & Pratiques, *Le téléphone mobile aujourd'hui—usages et comportements sociaux*, 2nd ed., Association Française des Opérateurs Mobiles, June 2007.

Penetration numbers are typically presented as subscribers (meaning subscriptions) per 100 persons. A key factor is that today's numbers are not household figures. In the past, telephone penetration levels were often based on household levels, as phone lines were generally shared by the members of one or more households. Now mobile phones have become personal instruments and life style accessories in many areas of the world, although they remain household instruments in many parts of Africa, India, and other markets.[14] In fact, it would be quite useful to have both sets of numbers—per household and per capita—when forecasting mobile adoption levels in countries with low levels of landline phones.

Finally, in comparing countries using their mobile penetration levels it is important to keep in mind that the levels of usage underlying the numbers may differ significantly, as may the revenues (not to mention profits) per subscriber. An operator's monthly average revenue per unit (ARPU) can vary from under $5.00 in countries such as Bangladesh and Pakistan to over $50.00 in Japan and the United States. As a result, care must be exercised in discussions of national rankings. China has more than four times as many subscribers (again, strictly speaking, subscriber units) as Japan, but its mobile industry generates lower revenues given the much smaller ARPUs of these subscribers. Similarly, Bangladesh, with its surprisingly high number of 22 million subscribers, generates lower revenues than do New Zealand's 4 million subscribers.[15]

[14] See Katja Konkka, "Indian Needs: Cultural End-user Research in Mombai," in Christian Lindhom et al., eds., *Mobile Usability: How Nokia Changed the Face of the Mobile Phone* (New York: McGraw Hill, 2003).

[15] Based on data in Glen Campbell and Flora Chen, *Global Wireless Matrix 4Q06* (New York: Merrill Lynch, March 28, 2007).

Chapter Three

Phases of Mobile Diffusion

Definitional issues also arise with respect to mobile phone diffusion—in terms of both technological evolution and how mobile phones are seen in social, economic, and cultural terms. This chapter suggests that mobile phones diffused in a relatively integrated way (reflecting a close correspondence among the technological, economic, and social vectors of diffusion) until the late 1990s, when the principal thrust of technological innovation separated from the economic and geographical vectors that ultimately drove mobile phone adoption to the 3.5 billion subscriber level of today.

The story is not entirely linear even at its beginning, when mobile communications technology was first being developed in the labs of New Jersey, Stockholm, Tokyo, and other engineering centers. The early developers built on previous technological breakthroughs in microwave communications, radar coding, space-division multiplexing, and signal processing and control. They were not particularly attuned to the economic and social explosion that lay ahead.

3.1 Waves of Technology Deployment

From a technology standpoint, waves of communications media adoption are often assumed to be uniform and long lasting. Videocassette recorders (VCRs), TVs, digital video discs (DVDs), fax machines (once standard protocols were introduced in 1983), and even fixed telephones, which have diffused over the span of a hundred years, are treated as uniform products and technologies. The one common exception is broadcast TV, which is generally divided into the black-and-white and color phases of adoption, and, more recently, the high-definition TV phase.

This uniform treatment reflects in part the nontechnological perspectives of some diffusion researchers and in part recognition that any technological changes that have occurred are of limited significance to the diffusion process. In other words, the changes were not obvious to the adopters—or, if obvious, were not considered relevant to the diffusion process. Technology changes that reduced the costs of manufacturing TV sets or the way in which telephone calls were switched are cases in point. Such changes may have led to lower prices or faster call completion, which in turn sped up incrementally the adoption or use of the product in question but did not alter the underlying adoption process. Also, some technological differences have been international in character (such as differing TV standards), whereas most diffusion studies have been nationally or locally focused.[1]

---

[1] Correspondingly, interesting questions such as why TV viewing per capita has been highest in NTSC [National Television System Committee] countries, the lowest resolution standard, have not gained much attention from media researchers and analysts.

Mobile phones, on the other hand, have undergone a number of product—and related technological—changes since their commercial introduction in 1979.[2] They have evolved from bulky, multicomponent devices embedded in automobiles to sleek gadgets that can be easily transported in pockets and purses. Correspondingly, coverage has expanded from zones only marginally greater than those of precellular car radio phones to near-national and international coverage, including the interiors of many buildings and homes. Prices have changed dramatically, although whether they would have dropped to a greater or lesser degree with fewer product and technological changes along the way remains open to debate.[3] Also, as the discussion below will illustrate, the geographical sources of technological and product innovation have changed, challenging the traditional model of U.S. or Japanese origination followed by European adaptation and eventual diffusion to the developing world.

Similarly, lead countries in terms of early adoption and penetration have changed over time. The United States was a leader in the 1980s when mobile usage was largely automobile-based and driven by small business. In the 1990s Europe assumed a more dominant position as urban street-level and in-building usage came into play. Concurrently, CPP and prepaid technology were introduced, supporting a surge in penetration in southern European countries and soon across other parts of the world. In the current decade youth-driven and high-volume Asian markets, such as those of China, Korea, India, Indonesia, and the Philippines, have assumed greater importance as market leaders.

The preceding discussion summarizes in very broad terms the evolution of the global mobile communications market. However, from the standpoint of technology development and diffusion this “market” is actually made up of a significant number of submarkets with each submarket involving a family of products and services. In general, these stages—or waves—of mobile technology deployment have been defined in “generation” terms:

- ***First generation (1G)***: Analog mobile telephony, voice-centric, largely frequency modulation (FM)-based, employing in-vehicle and eventually portable single-mode, single-band handsets (initially weighing over 20 pounds), operating in several analog standards and bands, such as Advanced Mobile Phone Service (AMPS) (U.S.), Japanese Total Access Communication System (JTACS), Netz-C (Germany), Nordisk Mobil Telefon (NMT) (Nordic Europe), TACS (UK), et cetera
- ***Second generation (2G)*:** Early digital technology, providing voice and narrowband data and employing small, portable, often multimode, multiband

[2] This is the year that commercial cellular mobile phone service was launched in Japan, in both Tokyo and Osaka. Of course, car-based mobile radio telephone service had been available in most developed countries for some time, but users could not roam automatically to adjacent cells; each service area was a single cell. When U.S. commercial cellular service began in 1983, there were about 50,000 traditional mobile radio telephone subscribers. Sweden, with the highest density of pre-cellular subscribers, had about 20,000.

[3] The economies of scale may have been greater with fewer changes. On the other hand, without the changes—and choices—not as many subscribers may have been attracted to mobile phones.

handsets over GSM, other Time Division Multiple Access (TDMA) (Digital AMPS (D-AMPS) in the United States and elsewhere, Japan Digital Cellular), and cdmaOne (United States, Korea, et cetera) standards-based networks.

- ***Third generation (3G)***: Enhanced digital technology, providing voice and high-speed data on a more spectrum-efficient basis over multimode, multiband handsets in Wideband Code Division Multiple Access ([W-CDMA], Universal Mobile Telephone Service [UMTS], Enhanced Data GSM Environment [EDGE]), CDMA2000 (1xRTT, Evolution-Data Only/Optimized [EV-DO], Evolution-Data Voice [EV-DV]), and other standards.[4]

- ***Fourth generation (4G)***: Next-generation technology, such as Worldwide Interoperability for Microwave Access (WiMAX), Long-Term Evolution (LTE), and UWB (ultra-wideband), which is slated to offer multimedia, broadband, highly spectrum-efficient transmission over adaptive-mode and -band handsets at comparatively much higher transmission rates.[5]

The variety of standards the global market has supported is noteworthy. While there are fewer 3G standards than 1G standards, achieving the often-voiced goal of a single world standard for all public mobile communications has so far proven elusive. At the same time, the emergence of software-defined radio (SDR) technologies that allow users operating with different standards to share a spectrum could help resolve many of the interoperability issues of a multistandard environment.

In addition, each successive mobile generation has exploited and incorporated increasingly sophisticated radio, semiconductor, and software technologies, embodying large-scale integration, adaptive antennas, modulation efficiency, advanced coding, direct radio frequency (RF) conversion, adaptive channel allocation, multiple Rake receivers, low-cost complementary metal oxide semiconductor (CMOS), and so on.[6] The combination of all these technological elements and the related core and applications software in an ever dynamically improving and cost-minimizing manner has contributed, along with the nontechnological factors discussed below, to the rapidly growing deployment of mobile communications technology—and handsets, specifically—across the world. Large-scale integration (CMOS and single-chip, nonheterodyne mobile phones) and large-scale manufacturing (“fabless”) have resulted in dynamic cost reduction, enabling the mass market adoption of mobility devices.

---

[4] China has developed and adopted its own 3G standard, time division-synchronous CDMA (TD-SCDMA), while indicating that its operators will also deploy networks in the W-CDMA and, possibly, CDMA2000 standards. Meanwhile WiMAX, a broadband wireless technology, at times considered to be 3.5G or 4G, was adopted into the UMTS 3G family at WRC 2007.

[5] A number of application-specific transmission technologies are also entering the mobile domain; for example, MediaFLO, DVB-H, and DMB for mobile TV distribution.

[6] The author is grateful to Hector Salgado for this summary of the technological elements involved in mobile technology development (email to author, February 8, 2007).

The $25.00 mobile phone (wholesale) is already driving the market in India, Bangladesh, and parts of Africa. Can the $10.00 phone, or the $1.00 ARPU, be far behind?

Of course the full technological story is both longer and much more detailed than the summary above could capture. For example, the original car-based cellular phones, complete with rooftop antennas and trunk-based transceivers, which operated over the analog 1G transmission networks listed above, were preceded by single-cell, metropolitan-wide mobile radio telephone systems.[7] Similarly, there were a number of important variations in 1G infrastructure and handset technology, including:

- *Transportable* phone units, the size of small car batteries, that were used for site work in specialized industries (e.g., construction) as well as in lieu of fixed phone lines in many developing countries;[8]
- Wider-area cellular networks operating in the 400 megahertz (MHz) range, which served not only low-density rural areas in Scandinavia and Canada, where they were initially deployed, but also offshore maritime users, given their transmission outreach capabilities;[9]
- Early 1G portable mobile phones ("bricks," as they were often called) that could be carried in briefcases and pocketbooks rather than in automobiles, first introduced in Hong Kong in the late 1980s and since miniaturized—in 2G and 3G versions—to fit into shirt pockets and purses around the globe; and
- Phones and networks initially configured for dispatch communications to which one-to-one connections, PTT (push to talk), and other capabilities have been added, for example in the current integrated Digital Enhanced Network (iDEN) version.[10]

Some innovations, mostly at the design level (e.g., handsets with built-in antennas, with changeable *facias*, or with very thin profiles), have been virtually instant successes. Most—

---

[7] This "0-G" generation lacked the cellular infrastructure, which allowed users to travel from a cell zone to an adjacent (partly overlapping) one without having calls dropped by the system. However, unlike other still earlier forms of mobile radio communications, including citizens' band radio, they did allow calls to terminate or originate on the public wireline telephone network.

[8] For example, early users of mobile in Hungary would carry such phones to their offices and keep them on their desks, given the long waiting lists involved in getting fixed connections. Meanwhile, the network, designed by a U.S. operator, assumed the predominant use would be car-based. The network had an abundance of cell coverage and trunking capacity along major highways but inadequate switching capacity in Budapest. Many more calls than expected were jamming the switches, which had to be upgraded.

[9] Higher frequency cellular networks that prevailed in most of Europe and North America did not have the same wide-area propagation characteristics at a given power level.

[10] The iDEN technology is one of two employed by Sprint Nextel in the United States. Radiocom 2000, launched in 1985 in France, offered an analog dispatch plus one-on-one radio communications capability.

whether digital cellular, i-mode, or 3G—have called for considerable adaptation of technology and/or their presentation to the public.[11]

Particularly when viewed in retrospect, these adaptations represent the twists and turns in what remains overall a straightforward story of technological evolution and deployment—from 1G to 2G to 3G to 4G. Moreover, the market seemed to evolve in a closely corresponding manner: car-based phones, pocket phones, and phones with data capabilities. Only some time in the 1990s did the world market veer off onto an unexpected track.

3.2 Prepaid and the Third Market Wave

The center of gravity of the emerging mobile communications market had already started to shift in the late 1980s and early 1990s from its sources in the labs of New Jersey, Tokyo, and Stockholm. The personal communications services (PCS) or pocketphone phase of development was led from Hong Kong, where marketing to car nonowners first began; from London, where the first PCS operator licenses were issued; and from Brussels, from which the pan-European Union (EU) effort to push SIM-based GSM technology was coordinated.

Yet industry historians are still trying to understand what happened next. The third phase of the mobile phone—3G and its many associated multimedia applications—was also coordinated from Brussels, with Asian centers (principally Tokyo and Seoul) mounting the most significant, albeit 3G-validating, challenges. However, the real challenge emanated from a group of Latin countries—Italy, Mexico, and Portugal—where prepaid mobile was introduced and was found to meet market needs much more consistently than 3G.[12]

The first two phases of mobile diffusion—analog 1G and digital 2G—were closely associated with corresponding phases of mobile, car-based, and pocket-based adoption. A disconnect occurred when it came to the third phase. The technology developers, aided and abetted by other supply-side planners—governments (treasuries seeking revenues from spectrum auctions) and financial institutions seeking new investment and credit markets—introduced 3G technology, confident it would ride a gigantic wave of consumer demand for multimedia applications and services. But the new wave failed to materialize, at least at the scale and tempo

[11] For example, the introduction of “digital” cellular in 1993 in the United States was not a success, due to the limited coverage, technical problems, and no obvious product or service advantages compared to analogue service. The price had to be discounted to encourage new subscribers to join the digital network—as opposed to the initial concept that “heavy use” subscribers would migrate to digital service and be willing to pay a premium price.

[12] Although prepaid had little to do technologically with the initial mobile communications development, there remained some industrial connections. For example, Motorola, which had been involved in the early development of mobile phones, set up an international investment group. This group was a minority investor in the regional mobile operator that first introduced prepaid mobile in Mexico as well as in the first Hong Kong operator to sell mobiles to people without cars.

the developers counted on.[13] Instead, a product the technologists considered marginal continued to make its presence felt across both developed and emerging markets.

Prepaid phones and service were first introduced (unsuccessfully) in Mexico in 1992, reconfigured (successfully) at the time of the "peso crisis" in 1993, and later combined very successfully with CPP capability in much of the world.[14] In retrospect, this introduction of prepaid technology, considered a peripheral achievement at the time, has turned out to be the most significant innovation since the development of the original cellular communications concept. Without prepaid technology, which consists largely of storage and billing software, mobile calling might not have reached as many as two-thirds of today's subscribers, especially those located in poor and moderate-income developing countries, where participation in the cash economy is often a stochastic or itinerant activity.[15]

The market impact of prepaid is reflected in **Table 3-1**, which lists some of the markets with the highest and lowest levels of prepaid subscribers.[16] As the table suggests, emerging markets have generally adopted prepaid technology as the dominant mode of marketing and billing for mobile service. Prepaid has also become the dominant form of mobile service in many developed markets; postpaid remains the dominant form in others, with a few (such as Finland, Japan, Korea, and the United States) operating predominantly in this mode.[17] Postpaid subscribers are generally considered more profitable, yet high prepaid levels are associated with high operator margins as well as subscriber growth.[18] For example, in the developed markets, Italy has the

[13] For an assessment of the overly optimistic assumptions underlying the introduction of 3G in 2000–2001, see Yale M. Braunstein and Kas Kalba, "Reviewing 3G 'Optimism': Services, Segments and Stages of Reality," paper presented at the 8th International Workshop on Mobile Multimedia Communications, October 5–8, 2003, Munich, Germany.

[14] The introduction and regulatory support of asymmetrical interconnection fees was a key element of the success of this product development in countries such as Brazil. It allowed mobile operators to collect incoming call termination fees (from fixed or other mobile operators) even when generating little in the way of revenues from prepaid users who used their phones primarily for CPP incoming calls.

[15] Curiously, prepaid diffusion has occurred without the handset subsidies that accompany postpaid subscriptions in many markets; yet this nondiscounted product offering, with higher per-minute charges than postpaid, has made huge inroads into the mass markets of low-income countries.

[16] Data derived from Glen Campbell and Flora Chen, *Global Wireless Matrix 4Q06* (New York: Merrill Lynch, March 28, 2007).

[17] It is important to differentiate between prepaid *subscriptions* (reflected in Table 3-1) and the share of mobile phone users who rely on prepaid. For example, Norway's 44 percent prepaid share in the table does not imply that 44 percent of the population uses prepaid only. In an email to the author, Richard Ling noted that in a recent survey of Norwegian mobile phone users he identified only 14 percent as prepaid. Besides different underlying dates, methods, and definitions, the seemingly large difference between these two numbers may reflect that some of the 14 percent of users Ling interviewed had multiple prepaid subscriptions; in addition, some of the postpaid users may have subscribed to prepaid services on a secondary basis. At the same time, the difference between the number of users and the number of subscriptions is likely to be smaller in low-income emerging markets, where the likelihood of individuals' holding multiple subscriptions (prepaid or postpaid) is likely to be lower than in countries such as Norway.

[18] Ibid.

highest prepaid subscriber share, the highest subscriber growth rate, and one of the highest margin levels.[19]

Table 3-1
Prepaid Subscriber Share in Selected Markets

High Prepaid Markets	Low Prepaid Markets
Nigeria—100 percent	Japan—3 percent
Iraq—99 percent	Korea—3 percent
Pakistan—99 percent	Finland—5 percent
Philippines—98 percent	United States—14 percent
Algeria—97 percent	Taiwan—22 percent
Bangladesh—96 percent	Canada—23 percent
Indonesia—96 percent	France—35 percent
Morocco—96 percent	Singapore—39 percent
Russia—96 percent	Austria—40 percent
Venezuela—95 percent	Switzerland—43 percent
Ukraine—94 percent	Norway—44 percent
Egypt—93 percent	Spain—46 percent
Italy—90 percent	
Mexico—90 percent	

Data source: Campbell and Chen, 2007

Table 3-2 shows the countries with the highest mobile penetration rates in 1987 (the automobile era), 1997 (the pocketphone era), and 2007 (the prepaid era). In 1987 the leading countries were Nordic (or Alpine in the case of Austria) and automobile-centric societies, such as the United States, Canada, and Australia. Mobile phones were carried by automobiles and not by persons. Moreover, more than was explicitly acknowledged at the time, mobile phones quickly became necessities for drivers of automobiles in harsh climates, as searching for a payphone in a snowstorm is not highly recommended (see **Section 4.12**; also note that except for the United Kingdom the list of leading countries in 1987 reads like the medal winners in the Winter Olympics).

As noted earlier, by 1997 the mobile phone had migrated from the car to the pocket and purse. A prospective adopter no longer needed a car to use a mobile handset, but did need a salary, as mobile billing was still very largely based on monthly payments (postpaid). Italy was an early exception as one of the first prepaid markets. Also, together with Singapore and Israel, Italy had a high penetration level in 1997, which indicated that extreme climate (hot or cold) and not merely a Nordic climate drove adoption. The 1997 list also reflects the successful transition

[19] Ibid.

Table 3-2
Countries with Highest Mobile Penetration in 1987, 1997, and 2007*

Rank	***1987***	***1997***	***2007***
1	Norway	Finland	UAE
2	Sweden	Norway	Estonia ***
3	Denmark	Sweden	Lithuania***
4	Finland	Israel	Italy ***
5	USA	Japan	Bulgaria***
6	Canada	Denmark	Czech Republic**
7	United Kingdom	Australia	Singapore
8	Austria	Singapore	Portugal*
9	Australia	Italy	Israel*
10	Holland	USA	Ukraine**

* Excludes countries <1 million population and territories (e.g., Hong Kong)

Over 50 percent prepaid * Over 90 percent prepaid

Sources: OECD (1987) and ITU (1997, 2007)

made in the Nordic countries from automobile-centric mobile phones to the pocket versions, while the classic car-based markets of the United States, Canada, and Australia lost ground or dropped off the list entirely. Meanwhile, Japan, one of the early innovators, finally appeared on the list, in part because the country adjusted its mobile phone and service charges after a comparatively long period of elevated pricing.

By 2007, prepaid and SIM-only subscriptions had become the dominant adoption factor, as shown in Table 3-2. Adopters no longer need a car, or even a salary, to have a mobile phone, just disposable cash from time to time. This has opened up a much wider market in terms of the world's 6.7 billion population. Six of the countries (Estonia, Lithuania, Italy, Bulgaria, the Czech Republic, and Ukraine—mostly aging societies) have prepaid shares of 90 percent or more, while a seventh (Portugal) is at the 80 percent level. Most are subject to extreme heat in the summer (Italy, Portugal, Israel) or year round (UAE, Singapore) or to harsh cold whether (the Baltics). Except for Italy and Ukraine, these are small countries in terms of both population and territory; thus, network economies do not seem to be operating.

In short, with regard to widespread mobile phone adoption the availability of a prepaid option has shaped the market more actively in recent years than the main technology drivers constructed by the labs of the leading technological countries. Prepaid has also proven more decisive than youth-driven enthusiasm for all things mobile and personal and than accepted economic precepts such as externalities and network effects. The adoption of the mobile phone

has been as complicated as its assembly from numerous electronic and semiconductor components, powering and battery inputs, and protective encasement materials obtained from four or more continents. As the following chapters illustrate, at least six continents have shaped the adoption and use of the mobile phone.

Overall, the “straight line” of technological progress and dynamism has been complemented, though periodically disrupted, by economic, social, and cultural dynamism in the adoption and use of mobile phones. The numerous forms of shared use represent a case in point, encompassing village kiosks in Bangladesh, informal payments (including payments in produce) for use of an acquaintance’s phone in East Africa, common access to a “stationary mobile” by members of large Indian families, and short-term phone rentals to tourists and international business travelers throughout the world. This dynamism manifests itself most vividly when the applications involved are most generic—calling someone or sending a short text message—and less clearly when new forms of behavior are required to take advantage of new capabilities and applications. Adoption—especially widespread adoption—of these *advanced* applications has lagged their proof of concept.

Chapter Four

Factors Affecting Adoption

The simplest view of mobile phone adoption is that it is predominantly supply driven. Where there is mobile coverage and service availability there is adoption; at most some competition is needed to keep prices at a reasonable level. Once this is accomplished, everyone, everywhere—rich and poor, young and old, from Sub-Saharan Africa to Siberian Russia—becomes a mobile phone user. The countervailing view is that mobile phone adoption is heavily determined by demand-side factors, particularly income. Mobile adoption reflects an individual's and a society's wealth. Correspondingly, even the availability of free phones would not solve the adoption challenge for everyone, as the ability to pay for usage would still reflect disparate (often limited) economic resources.

This chapter will show that neither of these views (nor both combined) suffices to explain the variability of adoption levels across the world. The rapid diffusion of mobile phones around the globe may indicate that today's world is *fast*—but not that it is flat.

4.1. The Jipp Curve vs. Mobile Adoption

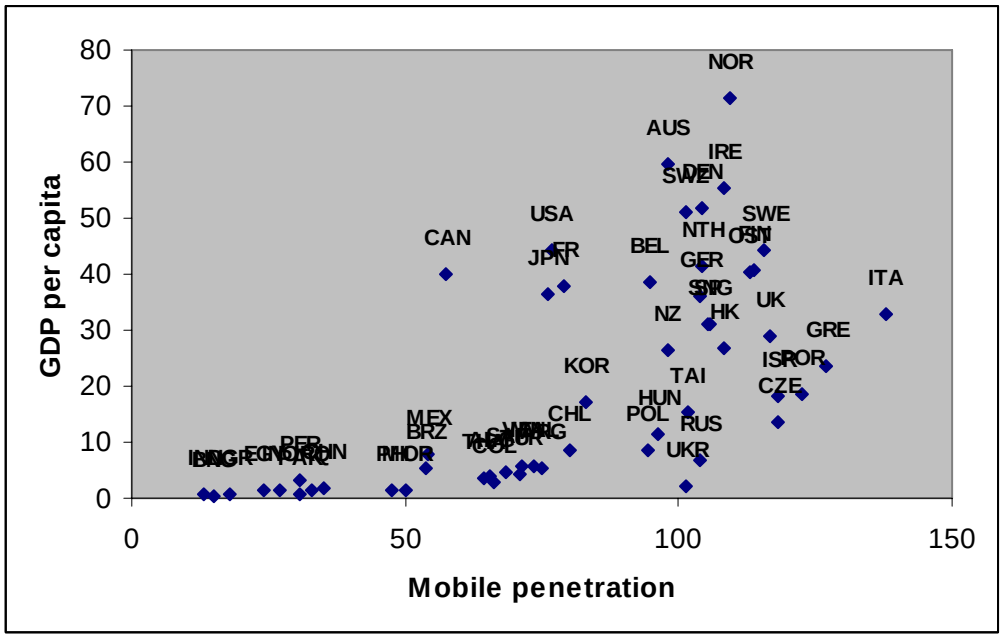
Scatter plots of mobile phone penetration levels (subscriber units per 100 persons) against gross domestic product (GDP) per capita are generally interpreted as indicating a high degree of correlation between a country's income level and its adoption of mobile phones.[1] They are considered to resemble the traditional Jipp curve that demonstrates the close relationship between telephone lines in use and GDP per capita.[2] Yet recent versions of the graph for mobile subscriptions (**Figure 4-1**) show a weakening relationship.[3] Instead of looking like a straight diagonal line, or something close to one, the scatter plot looks like a diffuse, diamond-shaped kite (right side) with a long tail (bottom left side).

---

[1] See, for example, Figure 1.4 in Manuel Castells, Mireia Fernández-Ardèvol, Jack Linchuan Qiu, and Araba Sey, *Mobile Communication and Society: A Global Perspective* (Cambridge, Mass.: The MIT Press, 2007), 29.

[2] The curve is named after A. Jipp, who first published a scatter graph showing the close relationship between countries' income levels and their telephone lines in usage. See A. Jipp, "Wealth of Nations and Telephone Density," *Telecommunications Journal*, July 1963, 199–201.

[3] Figure 4-1 reflects a Pearson coefficient of 0.62 ($p<0.01$).



Data source: Campbell and Chen, 2007; mobile subscriber units per 100 persons and GDP per capita in US$ (000s).

Figure 4-1

Mobile Adoption and Income

The tail portion of the graph resembles the Jipp curve, indicating that income is correlated closely with mobile phone adoption in low-income markets. This, incidentally, is the part of the curve where observers often claim that income has little effect—for example, in the poor countries of Sub-Saharan Africa—yet the graph suggests otherwise.[4] The middle-income markets, such as those of Greece, Korea, Poland, and Taiwan, also fit relatively consistently within the income-adoption trajectory established by the lower income countries. On the other hand, the higher income markets, from Canada and France to Ireland and Australia (including Japan, Sweden, and the United States—the originators of cellular mobile communications) appear as laggards on the map, merely keeping pace with the penetration levels achieved by middle- and lower income countries.

If one disregards the low-penetration cases—all countries with fewer than, say, 50 subscribers per 100 persons—one realizes that moderate- and even low-income countries (such as Ukraine in the latter category) account for a large number of the countries with high levels of mobile phone adoption. (Significantly, numerous other moderate- and low-income countries with 50+ percent mobile penetration levels are not included in the sample from which Figure 4-1 is drawn, not to mention quite a few with 80+ percent levels such as Estonia, Jamaica, Lithuania,

[4] The fifty-three countries included in the database from which the graph is drawn are twenty-three "developed" and thirty "emerging" markets, according to Glen Campbell and Flora Chen, *Global Wireless Matrix 4Q06* (New York: Merrill Lynch, March 28, 2007).

Mauritius, and Trinidad & Tobago.[5]) In short, graphic plots of GDP versus mobile penetration show that besides the mainstream group of countries that follow the conventional penetration-income assumption, there is a substantial group of "outliers": low- and moderate-income countries that defy the pattern and have much higher penetration levels than conventional theory would suggest.[6] Given that these outliers represent 10–20 percent of the total sample, they arguably represent more than what are conventionally considered to be outliers. Moreover, they are growing more rapidly than the overall "mainstream" group, which enhances their significance.[7]

Overall, the mobile income-penetration curve shown in Figure 4-1 can be seen as two curves: a relatively linear one for countries with below $35,000 income per capita and a more diffuse one for the higher income markets. As **Figure 4-2** illustrates, the emerging (i.e., lower income per capita) markets demonstrate a stronger relationship between income and phone adoption. The higher income markets, on the other hand, exhibit a weaker one—and one that places them at penetration levels similar to, rather than higher than, those of middle-income countries. In short, at the higher income level the effects of income are limited by other factors, notably by the limited presence of prepaid mobile products in many of the countries being plotted.[8] In fact, instead of converging toward a mean, these more mature markets exhibit greater diversity in their levels of mobile penetration.

4.2 Income and Disposable Income

The above heterogeneous pattern notwithstanding, the literature continues to treat income per capita as the lead indicator of a country's mobile phone penetration level.[9] However, the relationship between income and adoption is increasingly residual; that is, it applies to

---

[5] In some cases their penetration levels have exceeded 100 percent. For example, Lithuania with a GDP/PPP [purchasing power parity] per capita of $13,700 in 2005 already had a mobile penetration rate of 127.1 (see http://www.Infoplease.com , Economic Statistics by Country, 2005). Also see ITU, *The Internet of Things*, 7th ed., (Geneva: ITU Internet Reports, 2005).

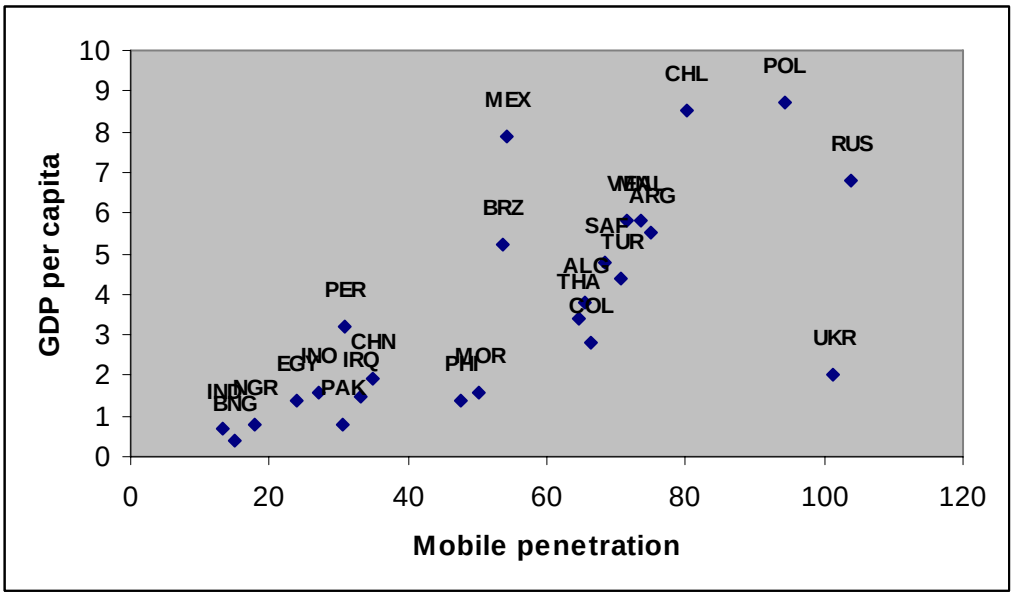
[6] There are also a few high-income country outliers whose penetration levels are 10–25 percent lower than theory would indicate. Given their small number, these are more conventional outliers.

[7] What used to be the exceptions of Central Europe and the Baltics are now the exceptions of the Baltics, Poland, Russia, Croatia, Romania, Ukraine, South Africa, Mauritius, Jamaica (and others in the Caribbean), Brazil, Mexico, Malaysia, Thailand, et cetera.

[8] The higher-income countries with lagging mobile penetration generally have prepaid shares of 20–50 percent (with an occasional exception such as Ireland), whereas their middle-income peers have higher prepaid levels. This is also true of high-income, high-penetration markets such as Hong Kong and Italy.

[9] For a traditional regression-based analysis of income and penetration, see H. Gruber and F. Verhoven, "The Evolution of Markets Under Entry and Standards Regulation—the Case of Global Mobile Telecommunication," *International Journal of Industrial Organization*, 2001. See also Manuel Castells, Mireia Fernández-Ardèvol, Jack Linchuan Qiu, and Araba Sey, *Mobile Communication and Society: A Global Perspective* (Cambridge, Mass.: The MIT Press, 2007), 28, which cites a UK market researcher, TNS, as indicating that "GDP alone...explains about half of the variation in mobile-phone penetration rates." Castells et al. caution that this does not imply causality.

increasingly lower bands of the income scale. As noted above, the relationship is becoming more tenuous at the high-income level. At the same time, a look at a cross-section of twenty-five emerging markets (**Figure 4-2**) shows a relatively strong income-penetration relationship.



Data source: Campbell and Chen, 2007; mobile penetration per 100 persons and GDP per capita in US$ (000s).

Figure 4-2

Mobile Adoption and Income: Emerging Markets

Overall, GDP per capita appears to be a proxy for disposable income in emerging markets, and reflects the financial capacity of consumers to purchase mobile phones and associated services and accessories. Correspondingly, the twenty-five emerging markets represented in Figure 4-2 show a strong relationship between mobile adoption and GDP per capita, with a Pearson correlation coefficient of 0.715 ($p<0.01$).[10]

At the same time, the declining role of GDP per capita in mobile adoption is difficult to deny, as a growing number of countries with GDP per capita below $2000 have attained mobile penetrations of 30 percent, 40 percent, 50 percent, or higher. To achieve mobile connectivity consumers in low- and moderate-income countries allocate a larger share of their disposable

[10] These levels are achieved despite some outliers. The most noticeable outlier in the data set of Figure 4-2 is in the lower right-hand corner (Ukraine), which may be due to the low income level ascribed to this country in the data base ($1968). Using the PPP approach, the *CIA World Factbook* listed Ukraine as having a GDP per capita of $6300 in 2004. The next most significant outlier is in the upper center of the graph (Mexico), where the large out-migration of workers may be a factor. Also, there may be a general argument for using PPP rather than GDP per capita figures for the analysis made here, as a mobile phone/service is a consumer commodity. Yet the official exchange rates in GDP better reflect the infrastructure imports that underlie the service as well as the handset imports that continue to dominate the market in most countries, the significant growth in local manufacturing in China, India and other larger markets notwithstanding.

income to mobile expenditures. This may be especially true of households in the lowest third of the income pyramid in countries with high income inequality. In general, this share, which is on the order of 0.8 to 1.6 percent in developed markets, is in the 1.9 to 3.9 percent range in emerging ones, and may exceed 10 percent in some low-income markets.[11] These numbers suggest a higher allocation of household budgets to communications than in the past, at the expense of reduced expenditures on transportation, food, clothing, and possibly housing. At the same time, this kind of hyper-allocation of consumer budgets to mobile communications may reflect in part under-reported income in the national statistical accounts.

Another factor that enters into the disposable income-mobile adoption equation is the progressively declining price of mobile phones coupled with the declining increments of prepaid minutes that can be purchased, allowing new subscribers to buy a phone and activate service for under $50.00. As a result, mobile adoption, as reflected in subscriber levels, is now associated with monthly ARPU of under $5.00 in some emerging markets.[12] Still another factor is variations in forms of payment, including the use of barter and phone sharing as a means of accessing mobile services. This is occurring in a growing number of markets, as summarized in **Section 4.5**.[13] In addition, demographic differences can affect adoption (see **Section 4.9**).

Finally, usage levels and pricing formulas, which vary significantly across countries, represent a key dimension of demand modulation. As noted in Section 2.2, the average monthly mobile phone bill in Japan (mostly postpaid service) is over $50.00 while in India (almost all prepaid) it is approaching $5.00.[14] Japan's higher income per capita supports a much higher buy-in level than does India's. Yet mobile phones are now being adopted in India each month by some 10 million new people (representing in many cases larger families that share phone use). The running adoption cost is an order of magnitude lower than in Japan, but is about the same relative to the respective GDP per capita levels—India's $3300 and Japan's $31,500.[15]

For the moment, whether the income level "determines" mobile adoption, affects it but is not determinative due to other influences, or is simply correlated with adoption remains open for discussion. Income effects are not a closed and shut case. In fact, both income and mobile phone

---

[11] Campbell and Chen, 2007.

[12] This is the case in markets such as Bangladesh, Pakistan, and the Philippines; compared to ARPUs in excess of $50.00 in Japan, Switzerland, and the United States.

[13] See, for example, Castells et al.

[14] See Wireless World Forum, *Japan Mobile Market 2006: Your Statistical Guide to Understanding the Mobile Opportunities in Japan 2006–2007*, summary, January 2007. Some operators in Bangladesh and Pakistan are experiencing ARPUs on the order of $3.00.

[15] Infoplease.com. The issue in India at these price levels is not demand but price sustainability, since operator costs may not be an order of magnitude lower.

adoption could reflect an underlying *modernization* drive.[16] At the same time some research indicates that mobile penetration may affect economic growth (and thereby GDP and GDP per capita) by as much as 1–2 percent a year.[17] However, this should not be taken to mean that high economic growth rates cannot occur in the absence of high mobile penetration rates—witness the experiences, at different economic levels, of India and Ireland, neither of which had high mobile adoption levels prior to experiencing periods of high economic growth.

4.3 Income Distribution—Early Adoption vs. Mass Market

Apart from the levels of income and disposable income, income distribution may have an effect on mobile phone adoption. In principle countries with a high degree of income inequality should exhibit more rapid adoption in the early stages of the market when the phones and service are expensive—and when, historically in Europe, North America, and Japan, car ownership was effectively a prerequisite for entering the market. However, once a "mass market" product becomes available, countries with relatively even income distributions should constitute the broader and more efficient consumer markets.[18]

The evolution of the mobile phone market generally supports this perspective. The United States, with greater income inequality (as measured by Gini coefficients, for example) initially led both Western Europe and Japan in market penetration. Then, following the introduction of handsets, both Europe and Japan achieved higher penetration levels compared to the United States. Similarly the countries of Eastern Europe, with low Ginis, have outpaced those of Latin America, where income inequality is high, in penetration terms, although in some earlier years Argentina, Brazil, Chile, Mexico, and Venezuela were ahead of Hungary, Poland, Romania, Russia, and Ukraine in terms of mobile adoption.[19]

However, the process of shifting from the early-stage high-end market to the broader mass market is fraught with marketing—and analytical—complexities. For example, when user surveys in Brazil first revealed that cellular phones were in the hands of "C" level individuals (widely used socioeconomic classifications, with the A level reflecting the highest strata), it remained unclear whether this indicated that the mass market had arrived. An alternative explanation was that the users were relatives or servants of "A" subscribers and in most cases were not paying for

---

[16] See Daniel Lerner, *The Passing of Traditional Society: Modernizing the Middle East* (Simon & Schuster: New York, 1958).

[17] See Leonard Waverman et al., "The Impact of Telecoms on Economic Growth in Developing Countries," paper presented at the Telecommunications Policy Research Conference, September 2005; available at http://www.tprc.org/publications.htm.

[18] See Benjamin M. Friedman, *The Moral Consequences of Economic Growth* (New York: Random House, 2005), 360, for a brief discussion of this point.

[19] Based on United Nations Gini coefficients (2000 to 2003, depending on the country), the Eastern European countries range from 26.8 (Hungary) to 39.9 (Russia) while Venezuela (44.1) is at the bottom of the Latin American range with Brazil (58) at the top. According to the CIA's Gini index, the United States is at 45 (2004).

their phones and service.[20] In more economically homogeneous societies these types of marketing puzzles are less likely to emerge, and both products and distribution channels can be more readily streamlined, benefiting from scale factors in the process.

At the same time, there are enough exceptions to the trends outlined above that caution should be exercised in assuming that "income distribution" offers a universal explanation of mobile phone adoption. Canada's Gini coefficient is significantly lower than that of the United States, and yet its mobile penetration level is lower. South Africa's Gini is much higher than that of the United States, yet its penetration level is also higher. Hong Kong has about the same level of income equality as the United States but also a much higher penetration rate. In other words, other factors affect the mobile penetration level. They include the geographic size of the market (rendering Hong Kong easier to cover and penetrate); the early advent and widespread adoption of prepaid phones and cards, which occurred, for example, in South Africa; and the greater penetration of broadband, which may explain Canada's slower mobile adoption rate on the basis of household budget trade-offs.

In short, a country's income per capita, disposable income, and income distribution all interact with other factors, such as product offerings, pricing, and prepaid billing. Product innovation, marketing, and adaptation to local circumstances are key ingredients of mobile adoption, as are the asymmetric interconnection rates that often accompany prepaid products in lower income economies. These factors are covered in **Chapter Five**.

4.4 Legacy Phone Service

Mobile phone demand can also be affected by the availability of wireline phone service. It is commonly thought that countries with high mobile penetration have nonexistent or weak legacy networks and service, and that "pent up" demand explains much of the mobile growth.[21] The high mobile penetration rates in countries such as Jamaica, Russia, and South Africa are often associated with the absence of legacy phone systems. Yet the highest levels of mobile phone adoption generally appear in countries where there are high levels of fixed phones, such as Sweden, Norway, Hong Kong, and Singapore. At a minimum, the issue is a tricky one.

China, which has added about 500 million mobile subscribers since 2000, also has a high base of fixed phones: well over 400 million.[22] South Africa has traditionally had the highest level of fixed telephone lines per capita in mainland Africa, and Russia claimed high levels of fixed

---

[20] The author advised several teams on forecasting and segmentation of Brazil's mobile market during the 1990s.

[21] The author has frequently encountered this view in his informal surveys of a wide range of people in the United States on this issue.

[22] ITU, ICT Statistics; available at http://www.itu.int/ITU-D/ict/statistics/ .

penetration for several decades, although the quality of the lines was often poor and the waiting lists for new ones were very long (approaching a decade for residential subscribers).[23]

Thus, an argument can be made that demand for—and availability of—fixed lines is a stimulus, rather than a substitute, for mobile demand. Once businesses and consumers know the benefits of fixed communications, the added value of mobile communications becomes readily apparent (although this was not always the case when mobile phones were first introduced, in part due to the price of the early phones: approximately $2000 in 1983). Even in low-income developing countries with relatively few legacy phones, mobile networks are installed in urban areas with a tradition of calling over public payphones, work-site phones, and (for the affluent) residential phones.[24]

This is the argument, but what can we glean from the data? **Figure 4-3** depicts the relationship between fixed and mobile penetration in twenty-six developed markets.[25] It suggests a reverse legacy effect rather than a "fixed stimulus" effect. In other words, the lower the fixed penetration, the higher the mobile penetration tends to be. Mobile appears to substitute for fixed where fixed is not highly developed. Yet the negative relationship is quite weak (Pearson coefficient of –0.50, $p<0.01$) and so not very much should be made of it, other than to confirm the absence of a fixed stimulus effect.

Given these results from developed markets, it is easy to assume that even less of a "fixed stimulus" effect exists in emerging markets. In fact, in emerging markets mobile penetration may be a substitute for weak wireline presence. This "mobilization" is evident in many areas of the developing world. Albania, Bangladesh, Cambodia, the Dominican Republic, Jamaica, Lithuania, Nicaragua, Oman, Paraguay, the Philippines, and Thailand are some of the low- and moderate-income countries where more than 80 percent (in many cases 90 percent) of the telephone connections are mobile.[26] With one or two exceptions these are markets with very young populations that are experiencing rapid urbanization as well as intense competition in the provision of mobile services. This competition occurs almost entirely in the prepaid sector, reflecting the itinerant working conditions of much of the newly urbanized population. Meanwhile, the rural communities the workers have left behind are often unserved by mobile networks, except in geographically compact countries such as Jamaica and Lithuania.

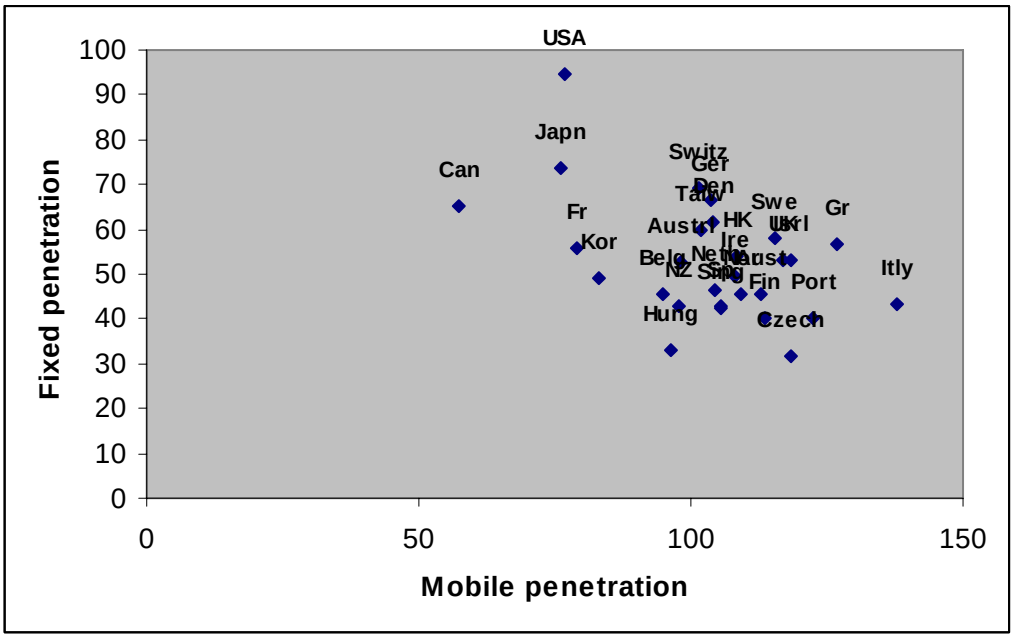
---

[23] Ibid.

[24] A countervailing conclusion is reached in a recent analysis of 200 countries during 1995 to 2005. The results indicate that greater legacy telecommunications infrastructure has a negative effect on a country's development of its ICT sector (though not mobile communications, specifically). See Philip N. Howard, "Testing the Leap-Frog Hypothesis," *Information, Communication & Society*, **10**, 2, April 2007, 133–157.

[25] Data from Campbell and Chen, 2007.

[26] Ibid.



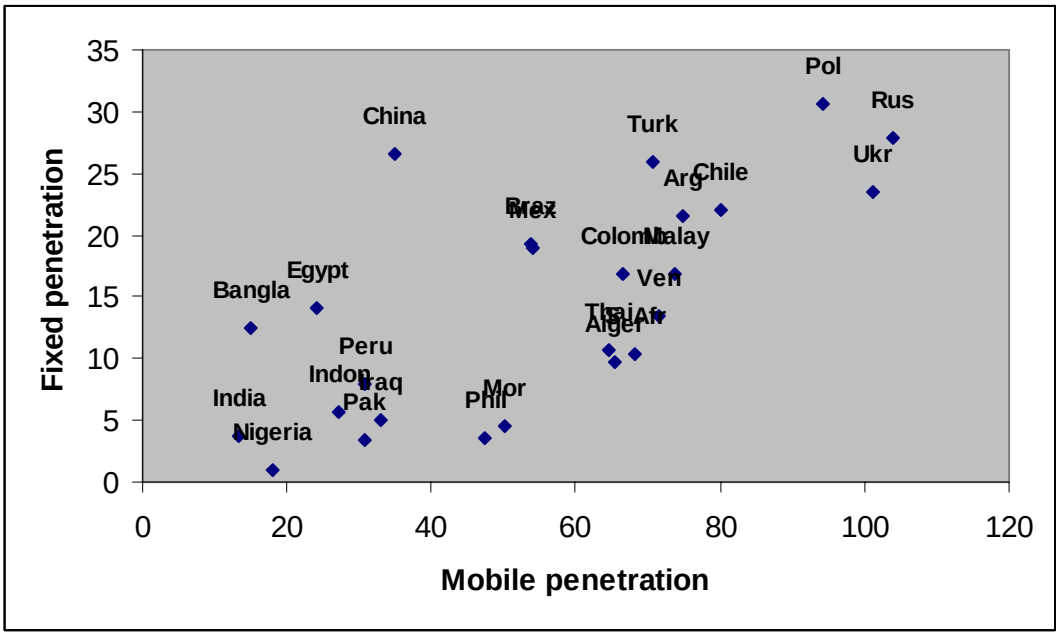
Data source: Campbell and Chen, 2007

Figure 4-3

Mobile vs. Fixed Penetration in Developed Markets

What is the underlying relationship between mobile and fixed penetration in emerging markets? As **Figure 4-4** shows for twenty-five emerging markets, the relationship appears to be relatively strong, though in an unanticipated direction.[27] The more fixed connections a country has, the more mobile ones it has generally activated. To be sure, there are outliers. Two markets (Morocco and the Philippines) have managed to achieve mobile penetration levels on the order of 50 percent with fewer than five fixed lines per capita. China, by contrast, stands out (upper left) as a market with more than 25 percent fixed penetration and a correspondingly low level of mobile adoption (35 percent). Yet, overall, the relationship between fixed and mobile is quite evident. The twenty-five emerging markets represented in the figure achieve a Pearson coefficient of 0.696 at $p < 0.01$ significance, whereas the relationship between mobile and fixed penetration across twenty-eight developed markets, using the same data base, was not significant.

[27] Ibid.



Data source: Campbell and Chen, 2007

Figure 4-4

Mobile vs. Fixed Penetration in Emerging Markets

In the end it seems two effects are occurring simultaneously. Mobile demand is replacing and exceeding fixed demand. At the same time, the demand for mobile remains related to the extent to which legacy service has been available. Is this because both forms of demand are driven by income levels or are other factors involved? This is explained below.

First, let us examine whether the relationship between fixed and mobile demand holds in countries with many more mobile lines than fixed lines. For example, what happens when one looks at emerging African markets—markets with very low GDP per capita levels and, generally, very few fixed lines?

The rapid pace at which mobile phones are being adopted in Africa is very evident. From a base of 10,000 fixed phones in 2000, the Democratic Republic of Congo gained nearly 3 million mobile subscribers by 2005; Nigeria started with about 1 million fixed phones but picked up 19 million mobile ones; Angola, Ghana, Kenya, Mali, Mauritania, Morocco, Tanzania, and Uganda have followed the same path. Only countries with relatively well-established fixed and mobile networks prior to 2000 (e.g., Egypt, South Africa), and a few with markets that have not been liberalized, such as Guinea and Zimbabwe,[28] have not experienced 100+ percent mobile compound annual growth rates (CAGRs) in the post-2000 period.

[28] ITU, 2005.

Figure 4-5(a) displays the mobile-fixed ratios of fifty African markets.[29] (**Figure 4-5(b)** provides an enlarged view of the markets concentrated in the lower left corner of Figure 4-5(a) to facilitate country label visibility.) While the fixed-to-mobile ratios presented on the graph are low, the correlation between fixed connectivity and its mobile cousin remains quite high. A country with virtually no fixed lines is also likely to have very few mobile ones. Correspondingly, one with a fixed penetration level of 10 percent or more is likely to have 20 percent or more mobile lines per capita. The Pearson coefficient for the fifty African countries in Figure 4-5(a) is just as high as the coefficient for the geographically more distributed markets in Figure 4-4: 0.696 at $p<0.01$.

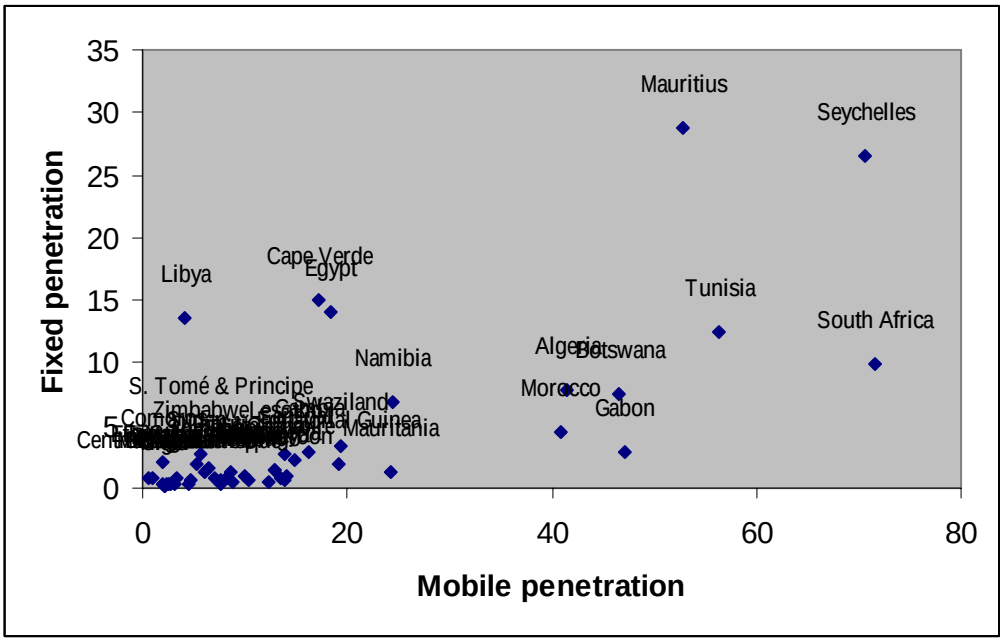
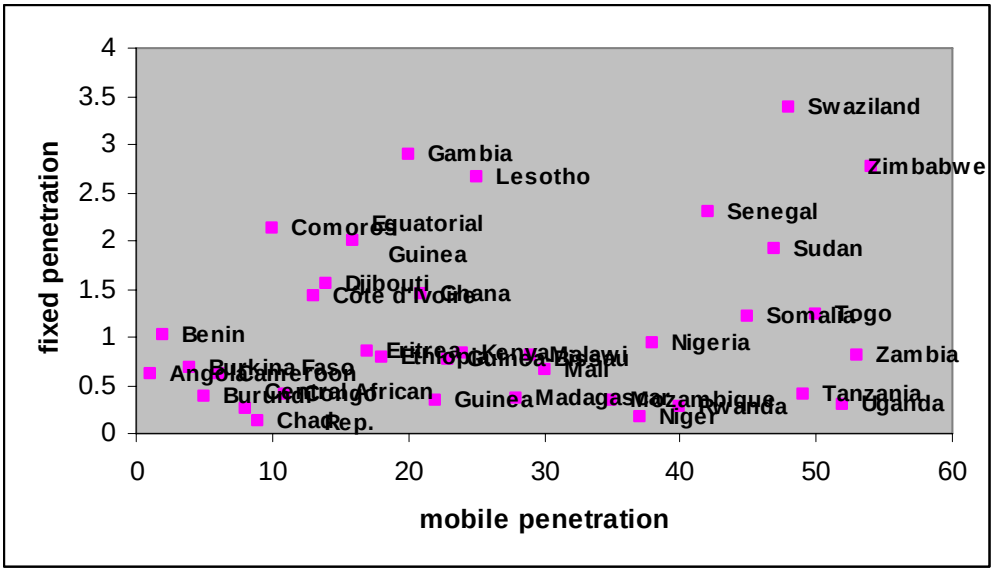


Figure 4-5(a)

Mobile vs. Fixed Penetration in African Markets

[29] Also based on the ITU data for 2005.



Data source: ITU (2005)

Figure 4-5 (b)

Detail of Lower Left Portion of Figure 4-5(a)

Quite probably, mobile substitutes for fixed service in many parts of Africa, and is also generating new demand that fixed service could not fulfill. At the same time, there remains a strong connection between fixed and mobile penetration. How can this be explained? First, the rankings of African countries' fixed and mobile levels are closely correlated, as both are with the countries' GDP per capita. So underlying income is likely to be the driver (or proxy) of both fixed and mobile adoption. But the explanation of the data probably does not end there.

Another factor is awareness or "observability" (in classical adoption theory terms). First, in markets with relatively more fixed connections the awareness of the potential value of telephone-based communications, including mobile, is greater than in markets with fewer fixed lines per capita.[30] Second, where there are more fixed lines (e.g., at work places) there are more opportunities to call mobile phones, which is especially important in Africa's and India's CPP billing environment. Third, greater fixed connectivity generally implies the presence of a more extensive backbone network, which in turn facilitates the deployment of mobile networks, at least where regulators have required incumbent operators to provide backbone access at reasonable rates to mobile entrants.

[30] The understood value includes the mobile phone's role as a status symbol and fashion article as well as a functional device. See Rohan Samarayiva and Ayesha Zainudeen, eds., *ICT Infrastructure in Emerging Asia* (SAGE and IDRC, 2008) for evidence of the status and fashion value of mobile phones to very low-income users (below $100/month) in Sri Lanka.

Overall, legacy phones seem to (1) dampen the demand for mobile in very high fixed markets such as the United States and Japan, (2) stimulate mobile growth where they have been visible and available on a relatively widespread basis—for example, most of Europe, and (3) complement prepaid penetration in emerging markets. Some of these effects may be due to different policy and operator licensing environments, as will be discussed in **Chapter Five**. Concurrently, most urban consumers in Africa and other low-income markets with very limited wireline networks are choosing mobile phones as their means of communication, thanks to classical adoption attributes such as innovation "observability" and "trialability" as well as relative advantage, ease of use, and compatibility with user needs.[31] Still, because of CPP economics, many low-income users prefer receiving calls, including those originating from wireline phones, to making them.[32]

4.5 Fractional and Seasonal Demand

A key reason mobile subscriber levels are growing so rapidly in developing regions is that the market has come to accept "fractional" and variable levels of demand as well as continuous service arrangements. In the traditional *postpaid* market the registration of demand called for a commitment to subscribe to a mobile service for one or two years. In other words, it involved a mobile phone purchase (subsidized or not, depending on the market), twelve or twenty-four monthly service obligations, usage charges, and a service connection fee (sometimes waived), not to mention a credit check. The introduction of *prepaid* reflected the new variable market, where the registration of demand required simply a down payment of cash for limited-use access to the service.[33] As noted earlier, this has now been followed by various forms of communal, shared, even bartered access to mobile minutes, with or without the ownership of a mobile phone.[34] As an extreme example, Orascom is installing mobile phones in remote, low-income areas of Algeria, where nomadic people use them on a per-minute basis.[35] New prepaid phones can involve a commitment of under $50.00, with prepaid cards costing under $5.00 and being replenished for as little as a few cents.[36] In short, both supply and demand are being fractionalized. Even barter

---

[31] Everett M. Rogers, *Diffusion of Innovations*, Fifth Edition (New York: Free Press, 2003).

[32] The growing use of mutual signaling, whereby a mobile call is placed and then interrupted simply to let the other party know who is thinking about them—or to elicit a return call—is an example of the sophisticated economics of prepaid communications in low-income emerging markets, in which calls from subsidized fixed lines (at work places, et cetera) play an important role.

[33] To the extent that prepaid cards remain active even when not used—or after their expiration in terms of outgoing call minutes—they allow quasi-continuous service access with respect to incoming calls.

[34] See Association Française des Opérateurs Mobiles, Discours & Pratiques, *Le téléphone mobile aujourd'hui—usages et comportements sociaux*, 2ème edition, Association Française des Opérateurs Mobiles, June 2007.

[35] See Cassell Bryan-Low, "New Frontiers for Cellphone Service," *Wall Street Journal*, February 13, 2007, p. B5.

[36] Ibid.

payments in exchange for prepaid cards (or minutes of use) on a communal handsete are becoming commonplace in many markets.

A great deal of phone sharing goes on as well. Many mobile phones are being effectively used as fixed phones in households in Africa, India, and elsewhere.[37] Usage is shared by anywhere from two to a dozen users, given the large households and extended families that form the social infrastructure of many communities. In developing markets where personal mobile use of the phones is the dominant pattern, the phones are still often shared with family and friends outside of the home.[38] Some of the friends involved in the sharing may own their own mobiles but may have left them at home or run out of battery power. Others may be merely itinerant users with no mobile phones of their own.

The fundamental demand questions as we look to the future concern how many of the world's nonsubscribers will be served by these various communal and shared forms of access, including mobile payphones, and how long it will take to convert such shared users into owner-users. Will shared use build awareness and interest in owning mobile phones and subscribing to the associated services, most likely on a prepaid basis, or will it serve as a substitute for full-scale mobile phone adoption?

4.6 Observability and "Trialability"

According to classical adoption theory, watching early adopters use a new product and being able to test it easily oneself are key drivers of adoption.[39] In the initial car-based phase of mobile communications, the special antenna (distinct in both size and placement from the car radio antenna) alerted drivers to the presence of a mobile phone. Then, as hand-held phones became available, the cell phone "mall" moved from highway to airport, restaurant, and Main Street. Public observability is undoubtedly one of the reasons why mobile phones have diffused through society faster than fixed phones, which took a hundred years to reach the billion subscriber level.[40,]

Unfortunately, the phenomenon has not been studied in a systematic way. The adoption literature would benefit from cross-country surveys comparing the exposure of both recent

---

[37] For useful descriptions of how mobile phones are shared in Bangladesh, Chile, Ghana, South Africa, and Uganda, see Castells et al., 231–239.

[38] Ibid.

[39] Rogers, 258–266.

[40] Admittedly, landline adoption could be observed where a wire from a telephone or utility pole entered a house. This is not entirely equivalent to observing a product being used to make or receive calls. There is also the phenomenon of fake adoption: the use of ersatz products for prestige purposes. There has been a brisk trade in wooden cellphones in some developing markets, just as, in the early days of television, some consumers purchased outdoor antennas before they could afford the TV sets.

subscribers and nonsubscribers, including shared users, to mobile phone usage and to the ability to "try out" a mobile phone. Instead we are left to rely largely on anecdotal evidence concerning the contrasting degrees of mobile phone visibility in different countries and the impact this has had on their respective diffusion curves.[41] What is clear is that the mobile phone has a highly visible product advertising function in addition to performing communications functions. The question is how effective and extensive this function is.

This issue has gained renewed importance as mobile phones have become available in countries such as Bangladesh and South Africa on a short-term usage basis, supported by microfinance and other entrepreneurial approaches. Are the observability and trialability of these arrangements stimulating more mobile phone ownership, or are the various short-term access services simply making phones available to those who cannot afford to buy them? While phone ownership and regular phone use by other means are more or less equivalent from a basic adoption standpoint, the subsequent uses can differ considerably.[42] Similarly, in countries with large households, such as India, to what degree does ownership of a mobile phone by one member stimulate other members to become mobile phone owners versus ongoing sharers of the initial household phone?[43]

A new context where observability and trialability may become instrumental in the adoption of a mobile communications innovation is mobile TV. Initial feedback from mobile TV trials across the world indicates that in some locations (e.g., in the United Kingdom), mobile TV is being used for extended periods of time, such as thirty to forty minutes per viewing, and that a significant portion of the viewing occurs within the home. Elsewhere (e.g., in the United States) viewing is more likely to occur "on the go" and last three to four minutes.[44] The UK pattern may result partly from the technology, which is better able to penetrate building walls, and partly from the smaller number of TV sets owned by the average UK household.[45] However, the resulting in-building use may reduce the observability of this innovation in some markets, while such

---

[41] For example, in the early 1990s the author found that mobile phone users in some locations (e.g., Caracas, Hong Kong) placed their phones on the table when eating at restaurants and generally treated the phones as a fashion accessory, while in other places (e.g., Prague) the phones were rarely displayed in public, possibly for security or cultural reasons.

[42] A survey of mobile phone owners, nonowning users, and nonowners/nonusers in South Africa and Tanzania found that nonowning users made significantly fewer calls than owners. More important, they made very few calls to "doctors, teachers and police or security forces." Nonetheless they regularly used mobile phones (typically one to three times per week). See Goodman, 62.

[43] See Castells et al.

[44] The early UK trials used DVB-H technology, which was developed specifically for TV transmission vs. the streaming over cellular networks approach that has been dominant in the United States to date.

[45] The lower ownership rate may be due in part to the government's charging a monthly rate for the use of TV sets. Whether the fee should apply to mobile phones used for TV viewing is not clear, but the author suspects that so far it has not been applied in practice. This is one of many interesting issues in the effort to develop a common regulatory framework for converging media.

observability grows in the United States and elsewhere, resulting in viral diffusion.[46] At a time when the United States was reported to have on the order of 7 million mobile TV and video subscribers, the figure for all of Europe was below 1 million.

4.7 Segmentation of Demand

Adoption studies seek to understand not only the extent of demand, but also its source(s). Is demand "across the board" or is it limited to certain segments of the population or industry? Is it regional in nature or skewed in any other definable way—for example, by age, gender, or lifestyle? While this issue receives a great deal of attention in mobile operating companies and can result in intricate marketing and distribution strategies, it is not always clear what the sources of demand are likely to be in new markets.

In 1983 British Telecom and its mobile affiliate, Cellnet, set out to determine where to extend the cellular phone network beyond London, the initial area of rollout. After a period of intensive research using economic analysis and focus groups, a consulting team projected the northern cities of Birmingham and Manchester as the best targets.[47] The car-based nature of early mobile phone diffusion and the large role that corporate fleets played in the United Kingdom indicated that these large northern cities—home to many company headquarters and regional centers—would exhibit the highest levels of early demand after London.

This conclusion proved wrong, as the main source of demand at this phase of the market was small business, and these businesses were more widespread—and were growing more rapidly—in the south of England. Meanwhile, the corporate market took a longer time to activate. Large organizations took a longer time to make decisions about communications (or, for that matter, most) innovations. Such businesses used a multistep process involving pilot trials, budgetary reviews, and other decision elements. In small businesses the decision often involved only one person and one step.[48]

A similar error occurred when NTT DoCoMo introduced its i-mode service in Japan. The service had been developed with the corporate market in mind,[49] since businesses needed

---

[46] Much of the industry discussion about early mobile TV adoption has focused on the technical quality of the TV signal. Yet adoption tends to be driven by a variety of situational, legacy, and other factors. (With traditional TV, NTSC was adopted even though it delivers a relatively poor level of signal quality. While this was not apparent at the time of its initial adoption, even today NTSC users tend to watch more TV than do their PAL and SECAM counterparts.)

[47] The consulting team was provided by Kalba Bowen Associates, Inc., under the author's oversight.

[48] As the author later learned, Vodafone, the other UK mobile service operator, also made the mistake of targeting the northern cities after London—and overbuilt capacity accordingly. Vodafone, however, corrected the error more quickly than Cellnet did and in this manner took a market lead position, which it held until the recession at the end of the 1980s, when Cellnet was able to catch up.

[49] See, for example, John Beck and Mitchell Wade, *DoCoMo: Japan's Wireless Tsunam*i (New York: AMACOM, 2003), 36.

information services of the kind i-mode offered (news, stock data, et cetera) and had budgets. Instead, young *geeks* and fashion-conscious teenagers took to the product when it was introduced in early 1999. Fortunately for i-mode's survival, DoCoMo switched its marketing and product promotion almost instantaneously. It then switched again when it ran out of young people—who are in short supply in aging Japan, the night-time crowds in Rappongi notwithstanding. By mid-2001, less than 10 percent of the 25 million i-mode subscribers were teenagers, despite the lingering image (especially outside of Japan) that they represented the dominant source of demand. In fact, i-mode very quickly reached the Japanese mainstream, and even penetrated the corporate market at which it was initially aimed. Soon, the typical i-mode user was between thirty and fifty years old. In sum, demand can travel across segments quickly, as in the case of i-mode in Japan, or slowly, or even not at all, as in the case of various failed attempts to launch new mobile services.[50]

At the same time, there are several ways of achieving high mobile penetration levels. The classical one remains that of enlisting all the major population segments—young, middle-aged, and old, male and female, rich and poor—in the adoption process. Another is to sell users two or more mobile phones and associated service subscriptions to use on noninteroperable (e.g., SMS) systems, take advantage of the respective pricing benefits (such as on-network discounts) or coverage areas, differentiate among categories of calls for billing or anonymity purposes (e.g., work and personal), or exploit the different service features (e.g., email vs. voice). A third approach is to target unofficial and nonresident populations, such as migrant workers or foreign visitors who prefer to have a local prepaid phone to paying roaming charges. Finally, machine-to-machine subscriptions can be marketed to companies supplying automated services for tracking vehicles or pets, monitoring medical or environmental sensors, and so on.[51] In societies such as the Cayman Islands, which claims 222 percent penetration, all these approaches have apparently been tried and been successful.

4.8 Competing Products and Services

Surprisingly, very little is generally known about the role of competing products and services in shaping mobile phone demand. It is clear that average expenditures on communications vary across countries and, especially, across different levels of GDP per capita. This implicitly confirms the different tradeoffs made between mobile and other forms of communications and other commodities, but there is very little specificity to this understanding. For example, households living on less than $2.00 per day spend a relatively greater share of their

[50] For example, ESPN's attempt to sell a service focused on the needs of sports fans was recently suspended. Similarly, the attempt to transplant i-mode to the U.S. market has not been nearly as successful as in Japan, given the different market conditions and user contexts involved.

[51] The author is grateful to Mike Short of O2 in the United Kingdom for some of these examples; email to the author, January 27, 2007.

income on entertainment and communications and less on food than do their counterparts in moderately poor and wealthier households.[52] What is less clear is whether buying a mobile phone means that consumers in very poor countries must go hungrier than usual for some period of time, are supported by extended families, or decide to postpone the purchase of another consumer good, such as a radio, a bicycle, or an item of clothing.

Data from the U.S. market provides some specificity. When the Pew Research Center recently asked consumers which products they considered necessities, several were rated as more important than cell phones. Home air-conditioning led the list, with 70 percent of the respondents considering it a necessity, followed by microwave ovens (68 percent), car air conditioning (59 percent) and home computers (51 percent).[53] Cell phones came next at 49 percent, ahead of dishwashers (35 percent), cable or satellite TV (33 percent), and high-speed Internet (29 percent); fixed phones did not make the list. In sum, Americans seem to place climate control and some food-related appliances ahead of communications. On the other hand, cell phones are in a virtual tie with home computers and lead other forms of communication services, such as cable TV and broadband.[54] A McLuhan adherent could point out that, overall, Americans depend on *oral* technologies—those bearing on eating and talking—more so than on *visual* ones, although the tension between the two categories is apparent.

What remains unclear is whether consumers in other high-income countries would rate mobile phones as greater necessities than Americans do, despite the popular domestic impression that the latter are very mobile-oriented. If so, this could provide a demand-side explanation of the lower U.S. mobile penetration level compared to Europe and Japan.[55] Meanwhile, mobile phones may rank ahead of climate control in terms of perceived necessity in many very poor countries, despite the hotter climates often involved, and ahead of microwave ovens as well. In short, markets probably differ in the degree to which consumers value particular communications devices and services compared to each other and compared to other classes of consumer products and services.

4.9 Demographics: Age, Gender, and Household Size

This leads us to demographics, which have generally received little attention in mobile adoption studies, apart from the role generally ascribed to youth in stimulating demand. Overall, developing countries (except for such aging counterexamples as Argentina and the countries of

---

[52] See Abhijit V. Banerjee and Esther Duflo, “The Economic Lives of the Poor,” Massachusetts Institute of Technology; as reported in *The Atlantic*, March 2007, 34.

[53] Pew Research Center survey, as reported in *The Atlantic*, March 2007, 30.

[54] The summary of the Pew survey does not mention refrigerators, TV sets, and other common household goods, which may rate higher than at least some of the items listed.

[55] For supply-side explanations, including prepaid availability, CPP, and few operators per market, see **Chapter Five**.

Eastern Europe) have much higher proportions of population under the age of twenty-five than do developed ones. In most African countries well over 50 percent of the population is under twenty-five years old—a function of both the high fertility rate and high mortality.[56]

Higher income countries generally have an older population profile. Exceptions are Asian markets such as Korea's. Its large youth segment is one of the reasons Korea has such a high broadband penetration level—significantly higher than Japan's (not to mention than that of the United States, Scandinavia, Canada and all other countries, when measured on a per household basis). Japan has far fewer young people and about twice as many older ones (sixty-five+) as Korea. Korea also has a very well-educated population, averaging about a year more of education than Japan or the United States. This also affects its broadband penetration level, which has been generally shown to be more correlated with years of education than with any other single factor, including income.[57] On a household basis Korea has almost twice the years of schooling of a U.S. or Japanese household, given the larger size and younger age composition of Korean households. Korea's older population has fewer years of education than Japan's, but its younger population—a much larger cohort—more than offsets this.

The government of Korea is not about to rest on its laurels. It is developing programs for the population segments that have not kept up with the population as a whole in adopting and using broadband. The five segments that the programs target are housewives, the elderly, members of the military (many of whom are young but apparently have limited opportunity to use broadband), farmers, and the prison population.[58] On the mobile side, Korea's penetration level exceeds that of Japan, the United States, and Canada but is lower than that of most European countries and of Asian markets such as Hong Kong, Singapore, and Taiwan. This suggests that these other markets have been able to narrow the gender, age, and rural-urban adoption gaps with respect to mobile phones more effectively than Korea has.

In fact, an argument can be made that the elderly population is really pivotal to a nation's mobile penetration level, particularly in developed countries with aging populations. Countries such as Norway, where more than 80 percent of the above-sixty population has adopted mobile phones, have a relatively unassailable lead in market penetration, even when compared to youth-driven markets such as those of Korea.[59] When an aging developing country such as Ukraine reaches 100 percent penetration, following its more affluent but also aging neighbors such as the Czech Republic, Hungary, Lithuania, and the Russian Federation, this is even more remarkable. It

---

[56] 2006 World Development Indicators, Population Dynamics; data for 2004. In the case of Uganda, over 50 percent of the population is below the age of fifteen.

[57] For a fuller discussion of the factors underlying Korea's broadband penetration, see Kas Kalba, "Korea, Japan, and the U.S. Broadband Gap," draft, August 2006; available from the author.

[58] See Ministry of Information and Communication, Broadband IT Korea Vision 2007: The Third Master Plan for Informatization Promotion," April 2004; available at http://www.nca.or.kr/data_pdf/vision2007/vision2007_english.htm

[59] See Castells et al., 130.

suggests that the prepaid culture, so suited to young populations (who receive phones as gifts from their parents or purchase them during intermittent periods of disposable income), has started to penetrate the realm of limited fixed-income household budgets.[60]

Gender differences also remain a factor in mobile phone adoption, though not in the United States, where most surveys show that more women own mobiles and use texting sites than men. Elsewhere, including much of Europe, male adoption leads female adoption by a few percent (Nordic Europe), 10–25 percent (other developed Europe), or 25–100+ percent (selected developing countries).[61] As a broad generalization, the gender *divide* increases as one moves from north to south in the northern hemisphere and south to north in the southern one, reflecting the same (i.e., reciprocal) climate gradient.[62] Some of the differences are due to economic and security factors (e.g., percentage of women working away from home) and some to cultural ones (e.g., women ascribing the ownership of the mobile phones to their husbands even where they may be the/a principal user).[63]

Finally, there is the household size factor. This factor helps to explain why China's population adopted mobile phones more rapidly and broadly than did India's. With an average size of 3.4 persons, compared to India's 5.3 and Pakistan's 6.8, China's average household has more readily acquired the disposable income needed to obtain mobile phone service (involving phone purchase plus connection, monthly, and usage service charges). China's nominal household GDP of about $5800 (on average) "feeds" (and houses, clothes, transports, et cetera) 3.4 persons, while India's average nominal household GDP of about $3700 must cover the expenses of 5.3 individuals. Chances are that there is more cash left over in the average Chinese household than in the Indian one, China's higher savings rate notwithstanding.

By the end of 2005 China's mobile penetration was 29.9 versus India's 8.16. Since mid-2005 India has experienced a surge in new mobile subscribers, adding them at a rate of 6 to 10

---

[60] What is less clear is whether the elderly have learned how to use SMS with any degree of regularity. The suspicion is that this remains largely the realm of the young mobile user.

[61] See Castells et al., 41–44. A wide range of differences in how women and men *use* mobile phones are also covered in this source; see 45–55.

[62] Ibid. See also Jonathan Samuel, Niraj Shas, and Wenona Hadingham, "Mobile Communications in South Africa, Tanzania and Egypt: Results from Community and Business Surveys," in *Africa: The Impact of Mobile Phones*, The Vodafone Policy Paper Series, Number 3, March 2005. Castells cites a source (Huyer et al., 2005) that indicates that mobile phones in South Africa are owned disproportionately by men. However, Samuel, Shas, and Hadingham indicates otherwise. Part of the issue may be different survey methodologies. In general, the higher the overall penetration rate, the smaller the gender divide, with South Africa's rate being the highest on the African mainland.

[63] There is also a significant gender divide with respect to Internet access across developing countries. However, the exceptions—countries such as Thailand, the Philippines, and Mexico—do not reflect the same geographical pattern as the mobile statistics. In Thailand the traditional matriarchic family system and the broad presence of women in bookkeeping and other financial positions may be a factor.

million per month over the past two years, in most months higher than the rate in China.[64] This is a testament to the prevailing prepaid formula in India, which requires little financial commitment. By contrast, until 2007 China did not rely on prepaid, in part because more of its population works on a fixed salary basis and in part because China has not adopted CPP technology.) At the same time, India's subscriber surge reflects the competitive pressures its mobile industry is experiencing, with ARPU dropping below $6.00 per month and consumer satisfaction with mobile service dropping below the levels mandated by the regulator.[65]

Figure 4-6 shows the close correlation between mobile penetration and household size for six low-income markets: China and India as well as Bangladesh, Egypt, Indonesia, and Pakistan. The one outlier is Pakistan, which despite is large households (6.8 persons) has a relatively high mobile adoption rate.[66] Otherwise household size reflects the mobile penetration rates of the other five countries in Figure 4-6 more closely than do their income levels (i.e., GDP/capita).[67]

A similar pattern may underlie the penetration differences between Eastern Europe and Latin America. In Latin America, household size generally ranges from 3.4 (Chile) to 4.8 (Colombia). This compares with a range of 2.4 (Estonia) to 3.2 (Poland) in Eastern Europe. The largest countries include Russia (2.8), Brazil (3.8), and Mexico (4.4). In the end, the aging but smaller households of emerging Europe have adopted mobile phones more rapidly than the younger ones in Latin America.

What accounts for Eastern Europe's overall lead in penetration among developing regions? Some of it is higher GDP per capita. But significant differences persist even when Eastern Europe's high economic flyers—the Czech Republic, Estonia, Hungary, Slovenia—are taken out of the equation. Russia and Ukraine still have much higher subscriber levels than Brazil and Mexico. In the end the explanation may come down to a cluster of socioeconomic factors. The region's older demographics are actually a positive factor (in Latin America relatively aging Argentina and Chile have the highest penetrations), especially when coupled with Eastern Europe's smaller households, higher education levels, greater income equality, and greater average disposable cash.

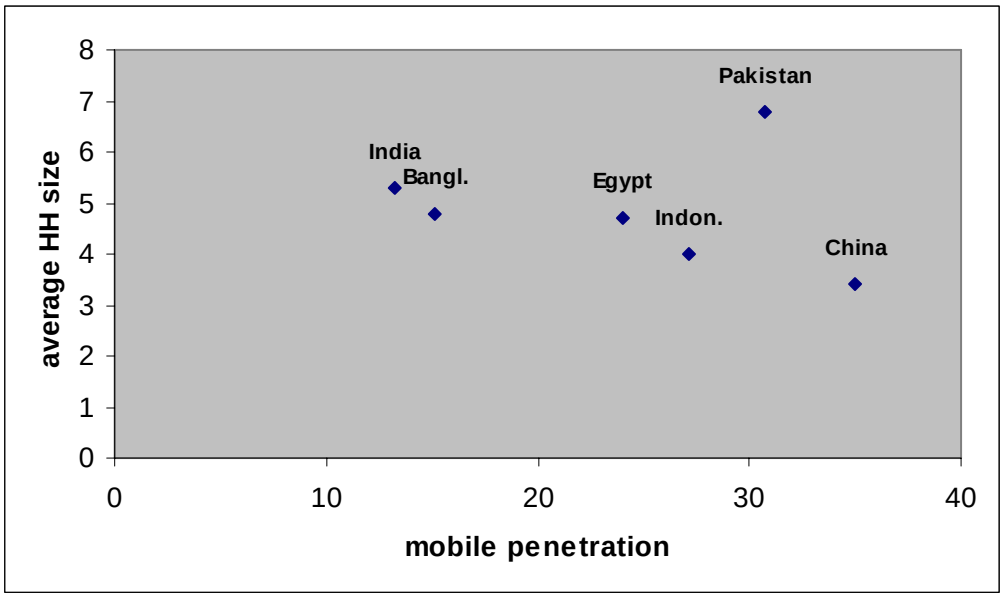
---

[64] As of mid-2007 China was adding about 8 million new subscribers per month, which may reflect the recent launch of prepaid subscriptions.

[65] According to a news report, only two of India's ten leading mobile operators have managed to exceed the 90 percent consumer satisfaction benchmark level set by the telecommunications regulator, based on a nationwide survey by *Voice & Data*, the Indian telecoms magazine. See "Strain Tells in India," *Financial Times*, January 15, 2007, 15.

[66] The household data comes from the World Bank, with the original data varying. The data for the markets represented in Figure 4-6 is from the last five years. One reason Pakistan may be the exception is its low average ARPU (2006) of $4.50, according to Campbell and Chen, 2007.

[67] The relationship is not significant in statistical terms, due to the small sample of countries. When the number of markets is increased to seventeen—all the emerging countries in the Merrill Lynch database with GDP per capita under $10,000 for which average household size could be obtained—it becomes significant at the 0.05 level, with a weak Pearson coefficient of –0.533.



Data sources: Campbell and Chen, 2007 and ITU (various years)

Figure 4-6

Mobile Adoption and Household Size in Selected Markets

4.10 Usage Levels—How Much Do Mobile Talkers Talk?

Adoption studies generally focus on penetration levels. Yet level of usage is also an aspect of adoption. It is one thing for consumers to adopt a technology and then rarely use it (or use it a great deal initially and then set it aside) and another to be regular, even heavy users. This usage level is likely to result from several factors, including price, income, pricing method, the availability of substitute products and of "dead time," and, according to some, cultural norms (see below).

A common perception is that mobile phone users, especially young ones, talk on the phone more than landline phone users. Yet this may be a function of the public visibility of mobile calls and not of their length or frequency compared to fixed calls. One of the few extended time series available to address this question are statistics on calls in Finland.[68] They show that mobile calls last on average about half as long as fixed calls, though they are getting longer—from about 2.1 minutes on average in 1995 to 2.7 minutes in 2005. (Fixed calls in Finland peaked in length in 2003 and have since been declining.) Also, total outgoing call minutes—fixed and mobile—peaked four years ago and have declined by a third since then, dropping from 24.1 billion in 2002 to 18.3 billion in 2005.[69]

---

[68] Statistics Finland, "Number of call minutes of outgoing calls from local telephone networks fell by a third from the previous year in 2005," 2006.

[69] Calculations based on ibid.

Some of this drop is undoubtedly due to the use of voice over Internet Protocol (VoIP) services and software for voice calls. The Finnish statistics on outgoing calls do not capture VoIP calls. Yet the number of broadband subscribers in Finland increased by only about 1 million during the 2002–2005 period, with each subscriber having the potential capability of originating VoIP calls. The average calling rate during this period across mobile and fixed subscribers was about 3000 minutes per year, but even if every one of these new broadband subscribers placed 3000 minutes of calls via VoIP per year (in addition to originating a share of the recorded mobile and fixed calls), it would account for only about half of the drop in Finnish national calling time since 2002.

The bottom line, at least in Finland, is that the shift to mobile phones—and to a combination of mobile and fixed phone calling—seems to have lowered per capita calling time, possibly because such subscribers spend more time on email and other Internet-related uses. In any event, today's mobile subscribers in Helsinki, Espoo, and other Finnish localities make about the same number of calls per year as their fixed line counterparts, but the calls are more than 40 percent shorter. In Finland, and quite possibly elsewhere, teenagers huddled over the phone in a stairwell, hallway, or bedroom for hours at a time may be a vanishing sight. A telegraphic- (or SMS-) style call, serving as a quick interruption, previously a characteristic primarily of the business world, seems to be replacing the longer residential calls of earlier decades.

4.11 Cultural Norms—Which Country Talks the Most?

What about cultural norms? Perhaps laconic Finns are not highly representative of the more talkative human species. Perhaps the mobile subscribers in more expressive cultures talk much more.

At the penetration level one can point out that expressive Cantonese Chinese in Hong Kong subscribe at much higher rates than, say, the northern, discreet in public, Japanese: 108.4 vs. 78.1 per 100 persons at the end of 2006.[70] In part this difference may reflect the greater competition among mobile service operators in Hong Kong and the much lower usage costs, not to mention the apparent advantages of subscribing to more than one service.[71] Similarly, "expressive" Mediterranean societies such as Italy and Israel have high mobile penetration levels—138 percent and 118.2 percent, respectively—yet the allegedly chatter-challenged Nordic ones are not far behind, with Denmark at 104.2 percent, Norway at 109.3 percent, Finland at 113.7 percent, and Sweden, where mobile phones are generally not subsidized by the operators, at 115.6 percent.

---

[70] Campbell and Chen, 2007.

[71] Japanese operators on average collect $0.26 per minute of use vs. $0.04 in Hong Kong; this latter number should probably be adjusted about 50 percent higher, given that Hong Kong operators do not use CPP billing. See Campbell and Chen, 2007.

At the usage level, many cite the difference in average monthly minutes of use (MOU) in the United States and in European countries. A recent report from Merrill Lynch indicates that in 2006 subscriber MOU averaged 149 across Western European countries compared to 698 in the United States.[72] One is tempted to ask whether America's greater economic productivity is a direct function of its loquaciousness. The main reason for this great difference is simple: the average revenue generated by a minute of use in Europe is $0.20, whereas in the United States it is $0.04, which reflects a large difference in price. This difference is due not only to absolute price differences but also to differences in the respective pricing methods.[73] In addition, Europe's higher penetration rates may dampen the average usage level in that more "marginal" users are connected to mobile services in Europe than in the United States. These users presumably use fewer minutes on average than earlier subscribers.

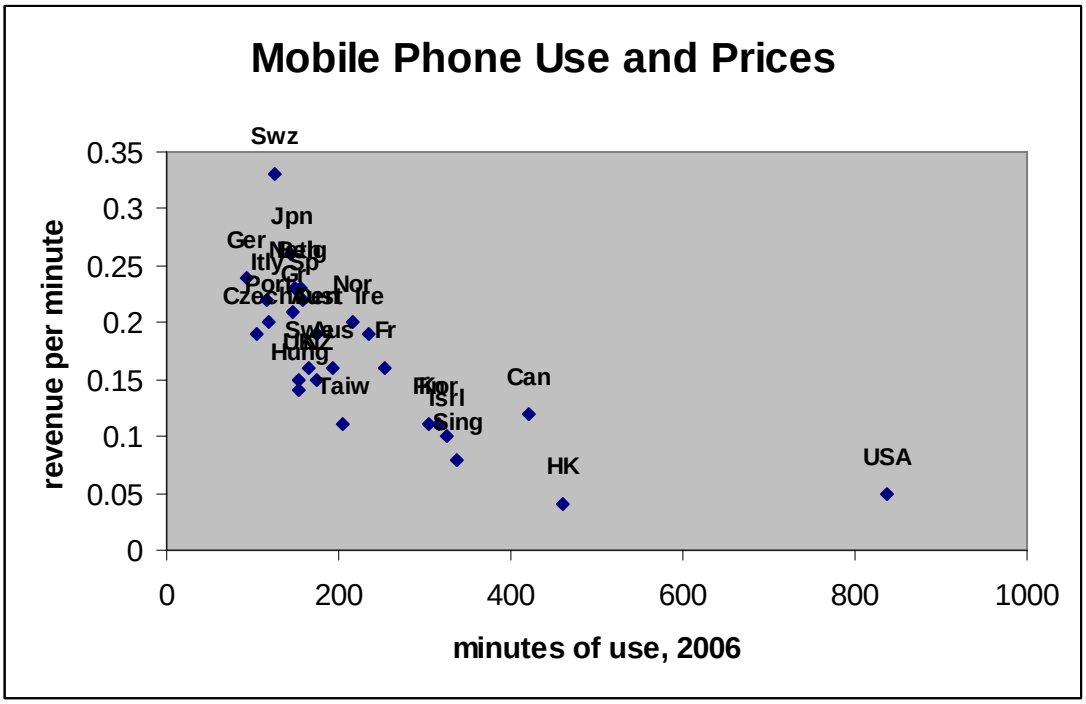
Meanwhile, **Figure 4-7** illustrates the strong reverse relationship between usage levels and effective price, with a Pearson coefficient of –0.73 ($p<0.01$). It also shows that the United States (bottom right corner) is the usage leader, due in large part to the low cost per minute (second only to Hong Kong's). At the same time, the comparative MOU numbers must be interpreted with care, as some double counting may occur in countries that do not employ CPP, while some misestimation of total talk time may occur in those that do.[74] Also, Europeans are more likely to hold two or more subscriptions, as reflected by the much higher penetration numbers (reaching

---

[72] Ibid., 51. The U.S. MOU level grew from 471 in 2002 to 698 in 2006, rising to 838 in 4Q 2006. This last increase presumably reflects a combination of underlying growth and end-of-year seasonal effects. Another source reports 743 as the U.S. MOU for the second half of 2006; email to the author from Dr. Robert F. Roche, Vice President, Research, CTIA (wireless industry trade association), April 2, 2007. The time period on which this estimate is based is different, as was the population surveyed. (According to the CTIA source the outgoing portion of U.S. MOU is estimated to be in the 55–57 percent range currently.)

[73] In the United States most mobile subscribers buy mobile minutes by the bucket, not by the minute as is the norm in Europe as well as most markets where prepaid dominates. Bucket pricing stimulates greater mobile usage just as flat rate local calling stimulated higher usage levels in the U.S. landline market in the early twentieth century, resulting in higher usage and subscription levels than in other countries. (In those early days, prior to automatic switching, the marginal costs of manually switching individual calls were high, Consequently most countries adopted usage-based pricing methods to avoid cross-subsidies of high-volume callers by low-volume ones. Yet the U.S. approach drove higher overall usage and more rapid expansion of the telephone network. For a discussion of the effects of different pricing methods in telecommunications and transportation, see David Levinson and Andrew Odlyzko, "Too expensive to meter: The influence of transaction costs in transportation and communication; see page 17 in particular on how the introduction of the Digital One-Rate™ plan by AT&T Wireless in early 1998 led to a general adoption of bucket pricing in the U.S. market and increased average mobile usage several fold. For a detailed look at the early adoption of the telephone (and related pricing methods) in the United States, see Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, Calif.: University of California Press, 1992).

[74] As stated in Campbell and Chen, 2007, "For carriers that disclose only outgoing traffic (e.g., Australia, New Zealand, Finland), we gross up the reported outgoing-only MOU figure by 20–30% to capture incoming minutes. It is consistent with traffic patterns in other [developed—*author's addition*] countries to assume incoming minutes as one-fifth to one-third of outgoing minutes. We also note that MOU figures are potentially somewhat overstated in countries that do not employ the calling party pays system (Canada, China, Hong Kong, India, Singapore, United States) relative to other countries who [*sic*] do as a result of the double counting of on-net mobile-to-mobile minutes." For a fuller explanation, see ibid., 182–183.



Data Source: Campbell and Chen, 2007

Figure 4-7

Mobile Phone Use and Usage Prices in Developed Markets

138 percent in Italy, for example). As a result, the comparative numbers per user (vs. per subscribing unit) are likely to be closer than the initial four-to-one or five-to-one ratio would suggest. When compared to the most talkative Europeans—the Finns, with an MOU of 304, rising to as much as 500 to 600 minutes when fully adjusted for incoming calls and multiple SIMs per user—the U.S. propensity to talk may be less dramatic than it first appears to be, given not only the Finns' alleged reluctance to say very much but also that they pay an average of $0.11 per mobile minute while U.S. subscribers probably pay half of that (adjusted). [75]

This is not meant to suggest that Americans are abandoning the chatting mode. Traditionally U.S. fixed minutes have run about 1000 per month, presumably in part because of the way in which local telephone service was billed—with no usage charge and no limit on the minutes that could be used. U.S. mobile plans also reflect this tradition, with "buckets" of minutes provided at a fixed rate, compared to per-minute charging as the dominant billing method in Europe. This helps explains the lower per-minute revenues of U.S. mobile operators as well as the high U.S. usage levels, which reached 838 MOU in the last quarter of 2006.[76]

---

[75] Ibid., 2. The individual country MOU that follow, and Finland's above, are from the 2006 Q4 data presented in Campbell and Chen, 2007. They may be higher than MOU based on a 2006 annual average.

[76] Ibid.

A contributing factor is that in the United States the commute typically occurs in automobiles, and until quite recently this was where the majority of mobile calling minutes originated.[77] Time spent in the car is also considered a kind of "dead time," and is often filled with mobile calls.[78] The same "cultural" concept extends to public transport, with Americans freely using mobile phones in buses, trains, and airplanes, despite often complaining when their fellow passengers do so.

Other differences in user environments contribute to different usage patterns across countries. In Japan, i-mode emerged in part because of the social (and, at times, legal) taboo against talking in public places, particularly trains and public transport. Combined with the greater reliance in Japan on public transport for commuting and the long periods often involved, commuter trains were instrumental in the development of the i-mode service and in the "dead time" they accorded users of the service. Similarly, SMS may have developed in Scandinavian schools where the cultural—and, possibly, explicit—prohibition of classroom chatter may be greater than in American schools.[79]

What happens in emerging markets? Does price have the same pervasive effect on mobile usage or is the role of cultural or other factors more evident? **Figure 4-8** depicts the price-usage relationship. It turns out that, if anything, it is even more pronounced than in developed markets. South Africa is a mild outlier in that its subscribers talk more than the general curve would suggest, possibly due to higher per capita income and shared use of mobiles by friends and family members, while subscribers in the Philippines talk relatively less, replacing talk, which is expensive per minute, with heavy use of SMS texting, which is cheap. Overall the trend could not be clearer. As the effective price per minute drops, the talk time increases. The Pearson correlation coefficient is –0.74 at $p<0.01$. A rate of $0.10 per minute generates about 100 minutes of use; a rate of $0.03 generates about 250. Moreover, the pattern generally corresponds to the income levels of the markets, with the higher and moderate income markets on the left and the lower income ones at the far right.

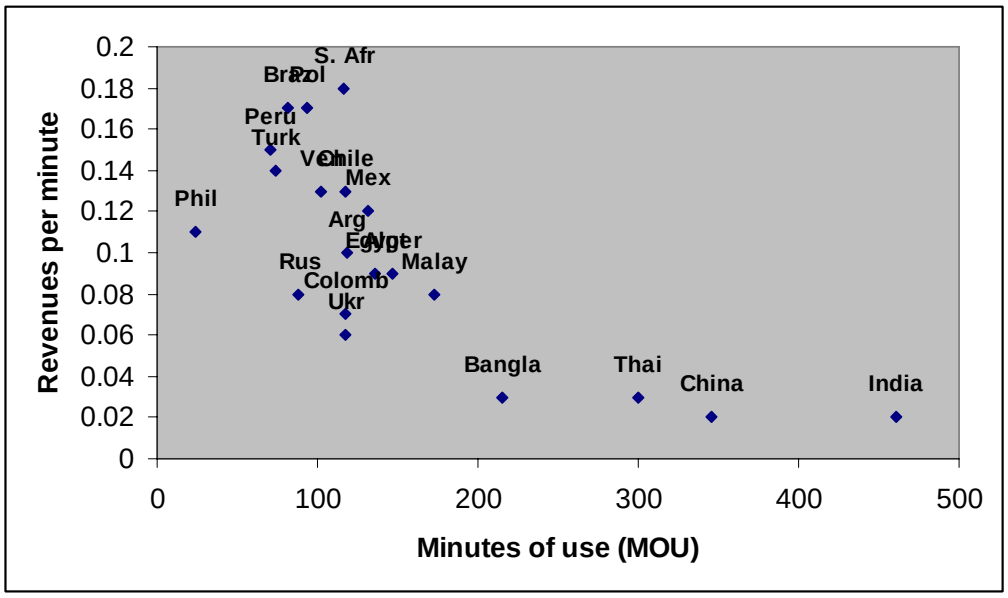
Who talks the most on mobile phones outside of Europe, the United States, and the other developed markets? The answer is subscribers in India. This is not entirely surprising, as the average revenue per mobile minute is only $0.02. India's MOU of 461, however, may have to be adjusted downward on a per-user basis. Some of India's subscribers use their mobiles as fixed phone substitutes, with several family members (or small business employees) sharing phone use.

---

[77] Yankee Group study, circa 2002.

[78] The recent spate of state laws prohibiting mobile phone use in automobiles (other than, in some cases, on a hands-free basis) may be reducing this mobile calling segment, depending in part on how aggressively the laws are implemented. In general, public surveys indicate that a large majority of drivers continue to use mobile phones in cars.

[79] While cultural freedom is generally considered a breeding ground for innovation, these may be interesting counterexamples where cultural restrictions result in innovation.



Data source: Campbell and Chen, 2007

Figure 4-8

Mobile Phone Use and Usage Prices in Emerging Markets

Thus, the effective single-user MOU in India is somewhat lower than the recorded number derived from operator billing accounts. China, with an MOU of 346 minutes, may not be far behind on a user-by-user basis.[80]

Indians and Finns are close contenders for the title of the world's most loquacious mobile talkers (or, at least, consumers of mobile minutes), though low usage prices rather than a common communications culture tie them together. At the same time, the MOU of cultures that are considered to be highly expressive are often, though not always, near the highest level: for example, Hong Kong's 460 (including incoming minutes) and Israel's 326, with Korea not far behind at 316. Keeping in mind that many subscribers have two or more SIMs, the effective MOU may be significantly higher. Italy, on the other hand, has MOU of only 120, reflecting the relatively high revenue per minute that its operators generate ($0.22 vs. Hong Kong's $0.04 and Israel's $0.10).[81]

Nonetheless, the U.S. mobile subscriber out-talks peers around the world because of the factors mentioned above: lower prices, bucket plans, a tradition of heavy telephone usage (possibly because face-to-face has been a less available option due to population dispersal or other factors), a larger proportion of teenagers than in other developed markets (aided by the large

[80] At the same time, as China is a non-CPP market, its MOU may have to be adjusted downward. On the other hand India's MOU may go down as well as it reaches China's penetration level.

[81] Ibid.

immigrant population), more “dead time” in cars and at check-out counters, and fewer inhibitions about using phones in public places. It may also be that there are more other people to talk to, although this “connectivity” principle does not seem to apply universally; subscribers in Europe’s largest market (see below) have the lowest MOU, while small markets such as Finland, Hong Kong, and Israel exhibit very high ones.[82] Finally, the low U.S. penetration rate is a factor. As more of the U.S. population adopts mobile communications, the average talk rate will probably decrease, even as more telephone users switch to mobile only.[83]

It is also important to note the relative pricing theory of mobile use. According to this view mobile use is driven by a small differential between wireline usage prices and mobile prices. This theory has been used to explain subscriber behavior in many European markets. In Germany, for example, where fixed calls are priced at a flat rate, mobile usage is low because of the high charges. On the other hand, mobile calls are attractive from a relative pricing standpoint in markets such as Finland and France. The theory may also explain why mobile usage prices in markets such as Hong Kong and the United States (not to mention China) have been set so low—namely, as recognition that wireline prices for local calls approach zero in these markets.

Finally, who talks the least on their mobiles? The general answer may be the Filipinos, who register only twenty-four MOU. At the same time, as suggested above, they are one of the world’s heaviest users of SMS, generating nearly half of their mobile expenditures with expressive thumbs and fingers.[84] The Peruvians are also relatively low users with seventy-one MOU, reflecting the unusual combination of low penetration and low talk time. They are closely followed by the Turks (seventy-four MOU), where the penetration level, however, is more than twice as high as in Peru.

Among developed markets, Germany’s scores lowest with an average MOU of only 93, compared to a European average of 150. The French, who pay almost 25 percent less per minute (and where fixed rates are higher than in Germany), talk more than two-and-a-half times as much as the Germans and more than twice as much as the Italians.[85] On usage, economics seems to trump culture.

---

[82] See **Section 5.4** for a discussion of the effects of market size.

[83] The author suspects that the percentage of mobile-only users is higher in Europe, as coverage (including in-home) tends to be more extensive in Europe due to population density, size of dwelling, fewer second lines (wireline), antenna permitting, and other factors.

[84] Based on the emerging markets covered in Campbell and Chen, 2007.

[85] These ratios are not adjusted for number of phones/SIMs per subscriber, which are highest in Italy but the overall directionality of the above comparisons would not change with such an adjustment.

4.12 The Role of Extreme Climate

In addition to widely accepted drivers of mobile subscriber growth, such as per capita income, price and market competition, there are some signs that climate may also be a factor.[86] The theory is that extreme weather conditions—as measured, for example, by days with temperatures above 90° F, below 32° F, or both—render mobile access more of a necessity than in moderate climates, where it is merely a convenience.[87] This would help explain the high penetration levels in the Nordic European countries as well as in Italy, Spain, Singapore, and Korea.[88] Conversely, countries such as France and Japan, with more moderate climates, would be expected to have relatively lower penetration levels, as is the case.

Climate may also help explain why the countries of Eastern Europe have outpaced those of Latin America in mobile adoption. The number of extreme temperature days in Moscow, Kyiv, Warsaw, Prague and in the Baltic countries, where the national penetration levels average above 90 percent, is much higher than in places like São Paulo, Mexico City, Buenos Aires, Caracas, and Santiago, with country penetrations averaging below 60 percent.[89] It is only in Maracaibo, Venezuela's second largest city, and Monterrey, Mexico's second largest, that the intense heat begins to offset the blistering cold of northern Eastern Europe in extreme temperature days per year.

What is less clear is how to factor in other aspects of extreme climate, such as high levels of precipitation, humidity, or wind. Cities such as Hong Kong and Taipei, for example, average over eighty inches of precipitation per year, while not experiencing the extreme temperatures of Singapore or Seoul.[90] Is this reflected in their high penetration levels or does the explanation lie primarily in the high levels of price competition in these markets, with five operators?

In the United States, the same theory suggests that cities such as Phoenix, Chicago, Detroit, and Dallas would have above-average penetration levels, while places with "moderate"

---

[86] This possibility was first addressed by Sontine M. Kalba in 1994. In a regression analysis of seventy countries' mobile penetration levels covering some twenty variables, she found that extreme temperature in the principal city correlated most closely with penetration after GDP per capita and the presence of competition.

[87] As mobile phones were first introduced in Europe, Japan, and North America the main alternative was public payphones. Finding—or waiting in line for—one in very hot or cold weather was often more than an inconvenience.

[88] Weather data is generally organized by cities rather than countries. On this basis, the average number of "extreme temperature days" is: Stockholm (151), Singapore (149), Milan (119), Madrid (111), and Seoul (99) versus Paris (53) and Tokyo (38); see http://www.weatherbase.com.

[89] The average number of extreme temperature days in Moscow (174), Kyiv (145), Warsaw (117) and Prague (119) approximates those of Scandinavia, while São Paulo (16), Caracas (approx. 22), Buenos Aires (35), and Santiago (48) are quite mild by comparison; ibid.

[90] Ibid.

temperatures such as San Francisco, San Diego, and Los Angeles would be below average.[91] In fact, historical city-level penetration data from 1996 does reflect this pattern.[92] It shows that the four "extreme" climate cities had an average penetration of 18.0 while the three "moderate" climate ones averaged 15.2.[93] These differences prevail despite the higher median household income of the moderate climate cities ($36,827 vs. $33,517).[94,95]

At the same time, it is important to note another theory of why the three (relatively mild) California cities had lower penetration rates during the late 1980s and early-to-mid 1990s: namely, that they were subjected to regulation of intrastate calling rates by the California Public Utilities Commission.[96] The Federal Communications Commission (FCC) reversed this form of state regulation in mid-1995, with the lagging effect potentially still apparent in late 1996.[97] So, is the reason regulation or climate? The answer in California is open to debate, but, worldwide, climate differences have had an effect on mobile phone adoption. This effect has been most evident in the early market stages, when functional factors play more of a role than social and lifestyle ones.

---

[91] Extreme days in Phoenix (176), Chicago (150), Detroit (145) and Dallas (139) contrast starkly with Seattle (21), Los Angeles (16), San Diego (4) and San Francisco (2); ibid.

[92] Metropolitan area penetration levels for the end of 1996, as reported in *RCR Wireless*, using data from Strategis. The highest penetration cities were Atlanta, Seattle, Miami and Boston, where precipitation levels are high but "extreme degree" days may not necessarily be. In fact, Seattle has a well below average figure of twenty-two on this latter score.

[93] These averages are unwieghted by the number of subscribers in each city, as is also the case with the median household incomes that follow.

[94] City median income data for 1989 from U.S. Census Bureau, Median Household Income by Metropolitan Statistical Areas (MSA), 1969, 1979, and 1989.

[95] It may be useful to note that some cities—Chicago, Los Angeles, and San Francisco, among them—are considered extreme commuting traffic cases. However, traffic congestion may translate more into levels of use (i.e.,, talk time) than subscriber levels. See Will Sullivan, "Road Warriors," *U.S. News & World Report*, May 7, 2007, 42–49

[96] Thomas W. Hazlett and Roberto E. Muñoz, "A Welfare Analysis of Spectrum Allocation Policies," George Mason University Law and Economics Research Paper Series, 06-28.

[97] See "FCC Denies State Petitions to Continue Regulating Rates for Commercial Mobile Radio Service Providers," *Mobile Phone News*, May 22, 1995.

Chapter Five

Supplying Mobile Service

When demand is relatively broad and strong, as it has been for mobile phones, supply-side factors may become less important. Still, technology developments that have increased capacity have been critical to making mobile communications available to the mass market, as have been developments that have eased consumer entry (such as prepaid) or made the ownership of phones more attractive—whether ring tones, new designs, or lighter and longer lasting batteries. By contrast, technological developments aimed at adding new capabilities, such as data applications, have been less important and, except for SMS, have so far had limited success outside of a few Asian markets. During the next phase, higher speed and wider area technologies such as LTE and WiMAX will add capacity and coverage as well as more applications to the diffusion and adoption mix.

Meanwhile, it is useful to review and assess how supply-side factors—technological and other—have shaped the global market to date. This review begins with the role of investment in the deployment of mobile networks.

5.1 Investor Initiative

Since the late 1950s laboratories in New Jersey, outside Stockholm, in Tokyo, and elsewhere had tinkered with early cellular telephone technology—the transmission technology as well as the tracking software that allowed callers to move from cell to cell without losing their calls.[1] At some point in the 1970s a few executives thought "cellular" was ready for prime time. In some respects this was the first "adoption" moment, when an investor—or in the cellular telephone case, an executive at NTT, L.M. Ericsson, or AT&T—decided to stake reputation and budget on the technology. Yet at the time everything worked against the mobile phone. The top telecommunications engineers were focusing on transistors and fiber optics, consumers were not clamoring for mobile phones, and no vendor or country was introducing the technology. The forces of inertia were great.

Nonetheless, by the late 1970s the developers of cellular mobile asked their respective governments to grant them permission to test small-scale systems using a particular frequency band, and then to conduct initial commercial trials. Japan did this in 1979, Sweden in 1981 (followed soon by Norway), and the United States in 1983.[2] Most observers and analysts still

---

[1] The original cellular telephone concept, involving the spatial reuse of frequencies to accommodate larger volumes of users and usage, was developed in 1947 at Bell Labs. See Jon Agar, *Constant Touch: A Global History of the Mobile Phone* (Duxford, UK: Icon Books, 2004), 19.

[2] On the initial commercial deployment in October 1981 of the NMT cellular system in the Nordic countries, see Dan Steinbock, *The Nokia Revolution: The Story of an Extraordinary Company That Transformed an Industry* (New York: AMACOM, 2001), 96 ff. The U.S. commercial launch in October 1983 is described in James B. Murray, Jr.,

predicted there would be little demand.[3] Yet when the FCC called for license bids for the top thirty metropolitan markets, and then the next thirty, prospective investors appeared—mostly in the form of young entrepreneurial companies, such as Graphic Scanning and MCI, along with mid-sized media companies such as LIN Broadcasting, McCaw Cable, and Metromedia.[4] The only big players in the game were the telephone companies, primarily the operating entities of the Bell system, which were automatically allocated one of the two licenses in each metropolitan area where they operated, with little expectation that these would be significant businesses.[5]

The early years of mobile network and service deployment brought immense uncertainties. Theories abounded as to who the early subscribers would be, as did marketing concepts of how to target and reach them. The early U.S. cellular phone companies changed sales and marketing chiefs faster than TV viewers changed channels, as the recruit who relied on radio advertising was replaced by another who thought that sales should be pushed through specialized electronics dealers, who in turn was replaced by one who believed in personal selling to small businesses. This last chief usually survived for a while, since the early market was largely driven by small business—a realization that did not emerge overnight.

Once the initial demand for mobile phones materialized in Scandinavia and the United States, the global investment climate turned positive. In addition to local telephone companies (usually monopolies at that point) and broadcasters,[6] the mobile market attracted investors from a growing circle of industries. They included electronics (Racal, subsequently Vodafone, in the United Kingdom; Kyocera in Japan), engineering (Mannesmann, Germany), ports and utilities (Hutchison, Hong Kong), property (Sun Hung Kai, Hong Kong), and even agribusiness (Algar Group, Brazil). Other waves of investment came from cross-border expansion. One wave was

---

Wireless Nation: The Frenzied Launch of the Cellular Revolution in America (Cambridge, MA: Perseus, 2001), 69–70. The first U.S. operating precommercial service began in the Chicago area in December 1978, according to Agar, 38; Agar (174–175) also indicates that Batelco, Bahrain's phone company, may have operated a small cellular system as early as 1978. Similarly, a reviewer of an earlier version of this report cites the launch of an NMT 450 system in Saudi Arabia in 1979; email from Wolter Lemstra, November 13, 2007.

[3] The market forecasts that Yale Braunstein and the author developed in 1982 at Kalba Bowen Associates, Inc. for the Washington Post Company were considered bullish by some and wildly bullish by many others, even though a few years later they would be shown to have been overly conservative. Under Katherine Graham's leadership, the Washington Post Company was one of the few established companies to believe in the demand for mobile phones at the time.

[4] For a detailed account of the initial winners and losers, see Murray, 2001.

[5] In areas where the Bell operating companies shared the market with other telephone companies, they initially formed consortia with these but over time largely bought out their partners.

[6] One of the reasons broadcasters became involved is because of their ownership of broadcasting towers and experience in managing radio transmission equipment. It turned out that the towers, which were optimized for wide-area signal distribution, were not especially useful in the cellular technology context, where the objective was distribution of the signal to a much more limited and contoured area.

dominated by the divested Baby Bells seeking international diversification and Wall Street favor;[7] another by pan-European and global forays of British Telecom, Cable & Wireless, France Telecom, Deutsche Telekom, Italy's TIM, Spain's Telefonica, Telenor, and especially Vodafone; and a third by developing country mobile operators expanding into adjacent regions, such as Mexico's Americas Moviles and Egypt's Orascom/Weather.

In the late 1990s the world experienced the first contraction of mobile investment. Following the passage of the 1996 Telecommunications Act in the United States the Baby Bells started to abandon their mobile investments in Asia, Europe, Latin America, the Middle East, and Oceania. They did so on the premise that they had better domestic opportunities to pursue and, in any case, needed to focus on domestic competition from long distance companies, competing local operators (competitive local exchange carriers—CLECs), and eventually cable TV operators. Their mobile divestments caused hardly a ripple, given that the other investment waves were at their height.

By contrast, a massive freeze in investment occurred after the telecommunications sector crash of 2000–2001, partly stimulated by Europe's 3G auctions. While mobile investment opportunities still abounded, especially in emerging regions such as Africa and the Caribbean, the interest of the principal financial centers (notably New York and London) in supporting any telecommunications-related ventures effectively vanished for about four years. Ventures in these emerging regions had to be broken into smaller pieces and funded with local and regional resources.[8] On the other hand, initial public offerings by affiliates of China's government-owned mobile operators continued to support mobile expansion in China, even during the post-crash freeze. A China play trumped the telecom downplay.

The ebb and flow of operator and investor interest in international mobile ventures was only partly consistent with how the market as a whole valued individual announcements that Operator X was going to enter Country Y. According to one analysis such international forays did not generally receive exceptional shareholder support—as reflected in the stock valuations of the operators—during 1989–2004.[9] Expansion by operators into markets with less than average levels of existing competition and relatively nearby markets (as defined by geographic and cultural distance) received favorable treatment from the market. At the same time, the market did not respond favorably to factors such as the market size of the targeted expansion countries or

---

[7] See Kas Kalba, *Telecom in the Time of Crash* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, November 2002), 11–12, [On-line]. URL: http://pirp.harvard.edu/pubs_pdf/kalba\kalba-i02-2.pdf.

[8] See, for example, Kas Kalba, "Telecommunications Development in the Caribbean Region after the Global Telecommunications Crash," paper presented at the 19th Annual Conference of the Caribbean Association of National Telecommunications Organizations, June 17, 2003, The Bahamas, 11–12.

[9] See Torsten J. Gerpott and Nejc M. Jakopin, "Firm and Target Country Characteristics as Factors Explaining Wealth Creation from International Expansion Moves of Mobile Network Operators," *Telecommunications Policy* 31 (2007), 72–92.

their potential for mobile subscriber growth. Announcements of intentions to enter markets with significant metropolitan populations usually resulted in negative valuations.[10]

The financial community's interest in backing mobile projects that would extend services to new adopters has largely returned in recent years, with support widening for ventures in Africa, India, the Caribbean, and the more remote parts of Oceania. The question that remains is whether and under what conditions financing will be available for expansion of mobile service into the rural areas of Africa and India. The investments involved will be monumental. Various approaches to implementing rural deployment programs are being considered, including infrastructure sharing by multiple operators and government subsidies, which have been supported by multilateral institutions.

Output-based aid (OBA) is a mechanism receiving increased attention as a result of early telecommunications trials in Peru and elsewhere, as well as a wider history of application in sectors such as energy, water, and sanitation. Typically private operators bid in reverse auctions for the right to operate mobile (or other telecommunications) services in rural parts of low-income developing countries. The bidder requiring the lowest subsidy is awarded the concession.[11] While promising, the OBA approach faces a number of challenges, including implementation of new technologies that offer sufficiently promising and dependable economics despite limited field testing and the ability of the winning bidders—in some cases relatively new companies—to meet financial and managerial requirements.

We are also witnessing attempts by private equity groups to enter the mobile sector. However, these have largely failed to date, as strategic competitors in merger and acquisition auctions have generally outbid the private equity players.[12] Moreover, the latter have been interested primarily in mature (usually wireline) operations rather than in mobile expansion opportunities in developing regions.

---

[10] This was defined as the "percentage of population living in urban agglomerations of more than 1 million residents;" ibid., 81. There was moderate support for entry into markets without "intensive" regulatory regimes in some but not all the data analyses that were run.

[11] See Geoffrey Cannock, "Expanding Rural Telephony: Output-based contracts for pay phones in Peru," in World Bank, *OBA Book*, World Bank, Washington, DC; available at http://rru.worldbank.org/Documents/Other/06ch1.pdf; also Andrew Dymond and Sonja Oestmann, *Rural Telecommunications Development in a Liberalizing Environment: An Update on Universal Access Funds*, Intelecon Research & Consultancy Ltd. July 2002.

[12] Some minority investments have been made, such as Blackstone's recent purchase of 4.9 percent of the shares of Deutsche Telekom, Europe's largest landline/mobile operator, which also owns one of the U.S. national mobile operators, T-Mobile.

5.2 Number of Competitors

Several studies have shown that competition is a key factor in stimulating mobile phone diffusion through lower prices and/or other marketing effects.[13] This is one of the main reasons why the United States led virtually the whole world in penetration during the 1980s. The United States and United Kingdom instituted two-operator frameworks from the beginning, whereas much of Europe and Japan allowed single-operator monopolies to prevail for several years. Even when second operators were introduced, their ability was in some cases limited by high interconnection rates set by the prior monopoly operator, usually a government-owned entity.[14]

While a few monopolies achieved penetration rates similar to those of competitive markets (e.g., in Switzerland and Singapore), in general mobile phone adoption lagged in the monopoly markets. In some cases monopoly operators did lower prices and increase their marketing efforts once competitors were licensed or were about to be, thereby reducing the market that would be easily available to the new entrants. Even in these situations, however, the market generally continued to grow at a brisk pace, allowing the competitors to secure significant market share.

A recent example is that of Trinidad & Tobago. The second operator did not enter the market until early 2006, at which point the penetration level was already approaching 70 percent.[15] Anecdotal evidence suggests this number reached the 80–90 percent range a year later, with the second operator, Digicel, securing most of the incremental subscribers. At the same time, the initial operator, C&W-affiliate TSTT, has largely managed to hold on to its subscriber base.[16] In Trinidad, the incumbent has benefited from the lack of SMS interoperability between the two networks and from its broader initial coverage, which has resulted in many users' subscribing to both services. Meanwhile, the two operators continue to argue over an appropriate interconnection framework while using "bill and keep" as an interim approach.[17]

---

[13] See, for example, H. Gruber and F. Verhoven, "The evolution of markets under entry and standards regulation—the case of global mobile telecommunication," *International Journal of Industrial Organization*, 2001, 19, 1189–1212; also Philip M. Parker and Lars-Hendrik Roller, "Collusive Conduct in Duopolies: Multimarket Contact and Cross-ownership in the Mobile Telephone Industry," *Rand Journal of Economics*, No. 28 (1997), 304–322; and Scott Wallsten, "An Econometric Analysis of Telecom Competition, Privatization, and Regulation in Africa and Latin America," *Journal of Industrial Economics*, **XLIX**, March 2001, 1–19.

[14] This was the case in France, for example. With high interconnection fees, the second operator's ability to compete on price was restricted. It took a number of years for the second (and later third operator, as well) to prevail in reducing interconnection charges to levels closer to other competitive markets.

[15] Ian Alleyne, "Mobile War in Trinidad – an Analysis," Caribbean360.com, July 7, 2006. The head of the original mobile operator, TSTT, is cited as stating that his company had 900,000 subscribers in February 2006, which is 69 percent of the estimated population of 1,305,000 in July 2005 (Wikipedia, January 20, 2007).

[16] By contrast, when Digicel entered the Jamaican market in 2001, it managed to secure a 60 percent subscriber share within a year. In both cases it is competing with cable and wireless affiliates.

[17] See Telecommunications Authority of Trinidad & Tobago, Decision 2/2006, August 16, 2006.

As this case illustrates, incumbents benefit from “head start” and other advantages. Yet the effects of competition in terms of speeding up adoption are usually quite evident. Prices tend to drop. Marketing activity and promotion pick up. Opportunities to observe and try mobile phone usage increase. In some cases coverage is expanded and new products or services are introduced by the new entrants to gain share or by the incumbent to maintain it—often both. The result is higher penetration than would otherwise be the case, including a rise in the number of subscribers with two or more subscriptions.

On the other hand, this does not mean that unlimited competition brings unlimited growth in penetration. For example, a review of Latin American penetration levels at the end of 2002 found that the number of operators does make a difference, though less than might be expected. The penetration level across the sample of sixteen countries grew from an average of 8.8 percent in single-operator markets to 13.1 percent in dual-operator markets to 21.6 percent in markets with three or more operators. However, a comparative adjustment of the results in terms of differences in GDP per capita and age of data (2002 in most cases, 2001 in others) effectively increases the difference between single- and dual-operator markets and decreases that between dual- and three (or more)-operator markets. In other words, the value-added of competition in making mobile service widely available drops off fairly quickly as the number of operators grows.[18]

Analyzing twenty Caribbean markets in the same way revealed a similar but even less pronounced effect. The single-operator markets had an average penetration of 21.4 percent, which grew to 29.8 percent and 36.2 percent for dual- and three (or more)-operator markets, respectively. Given the increase in average GDP per capita between dual-operator markets and those with three or more operators, the effects of adding a third or fourth operator on the overall market were less significant than the difference between 29.8 percent and 36.2 percent would suggest.[19]

Similarly, **Table 5-1** presents the penetration levels of twenty-four Organisation for Economic Cooperation and Development (OECD) countries at the end of 1999, based on OECD and other data. The table excludes OECD members with developing economies (Czech Republic,

---

[18] See Kas Kalba, “Telecommunications Development in the Caribbean Region after the Global Telecommunications Crash,” paper presented at the19th Annual Conference of the Caribbean Association of National Telecommunication Organizations, June 17, 2003, Paradise Island, The Bahamas, Slides 11A and 11B. Another study suggests that the benefits (measured in number of mainlines added) of increases in the number of competing operators in Latin America continue to grow with the number of additional entrants; see Scott Wallsten, op. cit., p. 16. However, Wallsten’s Latin American data on the number of operators per country conflates competing operators at the national level with multiple regional operators within the same countries (e.g., Chile, Colombia, Mexico); accordingly, the sample does not cover cases with more than three concurrent national competitors. If anything, Wallsten’s analysis may support subdividing national territories for licensing purposes as a means of speeding up penetration growth; see the discussion of this issue under “Diseconomies of Scale—The Case of Small Markets” below. (In the case of Africa, the data on which Wallsten bases his conclusions includes only one country with more than three mobile operators, including the incumbent.)

[19] Ibid.

Hungary, Mexico, Poland, and Turkey). It shows, and averages, the penetration levels of countries with different numbers of concurrent facilities-based mobile operators,[20] including cellular mobile and Enhanced Specialized Mobile Radio (ESMR) operators in the case of the United States and Canada.[21]

Table 5-1
Mobile Penetration by Number of Operators in OECD Countries, 1999*

Country	2	3	4	5+
Australia		39.5		
Austria		51.9		
Belgium		31.1		
Canada			22.7	
Denmark			49.4	
Finland			65.0	
France		34.9		
Germany			28.6	
Greece		38.1		
Iceland	62.2			
Ireland	42.7			
Italy		52.7		
Japan			43.8	
Luxembourg	45.0			
Netherlands				43.0
New Zealand	32.9			
Norway	61.5			
Portugal		46.8		
S. Korea				50.0
Spain		37.8		
Sweden		57.6		
Switzerland		41.2		
United Kingdom			40.2	
United States				31.5
Average	48.9	43.2	41.6	41.5

Data source: OECD; penetration figures are from end of 1999, number of operators from October 1999

The nonadjusted averages at the bottom of Table 5-1 do not seem to indicate a positive relationship between the number of operators and mobile penetration. In fact, the average

[20] "Concurrent" competitors were calculated by treating regional licensees, operating in the same frequency bands, as a single national competitor. Notable cases of regional licensing include the United States as well as Brazil, India, Russia and several countries in Latin America.

[21] Data analysis by Kalba International, Inc., 2003. The information is from OECD Communications Outlook 2001, Global Mobile and other industry sources. Affiliated operators—cellular, PCS, and/or ESMR—are counted as a single operator.

penetration is highest for markets with two operators (48.9) and is roughly the same for those with three, four, and five or more operators—namely, 43.2 percent, 41.6 percent, and 41.5 percent, respectively.

A number of intervening variables may be at play with respect to the above findings, such as tariffs, handset subsidies (or lack thereof), GDP per capita, and service launch dates.[22] The analysis covers neither levels of concentration, which can be higher where there are fewer operators and can produce anticompetitive effects, nor potential differences in the proportion of adopters with multiple subscriptions.[23] Still, it is noteworthy that among the five Nordic countries—all relatively early adopters of mobile service with relatively similar GDP per capita levels—there is no positive relationship between the number of mobile operators and penetration. With only two operators in late 1999, Norway and Iceland both had penetration levels above 60 percent. Sweden, with three operators, was at 57.6 percent, and Finland and Denmark, with four operators, were at 65 percent and 49.4 percent, respectively.

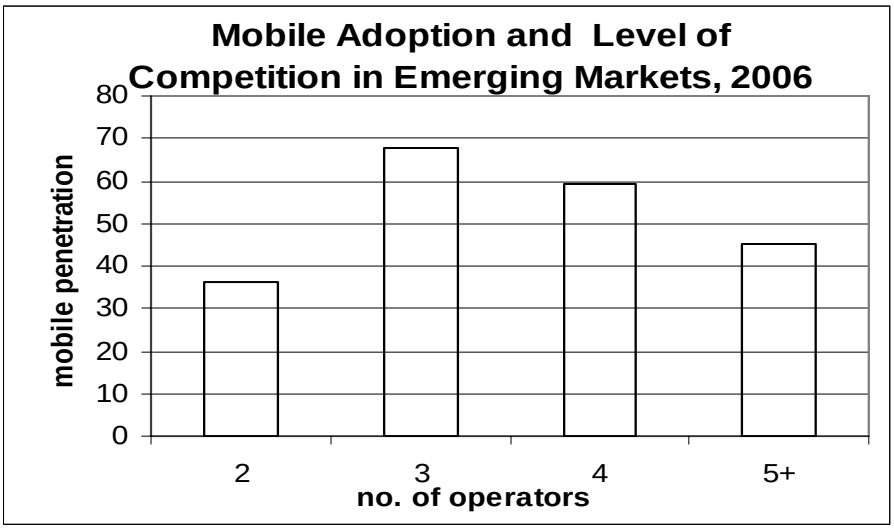
A review of more recent data covering twenty-four emerging markets in Africa, Asia, Eastern Europe, and Latin America, each with two to six operators, corroborates these earlier assessments.[24] **Figure 5-1** shows average mobile penetration rising when the number of operators goes from two to three per market and then declining when there are four and five or more operators.

---

[22] This includes the sequencing of new entrants. At least one study shows the benefits of not introducing multiple competitors at the same time; see H. Gruber and F. Verhoven, "The Evolution of Markets Under Entry and Standards Regulation—the Case of Global Mobile Telecommunication," *International Journal of Industrial Organization*, 2001. In general the sequencing of GSM competitors in Europe appeared to enhance adoption better than the simultaneous issuing of 3G licenses that followed.

[23] There are counterexamples as well, at least in terms of penetration levels. Italy and Japan were two of the most concentrated OECD markets in 1999, with Italy's TIM holding a 60 percent+ subscriber share in a three operator market and Japan's DoCoMo over 50 percent in a four operator one. Yet penetration in Italy was 52.7 percent versus Japan's 43.8 percent. At the same time the ARPU level in Japan was higher than in Italy, where a far higher share of the subscribers were on prepaid plans. (Whereas in Japan and elsewhere the dominant operator sought to retain control of high-end postpaid subscribers, Italy's TIM led the move into the lower-end but broader prepaid market, retaining its share and its profitability.)

[24] Glen Campbell and Flora Chen, *Global Wireless Matrix 4Q06* (New York: Merrill Lynch, March 28, 2007). Iraq (33.1 penetration level) was excluded until its competition level can be validated. Initially three operators were licensed on a regional basis in Iraq. Recently they were authorized to operate on a national basis; however, it is not clear whether all three have done so.



Data source: Campbell and Chen, 2007

Figure 5-1

Mobile Adoption and Competition in Emerging Markets

A finer analysis indicates that the two-operator markets and the five-or-more-operator markets have significantly lower GDP per capita levels—averaging $1632 and $2337, respectively—compared to $4646 and $4932 for the three- and four-operator cases.[25] At the same time, the five-or-more-operator markets achieve significantly lower ARPU levels than those with fewer operators.[26] The bottom line, based on the results to date, is that optimal diffusion seems to occur in the range of three to four national operators.[27]

A general pattern in emerging markets, as in developed ones, is that the first two operators capture a very large share of the market—65 percent or more (often above 80 percent)[28] Splitting the residual segment among two, three, or more operators does not always provide a sustainable base for increased competition on a full-fledged basis: competition at the level of coverage, quality of service, price, customer responsiveness, applications, and so on. The smaller operators may try to compete on price of service and/or handset subsidies but this can exact a cost (e.g.,

[25] Ibid. At the same time, Ukraine with five operators is listed at $1968 GDP/cap, compared to above $6000 PPP/cap by another source. See note 14 supra.

[26] The average ARPU is $11.15 for the two-operator markets, $11.76 for those with three-operators, $14.76 for the four-operator ones, and $6.66 for the five or more operator cases. Campbell and Chen, 2007.

[27] Governments, particularly in low-income markets, continue to issue larger numbers of licenses, possibly to build political support or to reduce the risks of failure by some operators at the startup stage. At the same time, by issuing "too many" licenses governments may be reducing the likelihood of financial support for the operators and thereby increasing the chances of startup failures.

[28] Major exceptions among emerging markets are Brazil and India, where the top two operators control about 50 percent of the subscribers. The United States, United Kingdom, and Hong Kong are similar exceptions among developed markets.

higher finance charges or reduced service quality and coverage) and can result in turnover not only in subscribers but also in the ownership of the operator. Emerging markets such as Chile, Malaysia, and the Philippines have experienced operator consolidation, with others exhibiting signs of forthcoming consolidation.[29]

Although more operators often result in greater competition at the retail level, profitability can drop due to duplication of capital investment, lower spectrum efficiency (as a result of dividing available spectrum into excessively small bands), and limited investment in coverage and other aspects of service quality.[30] While "welfare" benefits can result from hypercompetition among five, six, or more operators, long-term welfare and adoption are likely to suffer.[31]

The difference between European penetration levels, which averaged 98.75 at the end of 2005, and the U.S. level of 67.62 is another indicator that competition beyond the first three or four operators has only a weak influence on mobile subscriber penetration.[32] European countries generally had three or four mobile operators during the 2000–2005 period, whereas the United States had six national operators (since then consolidated to four) and two or more regional and local ones in most metropolitan areas.

5.3 Geography and Political Geography

The number of competitors seems highly significant in explaining the difference in mobile penetration between Europe and the United States. Yet geography could also be a factor. The EU

---

[29] A case in point is Brazil, where Telefonica will hold interests in two of the mobile operators, which it may try to consolidate, assuming its proposed acquisition (along with Italian financial entities) of a controlling management position in Telecom Italia is finalized; Telecom Italia controls TIM Brasil. Similarly major operator consolidations have occurred in developed markets such as Canada, Hong Kong, Italy, and the United States.

[30] See, for example, Raul L. Katz and Bharat Sarna, "The Importance of Scale and Scope in Driving Telecommunications Industry Structure," Working Paper, Research Program on Remedies for the Telecom Industry, Columbia Institute for Tele-Information, Columbia Business School, January 24, 2003. This recent comparative analysis of twenty-four international markets (ex United States) shows that one measure of financial viability, EBITDA margins (Earnings before Interest, Taxes, Depreciation and Amortization), generally varies with the number of mobile operators. As depicted in Exhibit 2, aggregate industry margins vary from a high of 40–60 percent in markets with two or three operators such as, New Zealand, the Philippines and China to a low of about 10–15 percent in Hong Kong (six operators) and the Netherlands (five operators). The analysis is based on fourth quarter data for 2001. The authors conclude that, "Industries with more than four players witness their EBITDA margins drop significantly, not only due to irrational price competition but also to the inability of players to leverage economies of scale." At the same time they note that competitive circumstances can vary widely among markets with an equal number of operators. For example, aggregate EBITDA in Italy (four operators) is much higher than in the United Kingdom (also four operators), due in part, contend Katz and Sarna, to the absence of handset subsidies in the former market as well as the relatively equal size of the competitors in the latter.

[31] See Thomas W. Hazlett and Roberto E. Muñoz, "A Welfare Analysis of Spectrum Allocation Policies," George Mason University Law and Economics Research Paper Series, 06-28.

[32] Data based on ITU Cellular Subscribers index; nonweighted average for subscribers per 100 persons in seventeen European countries and the United States.

has a population density of 116 persons per square kilometer (sq. km.) versus 31 per sq. km. in the United States. This could underlie the greater penetration in Europe. If so, however, it might constitute another argument for limiting the number of competitors in a comparatively low-density territory such as the United States. At the same time, the parts of the EU with the lowest population density—namely Finland, Norway, and Sweden—have among the highest penetration rates. If one includes Russia in Europe, which brings the population density to about the U.S. level, the penetration difference remains about the same: about four to three in favor of this "greater Europe."

Thus, density per se may not be the issue. More likely it is rural coverage. By most measures, Europe has a larger rural population than does the United States. However, the U.S. population is more widely dispersed and the uninhabited areas and areas with very few inhabitants are vaster, if we exclude Russia from the comparison. Given a fixed level of demand, fewer operators can, arguably, achieve rural coverage more efficiently than more operators. Having six national operators fully cover U.S. rural areas may be duplicative and financially straining.[33]

As already noted, this issue is even more critical in low-income developing countries. Over 30,000 small towns and villages in Russia currently have no fixed phone lines. In Brazil some 2500 towns lack mobile coverage.[34] The supply-side challenge in India and much of Africa is even greater. Wide-area technology such as WiMAX may be the solution but so may prepaid technology, which is more responsive to the more volatile cash flows and barter arrangements of rural communities, combined with more mature transmission technologies. Together with CPP, prepaid has proven an important ingredient of mobile service provision in exurban and selected rural areas of Brazil, Indonesia, Russia, South Africa, and other countries. Prepaid also began to become available in rural parts of the United States relatively recently, not always in a CPP mode.

Political geography may also play a role. An argument can be made that the United States should have licensed operators nationally from the outset: that this would have reduced the significant coverage gaps that remain a matter of course in the U.S. RF landscape, and would have introduced network and connectivity benefits faster than actually occurred through a messy process of operator consolidation. Again, the European example suggests otherwise. If Europe is seen as a single large region, its operators have been organized on a fragmented, country-by-country basis. A few—principally Deutsche Telekom, Orange (France Telecom), Telefonica, and

---

[33] On the other hand, an argument has been made that mobile communications is more valuable in dispersed rural areas, which could nullify or even supersede the higher costs of serving such areas. This is a possible explanation for the faster deployment of 2G networks in lower-density countries. See Heli Koski and Tobias Kretschmer, "Entry, Standards and Competition: Firm Strategies and the Diffusion of Mobile Telephony," *Review of Industrial Organization* (2005), No. 26, 106.

[34] "Anatel says mobile market needs USD 1.5 billion," TeleGeography's CommsUpdate, 2007.

Vodafone—have managed to develop multicountry presence, yet each country's operating entities are relatively independent, even as they share in certain procurement and branding benefits.

Overall, the European patchwork-quilt structure has supported a high level of consumer adoption of mobile phones. If anything, this structure is less uniform than its U.S. counterpart, although the technology is more so—a point addressed in **Section 5.5**. This suggests that there may be a benefit to organizing mobile communications operations on a relatively small scale. Moreover, historically, U.S. markets led the world in telephone penetration at a time when many observers thought they were overly fragmented in terms of ownership and operations.[35]

Finally, it may be noteworthy that the high levels of mobile diffusion first experienced in the western parts of Europe swept across the much less affluent, though equally aging populations of Eastern Europe. First Hungary, then the Czech and Slovak Republics, then the Baltics and Poland, followed by Slovenia and Croatia, then Russia, and most recently Ukraine, passed the 80 percent (and in most cases 100 percent) penetration level. Yet no similar wave has been evident in Latin America. In part this may be due to Eastern Europe's harsher climate,[36] but there may be a geopolitical factor as well. Could the region's panoply of small to medium-sized political jurisdictions (mostly under 10 million population) that imitated their nearby neighbors, particularly those to the west, have fostered the quick, viral adoption of GSM technology at both the government and consumer levels?[37]

5.4 Diseconomies of Scale—the Case of Small Markets (and Eastern Europe)

The geopolitical hypothesis should be further refined and examined. If political geography—or, more simply, market size—is a factor, what is the key driver? Is it the embodiment of local factors in the policy and licensing process? Is it the introduction of smaller entrepreneurial entities as operators and retailers that results from the smaller scale markets? Is it management focus at the operator level? Is it the ability to deploy mobile infrastructure with the local physical, RF, permitting, and tower-siting environment clearly in mind—versus

---

[35] See Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, Calif.: University of California Press, 1992), Chapter Four ("The Telephone Spreads: National Patterns"), 86–121. During the early development of the telephone in the U.S. rural regions often exceeded urban ones in penetration due to the high demand in farming households, the fragmented industry structure notwithstanding.

[36] See Section 4.12.

[37] Jared Diamond posits in *Guns, Germs and Steel: The Fates of Human Societies* (New York: W.W. Norton & Co,.1999) that agricultural innovations have spread over the ages in latitudinal directions more rapidly than along longitudinal lines, due to the similarities in climate and other factors. He noted this effect in the trade and other exchanges that diffused along the Eurasian Silk Route, and its absence from the North and South American trajectory, constrained by the isthmus of Panama, dramatic climate changes, and assorted natural barriers, despite the presence of great civilizations along the way. Is there a similar effect at play here: a mobile ethos that stretches across a greater Europe from the Atlantic to the Urals and well beyond to Siberia and Pacific Russia? Whom do the consumers of the emerging Eastern European economies think they are imitating when they acquire mobile phones—western Europeans? Americans? the Japanese?

coordinating a massive national deployment in a country the size of the United States? Does it all come down to distribution—the ability to introduce new mobile phones and other products, which can presumably occur in small countries or operating territories more rapidly than in larger ones? Or does it reflect the ability to fashion a marketing program targeted at relatively homogeneous local users and at particular local competition, including competition from fixed services?

Put more specifically, why has mobile phone diffusion occurred so rapidly across Eastern Europe—a region with an aging population where each country has its own culture, its own language, its own currency, even its own way of loading washing machines?[38] Is country size the key underlying factor? Is it proximity to Western Europe? Is it market focus? Is it the breakup of the Soviet-dominated COMECON [Council for Mutual Economic Assistance] bloc, which turned the mobile phone into a symbol and consumer expression of westernization and new-found liberties—or, alternatively, into a communications tool for dealing with residual insecurities about the political and economic system? Is it the relatively flat geography and relatively thin vegetation?[39] Or has the combination of a relatively egalitarian income distribution across the population with small household size and political geography fostered the rapid diffusion?[40] This last question, turned into a hypothesis (or multiple hypotheses), may begin to provide an answer.

As **Table 5-2** reflects, all developed markets with populations between 4 and 12 million have penetration rates of 95 percent or higher; in contrast, three of those above 25 million (Canada, Korea, and the United States) fall well below this level.[41] The small markets have an average penetration more than 20 percent higher than the larger ones.[42]

On average the two groups of markets have similar GDP per capita, similar population densities, and similar service prices.[43] Where they differ is in the diffusion of prepaid subscriptions, which the small markets have managed to promote more effectively than the larger ones. This difference remains significant when markets with less than 20 percent prepaid subscribers (e.g., United States, Japan, Korea) are dropped from the analysis. While Italy, one of the large markets, has shown that prepaid can be a very effective vehicle for mobile phone

[38] The “washing machine” metaphor is a reference to the attempt some years ago to use the same TV commercial for laundry soap across multiple Eastern European markets. It turned out most viewers were amused given the alien way in which laundry was loaded into the washers compared to prevailing local practice.

[39] The region does not have an Andean mountain range (short of the Urals) or a thick Amazon jungle.

[40] On the income distribution point, see Section 4.3.

[41] Campbell and Chen, 2007.

[42] Or 27 percent higher if Italy, the outlier among the large markets, is removed.

[43] The service price comparison is based on estimated revenues per minute; see Merrill Lynch, 2007. For density comparison purposes, the two hyperdensity markets, Hong Kong and Singapore, have been excluded from the table.

Table 5-2
Mobile Penetration and Market Size in Developed Markets

Market	Population (millions)	Penetration (percent)		Market	Population (millions)	Penetration (percent)
Ireland	4	108		United States	301	77
New Zealand	4	98		Japan	128	78
Denmark	5	104		Germany	83	104
Finland	5	114		France	63	79
Norway	5	109		United Kingdom	61	117
Israel	7	118		Italy	59	138
Austria	8	113		Korea	48	83
Sweden	9	116		Spain	45	106
Czech Republic	10	118		Canada	32	58
Hungary	10	96				
Greece	11	127				
Portugal	11	122				
Average		112		Average		93

Data source: Campbell and Chen, 2007

diffusion, its large-market peers have not generally succeeded in this as well as operators in markets such as Greece, Hungary, Ireland, and Portugal. The bottom line is that this comparison raises questions about externalities and economies of scale.[44]

Compared to Eastern Europe, Latin America has lagged in mobile diffusion. On the other hand, Latin America has, arguably, fared reasonably well when compared to China. The effective income per capita of these two "regions" is now roughly equivalent. At the end of 2005 the average penetration level across the Andean countries, Brazil, Central America, and Mexico was 35.33 compared to China's 29.90.[45] Is this another validation of the "distributed intelligence" view of mobile diffusion? Unlike Eastern Europe, Latin America does not have an egalitarian income profile. Again, the prevalence of prepaid/CPP in the Americas versus the dominance of postpaid/receiving party pays (RPP) in China may offer the real explanation, in addition to China's income level, until quite recently lower than that of Latin America. In addition, China has managed to increase its landline subscriber base very significantly during the last fifteen years,

[44] If the same comparison is made with emerging markets, the results are different in that many of the very large markets (Bangladesh, China, India, Indonesia, Nigeria, et cetera) are also among the poorest. Their penetrations reflect their GDP per capita more than any size advantages these markets may have. Russia, however, with a 104 percent penetration rate, is an exception.

[45] This is an unweighted average for Brazil (46.25), Bolivia (26.37), Colombia (47.92), Ecuador (47.22), Peru (19.96), Venezuela (46.71), Costa Rica (25.45), El Salvador (35.05), Guatemala (25.02), Honduras (17.79), Panama (41.88), and Mexico (44.34), based on ITU data, op. cit.; on a weighted basis the Americas average would be higher, as the larger countries (Brazil, Mexico, Venezuela, et cetera) have higher penetration levels than the smaller ones.

whereas many of the Latin American countries have deemphasized landline development.[46] Total teledensity (mobile and fixed) is higher in China than in many Latin American countries.

China's central guidance approach to communications development, combined with competition among government-owned operators, could still prove to be the better approach, especially if China facilitates broadband deployment by adopting landline conbetternections via DSL or other overlay technologies. On the other hand, if the dominant broadband technology turns out to be wireless, such as WiMAX or a home-grown variant, China's telecommunications infrastructure strategy could appear duplicative and the Americas' mobile-centric approach seem more efficient and viable.[47] China's ongoing adoption of CPP may indicate that the political balance is tilting in the direction of wireless technologies, as CPP is seen as detrimental to the interests of the primarily wireline carriers, such as China Telecom.

5.5 Technology Standards and Innovation

The role of technology standards in fostering mobile phone diffusion has been debated from the early days of the industry. The supporters of multiple standards have cited dynamic technological evolution, different local circumstances, and supply-side flexibility in support of their position. Those advocating a single global standard have focused on economies of scale, reduction of consumer complexity, convenience for international travelers, and the availability of a common platform for the development of enhanced applications and features.[48]

Generally the issue of global versus multiple standards has pitted European suppliers and governments against their U.S. counterparts, although the full picture is considerably more complicated. Traditionally European countries used a multiplicity of national standards (or variations of a common standard) to support "national champions" and limit the entry of U.S., Japanese, and other European electronics companies into their markets. By forcing outside suppliers to develop products (e.g., TV sets) in multiple standards or to adapt their products (e.g., computers) to local protocols, they gave their domestic suppliers more time to respond to innovative or lower-cost imports.

Europe's diverse analog mobile technologies reflected this traditional world, with the Scandinavians, British, and Germans, for example, supporting different standards or variations of standards, and in some cases relying on different frequencies for cellular mobile service (e.g., 450

---

[46] Landline subscribers were almost 50 percent of total subscribers in China in 2005 versus 20-40 percent in most of the countries in the comparison Americas group.

[47] So far China's approach is looking prescient in that landline broadband dominates in urban areas. China could still shift to wireless for broadband deployment in rural areas.

[48] Users who travel frequently across borders generally constitute a pro-unified standard interest. However, except in regions with many countries accessible by road or rail transport, such as Europe, they are not a very large group in the context of the global adoption of mobile phones. Consequently, they do not receive much attention in this report.

vs. 800 MHz). With GSM the Europeans adopted an “offense” position that not only succeeded in Europe but has managed to capture an 80 percent share of the world’s mobile subscribers.[49] Markets now fall into two categories: those that use GSM only (including its successor 3G technology) and those that use both GSM and non-GSM technologies.

Interestingly, the multistandard markets are typically (1) surrounded by large bodies of water, (2) vast spaces relatively unaffected by neighboring populations, or (3) island populations with no direct borders (or combinations of these characteristics). They include Australia, Brazil, Canada, China, India, Hong Kong, Korea, Japan, New Zealand, Russia, Taiwan, and the United States. By contrast, regions such as Western and Eastern Europe encompass a panoply of small and medium-sized countries, where many populations abut borders. The same is arguably true of other parts of the world such as Southeast Asia, the Middle East, and parts of Africa. In short, there is a certain logic to politically variegated regions’ choosing a single standard (unless they use standards defensively as a barrier to imports) while the large or more remote countries, with ocean- or land-locked populations, place less emphasis on such uniformity and more on the potential learning benefits bestowed by multiple technologies.

The picture becomes more complicated when one looks at suppliers as well as countries. The 3G version of GSM (W-CDMA) utilizes the CDMA transmission mode, which European suppliers criticized heavily at public forums when it was introduced as a 2G standard.[50] Qualcomm, the U.S. firm that is the principal developer of CDMA technology, supplies chips and intellectual property to both the W-CDMA and CDMA2000 versions of the technology, the latter usually considered the American version. (Qualcomm has, in turn, been the subject of several legal challenges to the validity and applicability of its patents and/or the license fees it has sought to charge for access to the patents.[51]) Motorola, the second-largest supplier of mobile phones, offers GSM and CDMA models as well as iDEN phones (a third technology used by Nextel, a mobile operator that has merged with Sprint). In sum, major suppliers from Europe, North America, and Asia are now generally developing and marketing products incorporating multiple technologies and standards.

Moreover, each generation of mobile technology has brought its variants, offshoots, and applications. 2G is known for its support of a vast array of content and interactive uses in the form of NTT DoCoMo’s i-mode technology in Japan (and subsequently in other countries),

---

[49] See http://www.itfacts.biz/index.php?id=P6625 .

[50] One of those forums was a seminar in Cannes, France (held on February 19, 1996) where a Kalba International consultant, Dr. Wes Vivian, was challenged for suggesting that over time CDMA would offer some capacity advantages and noted that at least one major European supplier was already working on the development of CDMA technology. Several representatives of that supplier, who were in the audience, rebutted these claims. Yet three years later the supplier, along with others in Europe, were touting the benefits of CDMA as a 3G technology.

[51] The challenges have come from competing patent holders as well as infrastructure and handset manufacturers; some have been settled while others continue to work their way through the courts.

showing that user context and market structure may have as much to do with the proliferation of data-based applications as bandwidth. PHS [Personal Handy-phone System], also emanating from Japan, has shown that a small-cell, quasi-mobile 2G technology could serve secondary mobile markets not only in its home market but also in Brazil, China, Thailand, and elsewhere.[52] Some of the most significant innovations have been virtual afterthoughts of technology development. They include SMS and ring tones, both of which represent what were initially considered trivial features or capabilities and both becoming drivers of mobile use, if not adoption, in many parts of the world.

The proliferation of technologies and products continues with dual-mode mobile-WiFi phones, new infrastructure standards and enhancements such as TD-SCDMA (time division-synchronous CDMA—China's indigenous "3G") and HSDPA (High Speed Data Packet Access), various mobile TV transmission technologies (MediaFLO, DVB-H [Digital Video Broadcasting-Handheld], DMB [Digital Multimedia Broadcasting], et cetera), and WiMAX, LTE, UWB, and other emerging "4G" technologies. The underlying point is that both the diffusion and the adoption of mobile phones have involved numerous, overlapping product and service deployments, not to mention associated regulatory precepts (e.g., number portability) and marketing elements (price plans, discounts, and "free" minutes, frequent user benefits and other bonuses, family plans, home zone discounts, et cetera), which have also required technological adaptation, if not innovation.

At the same time, given the various technological paths taken, it is remarkable that more than 3 billion users have adopted mobile phones. Often technology and product "fragmentation" can stifle the adoption process, creating consumer and supply-chain uncertainty and delaying the emergence of a mass market. The noncompatible fax machine (introduced originally in the mid-nineteenth century) and the multiple videophone and videoconferencing products launched since the 1970s are cases in point. In the case of mobile phones the ability to link multiple mobile technologies with the standard telephone network and the competitive and consumer benefits arising from this technological diversity have resulted in massive diffusion of this family of technologies. However, this has not always occurred in expected ways; for example, prepaid use and SMS trumped more sophisticated 3G applications in both extent of adoption and intensity of use.

Of course, standardization can still occur as technologies and marketplaces mature. This has happened with the global acceptance of GSM and GSM-affiliated 3G technology (i.e., UMTS, using the W-CDMA set of standards), which now accounts for more than three-quarters of the

[52] PHS allows 64 kbps data channeling as well as limited voice communications and has been used to under-price other 2G service offerings. With over 90 million *Xiaolingtong* ("Little Smart") subscribers, China is the lead PHS market; however, the growth rate of this segment of China's mobile market is rapidly declining. See Steven Lee, "Xiaolingtong days are numbered at telecoms duo," *The Standard*, February 26, 2007.

mobile phones in use.[53] However, China's support of an indigenous 3G standard[54] and the emergence of new uses of mobile communications (whether high-speed data, music downloading, TV reception and playback, or location-based applications, et cetera) suggest that the mobile technology environment remains dynamic. Moreover the GSM "family" itself relies on multiple technologies, including underlying TDMA (2G) and CDMA (3G) transmission modes, and operates in several frequency ranges while benefiting from overlay technologies such as GPRS [General Packet Radio Service] and HSDPA.

Is mobile phone adoption promoted by a single standard or by multiple ones?[55] The high European penetration rate suggests that the single standard approach (at least, with respect to GSM) results in greater diffusion, possibly because it simplifies consumer decisionmaking and expands the choices of handsets available in the accepted standard.[56] At the same time, the penetration rate for eight developed multistandard markets listed above is 90.8 percent—not a negligible level.[57] Also, it is not clear that a single standard results in lower prices.[58] Claims continue to be made about the superiority of different standards in different operating environments or with respect to specific capabilities, whether PHS in parts of China or iDEN for its PTT application. Meanwhile, some widely accepted standards, specifically W-CDMA, have largely failed to stimulate creation of the mixture of advanced applications and associated revenue streams that their proponents heralded, at least in Europe.[59]

---

[53] In June 2007 the GSM trade association announced that 2 billion GSM subscribers were connected to service. See http://www.gsmworld.com/news/press_2006/press06_29.shtml.

[54] The Chinese government has recently issued a 3G license for its TD-SCDMA standard to China Mobile, the country largest operator—as well as the world's when measured by number of subscribers and stock market valuation. See "China begins 3G commercialization," telecoms.com, January 30, 2007.

[55] For an argument that unified standards with respect to the transmission (air interface) method as well as commonality of frequency bands across countries, see Gustave Barth, "Cellular Phones: Is There Really Competition," Incidental Paper I-94-3, Program on Information Resources Policy, Harvard University, Cambridge, MA, August 1994, [On-line]. URL: http://www.pirp.harvard.edu/publications/pdf-blurb.asp?ID=7; also Gustave Barth, *Spectrum for Mobile Communications in the World*, Program on Information Resources Policy, Harvard University, Cambridge, MA, October 2003, [On-line]. URL: http://www.pirp.harvard.edu/publications/pdf-blurb.asp?ID=592

[56] See Heli Koski and Tobias Kretschmer, "Entry, Standards and Competition: Firm Strategies and the Diffusion of Mobile Telephony," *Review of Industrial Organization* (2005), No. 26, 106, who conclude that technology standardization "increases the expected user value of mobile services, resulting in quicker diffusion"; p. 109.

[57] This is based on data from Campbell and Chen, 2007. It compares to a penetration rate of 108.6 percent for developed European markets, according to the same sources.

[58] The regression analysis of Koski and Kretschmer (2005) concludes that lower prices are associated with multiple standards, reflecting a more intense level of competition. In the end these are somewhat countervailing findings as to the role of standardization (or lack thereof) in the diffusion process.

[59] Whether this has been due to the licensing and market structure approach adopted by European governments in introducing the technology, to excessive expectations, or to inherent limitations of the technology continues to be debated. For a market structure view, see Harald Gruber, "3G Mobile Licenses in Europe: Five Years After," European Investment Bank; available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=918003. For an excessive expectations perspective, see Yale Braunstein and Kas Kalba, "Reviewing 3G 'Optimism': Services, Segments and

The bottom line is that mobile phone adoption has moved forward at a brisk pace in most GSM-only markets and in some GSM/non-GSM markets, such as Brazil, China, and Russia, but in Japan and the United States diffusion has not been proportionate to economic level.[60] On the other hand, the GSM-successor technology, W-CDMA (or 3GSM, as it is sometimes called), reflects the issues surrounding the implementation of an aspiring single-standard technology in a way that has a material effect on the diffusion curve. So far the purchase of 3GSM phones by consumers has resulted as much from the technology's largely unheralded voice capacity (and contribution to lowering call prices and, perhaps, SMS) as from validation of the broader array of innovative features and applications it supposedly offers.

Overall, some, but not all, unification of standards works out well from a supplier and/or consumer standpoint. Critics of the U.S. multistandard position tend to overlook the mobile technology standard that the United States would have chosen had it opted for a single one—namely, TDMA. At the time the decision on digital mobile standards was made TDMA was the dominant option, while CDMA was at a relatively early stage in its development.[61] Yet by now both U.S. and international operators have largely abandoned the U.S. version of TDMA.

Of course, these standards issues may be resolved with the adoption of SDR technologies, which allow wireless handsets to switch across different coding schemes and frequencies more or less at will. SDR has been applied in military and other specialized contexts and is transitioning into the mobile communications realm. It was preceded by multistandard handsets, which work on two or more specific standards (unlike SDR's more generic flexibility) and by translation devices that convert from one standard to another. However, the market has been relatively slow to adopt them, due to their higher price, bulkier size, limited product features, and/or more limited availability.[62]

Meanwhile, the technologies that most noticeably underlie the global diffusion curve are SIMs that can be activated on a prepaid basis and CPP. These billing-related capabilities have allowed pricing of mobile communications to respond to the financial situations of many users. Correspondingly, the late U.S. adoption of prepaid and limited CPP adoption probably contribute to the U.S. penetration lag more than the parallel transmission standards pursued.[63] Curiously, this

---

Stages of Reality," paper presented at the 8th International Workshop on Mobile Multimedia Communications, October 5–8, 2003, Munich, Germany.

[60] At the same time it should be recalled that these are among the highest ARPU-level markets.

[61] The author was recently reminded of this situation by John Williams, who worked at the FCC at the time.

[62] In a retail market driven by feature-laden product launches, new designs and cost reductions, the multi-standard phone has had limited appeal (other than for some frequent business travelers), when the available multi-standard phone models do not keep up with other market developments.

[63] A case that CPP and prepaid increased adoption significantly in Latin America is made in Judith Mariscal, "Market Structure and Penetration in the Latin American Mobile Sector," WDR Dialogue Theme 3rd cycle, Discussion Paper WDR0616, Draft, December 2006.

lagging adoption of prepaid technology occurred despite the technology's original introduction in a northern province of Mexico in 1992. The product faltered but was fine-tuned and reintroduced during the "peso crisis" a year later, when it matched the needs of a credit-challenged market.

Instead of diffusing a few miles north to the United States, prepaid technology appeared next in Portugal, then in Italy, and eventually across the globe, where it now accounts for the vast majority of mobile subscriptions. In Portugal and Italy CPP was already the prevailing billing structure when prepaid arrived. Mexico adopted it in 1997. With the addition of asymmetrical interconnection rates, which regulators in Brazil and other countries condoned in order to promote mobile growth, prepaid caught on in the developing world as well—a dynamic process that continues today and is largely responsible for the high mobile subscriber growth rates in many African countries. **Section 5.7** offers a fuller discussion of the effects of the diffusion of this technology.

5.6 Prices as Drivers of Adoption?

Most economists consider product and service prices a supply-side variable. The issue is elasticity: if prices are lowered demand will go up. For marketers pricing often reflects demand rather than driving it. If demand is considered broad the price is set low to reflect and capture this reality. If it is top-heavy (i.e., much more robust at the high-income consumer level) the price is kept relatively high,[64] and if it is bifurcated (with distinct high- and low-end segments) two or more products with different prices are introduced.

Determining pricing comparability and context presents a challenge for the global analyst. According to the ITU, typical European monthly subscription plans in August 1999, including 100 minutes of usage, varied considerably. For example, in Germany D2 charged $61.91 while in the United Kingdom Orange charged $41.40.[65] Some of the variability may result from differences in the use—and extent of use—of handset subsidies, which may increase usage prices, although, as discussed below, handset subsidies and adoption are not highly correlated. In the same period the U.S. low-end bucket price was $25.00.[66] When one adds the likelihood that the U.S. price actually allowed 200 or 300 minutes and incorporated a significant handset subsidy, one might expect that U.S. prices would have stimulated far more demand than European prices. Significant handset subsidies prevail in some European markets such as Germany and the United Kingdom but not in others, such as Sweden or Italy. Moreover, usage prices have a clear-cut effect on usage levels or MOU.

---

[64] For a partial confirmation of this view, see Koski and Kretschmer, 2005, 111. The authors of this twenty-five-country regression analysis find that "Higher GDP/POP seems to also imply higher service prices."

[65] Tim Kelly, "Economic Aspects of Fixed-to-Mobile Interconnection," ITU Workshop on Interconnection, Sanya City, August 17–19, 2001.

[66] BellSouth's; ibid.

Since 1999 the U.S. subscriber base has grown at a faster rate than have the subscriber bases of Germany, Italy, Spain, and the United Kingdom. The U.S. five-year CAGR for 2000–2005 is 13.0 percent, while Germany's is 10.4 percent and the United Kingdom's is 8.9 percent.[67] However, when Russia and other fast-growing regional markets are included, Europe experienced a CAGR of 18.3 percent. Whether the higher U.S. growth rate means that Europe has achieved saturation or results from the lower cost U.S. "bucket" subscription plans is an open question.[68] However, U.S. ARPU levels remain slightly higher than those of Europe, perhaps reflecting a U.S. preference for buying larger amounts of minutes from a single mobile operator at a fixed price rather than arbitraging minutes across two or more operators and paying on a per-minute basis, thereby contributing to higher penetration levels.

Even so, at the beginning of 1999 the penetration rates in Europe were significantly higher than those in the United States and remained so at the end of 2005, even in markets with low handset subsidies and high usage charges, which characterize most prepaid offerings. During the 1990s Europe passed the United States in mobile phone penetration, largely because of the surge in prepaid that began in Portugal and Italy and then moved to most markets; and not because of lower postpaid subscription rates. Nor was it due to more aggressive handset subsidies, which have generally remained higher in the United States, to younger demographics, or to higher income per capita. It probably does not even result from what is commonly believed to be the greater integration of mobile communications into European life. "In America mobile phones are tools, in Europe they are a life style." Then why do Americans talk much more on mobile phones than Europeans do? U.S. MOU are nominally four or five times as high on average as are those in Europe and, even when adjusted, are about three times as high, which explains the higher ARPUs.[69]

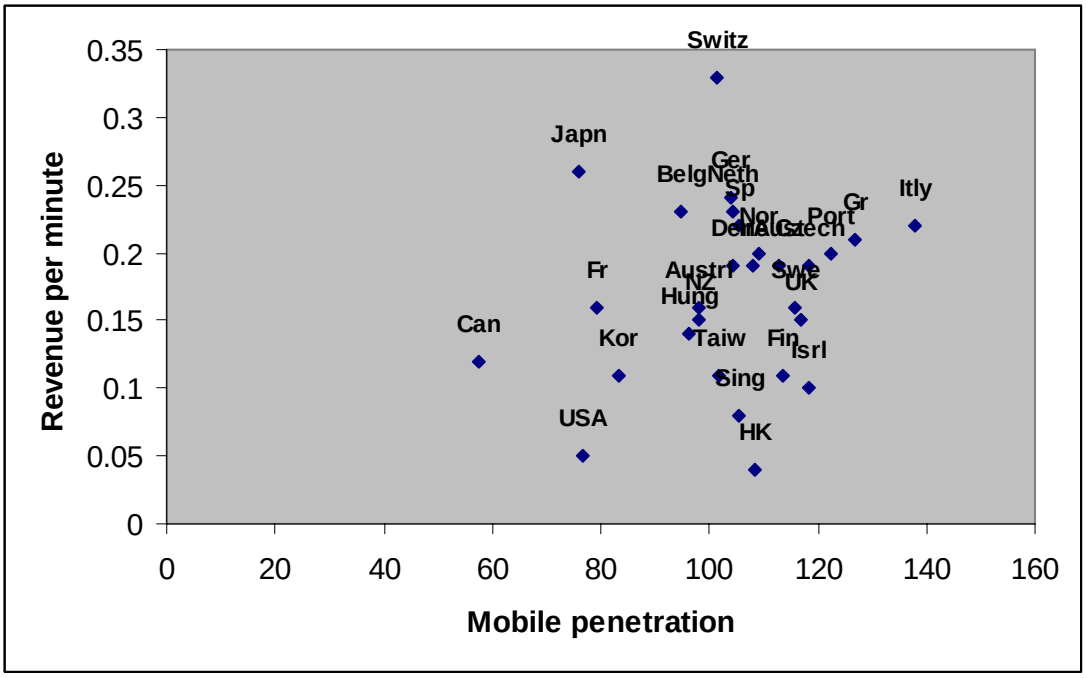
In the end differences in penetration levels cannot be explained on the basis of usage prices. **Figure 5-2** illustrates the independence of usage prices and mobile adoption. The countries with the highest penetration levels—Greece, Italy, and Portugal—have above-average usage prices. These are all high-prepaid markets. Similarly, counterintuitive though it may be, markets such as those in Italy and Sweden, where mobile phone prices are not generally subsidized, have among the highest levels of adoption.

---

[67] ITU, World Telecommunication Development Report: Mobile Cellular 1999; URL: http://www.itu.int/ITU-D/ict/publications/wtdr_99/ (accessed January 4, 2007).

[68] The U.S. growth rate could also reflect the greater level of market competition, with (until recently) seven or eight operators offering mobile service in most metropolitan areas versus three or four in most European cities. Yet this is unlikely, given the relative growth rates of Europe and the United States in the nineties. If anything, the recent higher U.S. rates may be due to the consolidation the industry is undergoing.

[69] The ratio is actually a bit lower due to the greater number of people in Europe with two or more mobile subscriptions. As a result the European MOU per person is a bit higher (perhaps on the order of 20–25 percent) than the MOU per subscriber numbers usually cited. U.S. MOU per user numbers are also higher, but by not as much as the European ones. Accordingly, the gap may be about 10 percent lower than indicated by MOU data.



Data source: Campbell and Chen, 2007

Figure 5-2

Mobile Adoption and Usage Prices in Developed Markets

Meanwhile, most of the markets in the bottom right quadrant of Figure 5-2—including Singapore, Finland, Israel, and Taiwan (yes, mostly islands)—have relatively low levels of prepaid (under 50 percent), no CPP, or both (i.e., Singapore). They also have very high penetration levels. Moving to the left one finds low-level prepaid markets, such as the United States, Canada, and Korea, all with very low usage prices yet well below average penetration rates.[70] In sum, we are dealing with a bi- or even trifurcated environment, which cannot be defined on the basis of a single (simple, at least) economic principle.

Table 5-3 summarizes the differences among the five main clusters of markets shown in Figure 5-2. The table shows two reciprocal clusters of countries in the top row, the core cluster in the middle row, and the two remaining (also reciprocal) clusters in the bottom row. It illustrates the existence of multiple paths to high adoption levels, as well as to low ones. The "Mediterranean" way to high penetration is based on prepaid and may benefit from weak legacy networks. The "Asian" way does not rely heavily on prepaid but uses low prices. Both approaches reflect the potential role of market size in that all of the cases highlighted (except Italy) are small markets.

[70] Switzerland, Japan, Germany, Belgium, and the Netherlands form the right wing of the butterfly—all markets with very high rates ($0.23 to $0.33 revenues per minute.

Table 5-3
Developed Market Clusters by Price, Prepaid, and Other Factors

Low prices Low prepaid **Low penetration** High to moderate wirelines Large markets *United States, Canada, Korea*		High prices Low to moderate prepaid **Low to moderate penetration** High to moderate wirelines *Switzerland, Germany, Japan, Netherlands*
	Moderate prices Moderate prepaid **Moderate penetration** Moderate wirelines *Australia, Denmark, Norway, Spain*	 *Ireland, New Zealand*
Low prices Low prepaid and/or no CPP **Moderate to high penetration** Low to moderate wirelines Small markets *Hong Kong, Singapore, Finland, Taiwan, Israel*	 *Hungary*	High prices High prepaid **High penetration** Low to moderate wirelines Small markets + Italy *Italy, Greece, Portugal, Czech Republic*

Data source: Campbell and Chen, 2007

All this suggests that other factors, such as those reviewed earlier in this report (i.e., income levels, legacy service, prepaid diffusion, propensity to arbitrage multiple services/SIMs, market size, climate, et cetera) affect penetration, although a different pricing database might result in a more homogeneous finding.[71] It is also possible that the role of competing expenditures, including other communications products and services, should be considered. The United States, Canada, and Korea have three of the lowest penetration levels, despite their very low usage prices and the availability of subsidized phones. However, two of these markets have the highest wireline penetration rates (United States, Canada) and two are broadband leaders (Canada, Korea).

In sum, the higher European penetration levels are not generally due to lower usage prices. On the contrary, the earlier and more widespread availability of prepaid pricing, which typically

[71] Possibly a better comparative profile of entry price, where handset costs weigh heavily, would be useful. At the same time, it is clear that high phone costs, as is the case in Italy and Sweden where phones are not usually subsidized by operators, do not necessarily result in low penetration, nor vice versa.

involves *more* expensive per-minute charges, appears to be an important factor in adoption.[72] The rapid and broad acceptance of prepaid in Italy, Portugal, and other European markets during the second half of the 1990s brought a broader population base into the mobile phone market. It also led many individuals to subscribe to prepaid in addition to postpaid; for example, using one for business or formal calls and the other for personal ones.[73] A pricing-related factor, CPP, has also added to the attractiveness of prepaid pricing in Europe.[74] Finally, coverage differences may also play a role, with the United States continuing to this day to have many pockets of uncovered territory, even within major metropolitan areas, as well as more limited in-building coverage.[75]

In emerging markets the relationship between usage prices and penetration also fails to follow a single clear-cut pattern, as **Figure 5-3** illustrates. However, some clusters are evident. The two markets in the bottom right corner of the scatter graph, Russia and Ukraine, are both low-price, high-adoption markets. The three in the bottom left corner—Bangladesh, China, and India—are low-income Asian markets with low usage prices and relatively low penetration. The core of the graph consists largely of Latin American markets plus some African and Middle Eastern ones. Specifically, the markets in the upper middle portion of the graph, reflecting higher prices, include Brazil, Chile, South Africa, Turkey, and Venezuela. Those in the lower middle, reflecting lower prices, consist of Algeria, Argentina, Colombia, Malaysia, and the Philippines. It is a messy picture but with a few exceptions (notably Peru and Poland) not a very surprising one.

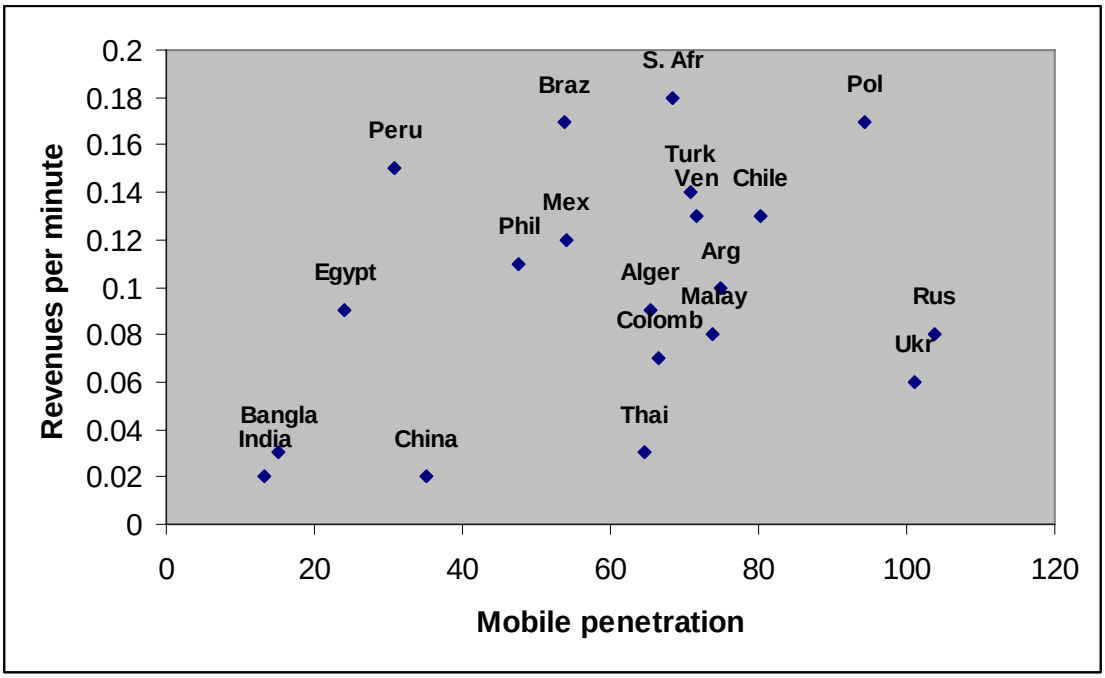
---

[72] Subscription and per minute pricing could be a factor in explaining Japan's below average (in the context of developed economies) penetration rate. Even after dropping dramatically in the last five years, Japan's rates continue to generate high ARPUs.

[73] Or in the case of prepaid for calls where anonymity (e.g., absence of call billing records) is important. The rules on prepaid registration have varied by country. Even where personal identification is called for at the point of purchase, informal reselling of prepaid cards is a common practice.

[74] CPP may also stimulate usage in that CPP subscribers, postpaid or prepaid, are more likely to give out their mobile phone numbers (whether through directories or on business cards) than RPP subscribers. Again, however, U.S. usage levels (mostly RPP-based) remain significantly higher than European ones.

[75] The in-building coverage advantages in Europe include the higher urban densities, the smaller average living quarters (facilitating externally-emanating electromagnetic coverage of a higher portion of the spaces, all else equal), and lower community resistance to tower placements—see Section 5.10. On the other hand, European housing structures are more likely to be built from stone and other difficult to permeate materials than are houses in some, if not all, parts of the United States.



Data source: Campbell and Chen, 2007

Figure 5-3

Mobile Adoption and Usage Prices in Emerging Markets

Overall, the graph illustrates the variety of paths that different groups of countries are pursuing, and their associated adoption results. The income level generally increases from left to right, with some exceptions, as do the age demographics. Usage levels (MOU), paradoxically, tend to be higher in the low-income, low-priced Asian markets (Bangladesh, China, and India), reflecting fewer fixed lines and greater sharing of mobiles in two of these cases (India and Bangladesh). At the same time, some of the high-priced markets, such as Brazil, Chile, Poland, and Turkey, have a relatively high number of fixed lines per capita, which generate incoming mobile calls that may not be reflected in their MOU counts. In general, prepaid, which is a large differentiator in Figure 5-2, plays a less obvious role here, as all the markets rely heavily on prepaid. In only two—Argentina and Poland—does the prepaid level fall below 80 percent.

All of this does not negate the critical role of price and pricing in making mobile phones and calls accessible to users in poor and moderate-income developing countries. The market in India has certainly been stimulated by the availability of inexpensive mobile phones (a $22.00 phone has been introduced) and extremely low usage charges (under $0.03 per minute).[76] The questions that remain in markets such as India are (1) whether operators will offer family-member

[76] On handset prices, a $35.00 model has been available for some time with a $22.00 version expected in late 2007, according to Amy Yee, "Villages Remain the Challenge," *Financial Times*, Special Report: India & Globalization, January 26, 2007, 6.

price reductions in the future, given the potential for further expanding the subscriber base once an Indian household has its first mobile phone,[77] and (2) whether the mobile operators in India will be able to sustain these prices. Recent reports that service quality is declining and that the majority owner of the country's fourth operator has exited the industry are potentially worrisome in this respect.[78] On the other hand, operators seem to be finding new segments of subscribers, sustaining overall profitability in the process.[79]

5.7 Prepaid Phones and Credit-free Calling

Overall, prepaid phones and SIM cards are key reasons why mobile subscriber levels are growing so rapidly in emerging regions. In the traditional *postpaid* market the registration of demand called for a commitment to subscribe to a mobile service for one or two years; in other words, it involved a mobile phone purchase (subsidized or not, depending on the market), twelve or twenty-four monthly service obligations, usage charges, and a service connection fee (sometimes waived), not to mention a credit check. The introduction of prepaid responded to, and further stimulated, the market for occasional or variable demand. It allowed adoption of mobile phones by users with variable usage needs and variable means to pay for access to the mobile network.[80]

Prepaid products were introduced in most emerging markets after first being widely adopted in Europe. Yet prepaid technology was originally introduced in Mexico in 1992. The product initially faltered, but was fine-tuned and reintroduced the following year. Instead of diffusing a few miles north to the United States, or south to Central America, Colombia, or Brazil, prepaid technology appeared next in Portugal, then in Italy, and eventually across the globe, where it now accounts for the vast majority of mobile subscriptions.

From a broad diffusion perspective this introduction of prepaid technology, considered a peripheral achievement at the time, was the most significant product innovation since the development of the initial cellular radio concept. Without prepaid, which consists largely of storage and billing software, mobile calling might have reached fewer than half of today's

---

[77] This first phone often serves as a fixed phone for the entire family, given India's large households with limited access to cash. See the discussion of this point in Section 4.9.

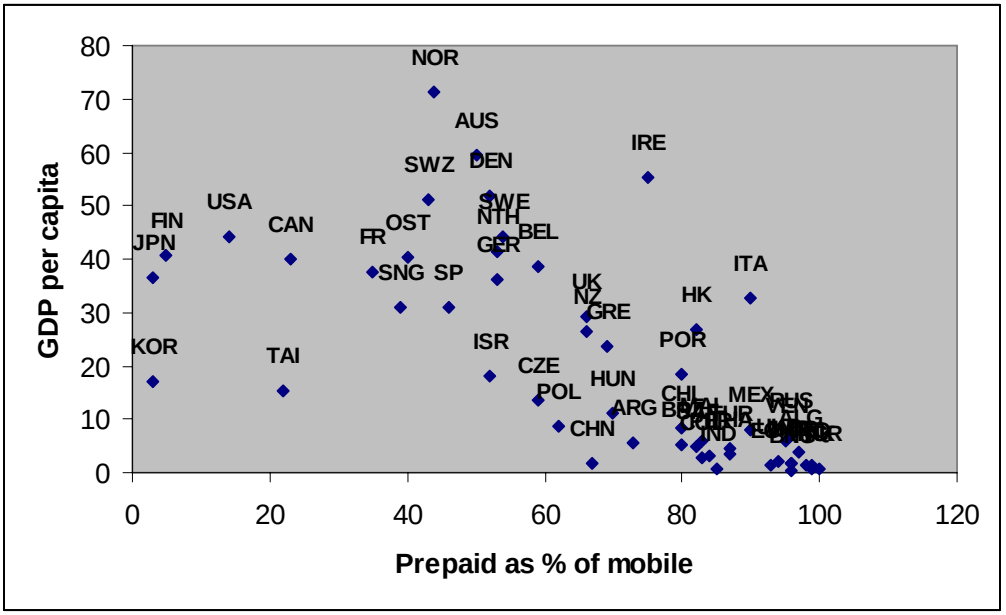
[78] "Strain Tells in India," *Financial Times*, January 15, 2007, 15.

[79] When Israel awarded its second mobile license (ca. 1990) it used a reverse auction method which required the winning operator, Celcom, to offer service at $0.03 per minute (plus the interconnection charge) for the first three years. Many questioned the sustainability of this price level. Yet Celcom became profitable within two years, in part because it found it could offer ancillary services—specifically, insurance policies against handset breakdown and theft or loss—for a monthly fee exceeding the basic monthly charge. Close to 90 percent of its subscribers availed themselves of these ancillary services, which were not subject to the service fee limitation.

[80] To the extent that prepaid cards remain active even when not used, or after their expiration in terms of outgoing call minutes, they allow quasi-continuous service access with respect to incoming calls.

subscribers, especially those located in poor and moderate-income emerging markets, where participation in the cash economy often reflects itinerant activity.

Figure 5-4 shows the impact of prepaid on emerging markets. For a cross-section of developed and emerging markets,[81] the share of prepaid subscriptions ranges from 43.2 percent in high-end markets (above $30,000 GDP/cap) to 92.2 percent for the lowest-income segment (below $3,000/cap). In sum, what started out as a solution to a credit authorization problem and was initially expected to affect 10–20 percent of the subscriber base has come to serve more than 1.5 billion accounts.



Data source: Campbell and Chen, 2007

Figure 5-4

Prepaid Adoption and Income

By 2006 prepaid had become the prevalent mode of mobile access worldwide. As Figure 5-4 illustrates, prepaid is especially dominant in lower income markets, although it is now heavily utilized in markets at all income levels. The main outliers are Korea and Taiwan (bottom left) and Finland, Japan, and the United States (middle left)—all developed markets with less prepaid use than the main trend line. These outliers notwithstanding, the Pearson coefficient for the fifty-two markets represented in Figure 5-4 is –0.664 ($p<0.01$), reflecting the reverse relationship between income level and prepaid penetration.

In lower income emerging markets prepaid offerings are being combined with various forms of communal, shared, and even bartered access to mobile minutes, with or without the

[81] See Campbell and Chen, 2007; 2006 data for fifty-three developed and emerging markets.

ownership of a mobile phone. Operators and resellers are responding not only to the "variable" segment of the market but also to *fractional* demand. As previously noted, Orascom is installing mobile phones in Algerian villages at the edge of the Sahara, where nomadic people use them on a per-minute basis.[82] Such phones may be used by several hundred users over the period of a month or a year.

Similarly, new prepaid phones can involve a commitment of under $50.00, with prepaid cards costing under $5.00 and being replenished for as little as a few cents.[83] In short, both supply and demand are being fractionated. In many markets people barter produce in exchange for prepaid cards or for minutes on a communal mobile.[84]

The fundamental question regarding future demand is how many of the world's nonsubscribers will be served by these various communal and shared forms of access, including mobile payphones, and how long it will take to convert such shared-users into owner-users. Will shared use build awareness and interest in owning mobile phones and subscribing to the associated services, most likely on a prepaid basis, or will it serve as a substitute for full-scale mobile phone adoption?

5.8 Effects of Asymmetrical Interconnection

Closely related to price are the effects of interconnection charges. These charges can represent mobile operators' highest operating cost, but can also be a significant revenue source, covering mobile operators' termination of calls from the fixed network and other mobile networks on their network.

In the early phase of mobile development interconnection costs per minute were often very high, in a few cases exceeding $2.00. In contrast, the United States set a standard of about $0.02 per minute, with interconnection charges in most countries falling between these two levels (between $1.00 and $0.01 by 1995). Currently, mobile interconnection fees generally fall in the

---

[82] See Cassell Bryan-Low, "New Frontiers for Cellphone Service," *Wall Street Journal*, February 13, 2007, B5.

[83] Ibid.

[84] Considerable phone sharing goes on as well. Many mobile phones are being effectively used as fixed phones in households in India, Africa and elsewhere. In the process their usage is shared by anywhere from two to a dozen users, given the large households and extended families that form the social infrastructure of many communities. In emerging markets where personal mobile use of the phones is the dominant pattern, they are still often shared with family and friends outside of the home. Some of the friends involved in the sharing may own their own mobiles but have left them at home or run out of battery power. Others are merely itinerant users with no mobile phones of their own. The emergence of fractional demand also has an effect on mobile statistics. If spouses, co-workers, or teenage friends share a mobile phone, are they not all "adopters?" This sharing practice is especially prevalent in emerging markets where mobile phones have become the dominant mode of communication, surpassing the landline count by as much as eight or nine to one. In many cases the mobile phone sits in a designated spot at home and is used as a fixed line by multiple household members, except on special occasions when it is taken outside the home. For useful descriptions of how mobile phones are shared in Bangladesh, Chile, Ghana, Uganda, and South Africa, see Castells et al., 231–239.

$0.30 to $0.01 range, with the interconnection charges in developing countries often at the high end of these ranges until fairly recently.

Several other developments have supported and extended the effects of the prepaid revolution. These have included CPP (effectively allowing “free” incoming calls), transferable SIMs (allowing one phone to be used with multiple prepaid subscriptions),[85] and asymmetrical interconnection fees. Asymmetrical interconnection regimes have allowed mobile operators to collect significant termination charges for incoming calls from fixed networks: higher on a per-minute basis than the fees they pay such operators to terminate their subscribers’ outgoing calls.

In some emerging markets, such as those of Costa Rica and Malaysia, the interconnection charges have been kept equivalent—or “symmetrical.” However, a growing number of countries have adopted the asymmetrical approach, with fixed-to-mobile charges being substantially higher than mobile-to-fixed rates: on average about two times and in some cases as much as four times as high.[86] Botswana, Brazil, Mexico, and the Philippines provide examples of such asymmetrical regimes.[87] This has resulted in mobile operators’ receiving on average about $0.09—and in some cases $0.20 or more—per minute when terminating calls from fixed operators, which have often represented a majority of their incoming calls.[88] This, in turn, has allowed operators to make a profit from prepaid customers who buy a prepaid card perhaps every six months for as little as $10.00 and make few outgoing calls but receive 100–300 minutes per month of incoming calls.

Such asymmetrical regimes were designed in part to promote the development of mobile networks.[89] They are justified on the basis of the substantially greater costs of mobile networks compared to fixed networks, in large part because the latter have been depreciated on the basis of their legacy status. In addition, mobile networks may be smaller and riskier, and involve fewer economies of scale and higher costs of capital. Depending on when they are built and the choice of technology, they may also involve a technology premium or risk (e.g., for innovative advanced technology). At the same time, fixed service operators have argued that these differences do not justify the large differences in interconnection rates that some regulators have imposed, or

---

[85] In the international business segment of the market it is not unusual to find users with five SIMs for five different countries or groups of countries. Similarly, within a country, mobile users can benefit from access to the pricing schedules and coverage areas of multiple mobile operators through ownership of two or more SIMs.

[86] There are also cases where the mobile-to-fixed rates are higher than fixed-to-mobile, but this usually occurs in RPP environments.

[87] Tim Kelly, “Economic Aspects of Fixed-to-Mobile Interconnection,” ITU Workshop on Interconnection, Sanya City, August 17–19, 2001.

[88] Ibid. This is based on 1999 data. The high level of fixed to mobile calling underscores the earlier point (see Section 3) about the continuing influence of fixed line connectivity on mobile usage and probably adoption as well.

[89] As John LeGates reminded me, asymmetrical rates were also used in the United States to promote universal service in the wireline sphere. Their sustainability was based on a stakeholder consensus, which fell apart as competition became entrenched in the 1980s and 1990s.

contend that the differences should be reduced as mobile networks are built out and become more mature.[90]

Mobile operators in many developing countries may be entering a relatively less favorable interconnection phase, as regulators such as Anatel in Brazil seek to rebalance interconnection rates in favor of landline operators.[91] The fact that over time more calls originate on mobile networks than fixed ones is concurrently reducing their interconnection revenues. However, many operators have benefited from the combination of asymmetrical rates, CPP, and prepaid offerings, allowing them to generate revenues as much, if not more, through interconnection settlements as directly through payments for prepaid services.[92] This, in turn, has served as a major stimulus to mobile phone adoption, in that operators were willing to charge nominal amounts to secure prepaid subscribers, as they could make money simply from the incoming calls these new, often low-income subscribers would generate.

5.9 S**pectrum Auctions and Availability—the 3G Effect**

In the mid-1990s, when the United States and Europe started to use spectrum auctions to determine license winners, they paid little attention to the effects on mobile phone diffusion. They focused on fairness and qualification issues versus other modes of licensing operators (beauty contests, lotteries, and fiat) and on the amounts that could be raised for public treasuries using this mode of "taxation." In retrospect, the U.S. diffusion rate was, if anything, depressed by the initial

---

[90] Also, at least one economist has argued that the lowering of incoming termination charges will force mobile operators to be more competitive and raise penetration rates. See S. C. Littlechild, "Mobile termination charges: Calling Party Pays versus Receiving Party Pays," *Telecommunications Policy*, **30** (5-6), 2006,242–277. Littlechild contends that CPP induces termination charges that are higher than related costs and results in pricing distortions in the way of handset subsidies and promotional service plans; one of the side-effects is lower penetration. RCC markets have lower termination charges, yet the major examples (United States, Canada) also have high levels of handset subsidization and compulsory service contracting and bundling compared to most CPP markets, at least on the prepaid side (which is dominant in a great majority of cases). More importantly, for the purpose here, they have lower penetration rates. Even the comparative table presented in Littlechild's article (Table 6) shows median as well mean penetrations for the RCC markets of 76 versus 89 for CPP markets; moreover, the RPP sample of four markets is heavily weighted by two small ones, Hong Kong and Singapore with respective penetrations of 106 and 90. Moreover, both samples exclude developing markets, where the adoption of CPP and associated asymmetrical interconnection rates appears to have had the most noticeable effect on penetration; unfortunately, there are few RPP cases to validate this conclusion. India and Mexico both changed to CPP a number of years ago, and China (arguably a mobile penetration laggard) has adopted CPP much more recently.

[91] They are being supported by the economic argument that mobile operators' incremental costs for terminating incoming calls are virtually zero. The counterargument is that this does not take into account their greater undepreciated plant expenditures compared to incumbent fixed operators with old legacy networks.

[92] Now, however, as their interconnection costs have risen, subscriber growth rates have slowed, and pressures to rebalance rates have grown, operators in Brazil and elsewhere are re-focusing their marketing efforts on increasing subscriber ARPU, primarily in the postpaid market segment. The emphasis on subscriber growth, so prevalent during the late nineties and early part of this decade, has largely vanished, though it continues obviously in India, where CPP was first introduced more recently. Previously the interconnection regime in India was asymmetrical in favor of the fixed operators, with only the mobile operators paying to terminate calls.

auction phase, experiencing a CAGR of 26.5 percent during 1995–1999, while France's rate was 86.1 percent, Germany's was 66.9 percent, Italy's was 60.9 percent, and the United Kingdom's was 49.9 percent.[93] Whether this was due to the auction amounts, the prolonged uncertainty surrounding the financial and legal fate of some of the bidders, or other supply-side factors is unclear. It definitely did not result from macroeconomic factors on the demand side, as jobs and the U.S. economy were booming.

Some European countries (e.g., Austria, Belgium, Greece, Portugal, Spain) first used auctions to issue GSM licenses, while others (e.g., France, Germany, Sweden) continued to employ the beauty contest methodology.[94] An unpublished analysis found that in general operators that had paid significant amounts for their licenses by auction were likely to deploy their networks more rapidly than their "beauty contest" counterparts and to price their services more aggressively.[95] The theory was that these operators needed to generate cash flow more quickly to justify their auction outlays. Not surprisingly, the number of new subscribers also grew more rapidly in the auction markets.[96]

What have been the results after the 3G auctions, some of which elevated spectrum costs to unprecedented heights? The winners of the 3G auctions in the United Kingdom and Germany paid close to $600 per capita for the 3G spectrum they were authorized to use as part of their fixed-term licenses.[97] This was an order of magnitude higher than what had been paid in previous GSM auctions.[98] Moreover, the 3G winners, which included two new players in markets such as Germany and Italy that typically already had three incumbent operators, found themselves in far

---

[93] ITU, 2005.

[94] Martin Spicer, *International Survey of Spectrum Assignment for Cellular and PCS*, FCC Wireless Telecommunications Bureau, September 1996.

[95] The analysis was conducted in the context of a multiclient study of the forthcoming 3G market: Kalba International, Inc., *3G Mobile Multimedia*, Waltham, MA, 2000. The study did not expect to see a similar auction boost in subscriber adoption in countries such as the United Kingdom and Germany, where the auction fees per capita were an order of magnitude higher than the earlier GSM auctions had produced.

[96] It is important to keep in mind the differences between the U.S. and European auctions. In Europe the original GSM auctions involved one or two licenses as a rule. They were followed a few years later with GSM 1800 (or PCS) auctions, typically involving two licenses. In other words, the introduction of new entrants was paced. Moreover, each phase of licensing took two or more years to complete across the countries of the European Union, allowing financial institutions some breathing room in organizing and digesting the various financings. In the United States new entrants were being licensed three or four at a time across the many metropolitan markets of the country, creating a great deal of concurrent pressure on the financing process. (In structuring its 3G license process, Europe overlooked some of the lessons of the GSM experience. Generally governments issued four or five licenses concurrently, with most EU countries completing the process in a nine-month period from June 200 to March 2001. The financial system, already under pressure from failing CLEC businesses, effectively collapsed under the added weight of the 3G auction and network deployment financing.)

more competitive surroundings than the earlier 2G auction winners, who often faced only one competitor.

Theories about how the record-setting auction fees would affect service rollout and growth were as diverse as the bidder selection methods employed, reflecting the uncertain state of the market. One view was that auction fees were sunk costs, reflected on company balance sheets, but would have no effect on the rollout or profitability of actual 3G operations. Another was that they would affect the auction winners' debt-laden financing capacity and costs, and would ultimately cause them to charge higher prices.[99] A third was that the higher auction fees would force the operators to be more aggressive in addressing the market, presumably with lower prices and innovative products, since these operators would need to generate cash flow more quickly to justify their auction outlays.

Surprisingly, in terms of the overall diffusion of mobile phones to new subscribers, the results five years later tend to support the first view: that it has not mattered much. Germany and the United Kingdom have seen mobile subscriptions grow by 10.4 percent and 8.9 percent respectively (CAGRs) during 2000–2005.[100] Finland and Japan, on the other hand, both of which gave out "free" 3G licenses, have experienced 7.0 percent and 7.2 percent subscriber growth.

Japan has succeeded in converting more 2G subscribers to 3G than any other country, followed by Korea, Italy, and the United Kingdom.[101] Finland, on the other hand, is a laggard, with only 1 percent of its mobile subscribers using 3G at the end of 2005.[102] Also, most 3G subscribers in Europe have benefited mainly from lower cost voice service, while video and other service advances have attracted more users in Japan and Korea.

Other countries where operators paid $100 to $200 per capita for spectrum rights were Denmark, Italy, and the Netherlands. They experienced subscriber increases (CAGRs) of 10.2 percent, 11.3 percent, and 8.0 percent, respectively, during the same five-year period. On the other hand, Greece, Portugal, and Sweden, where operators received 3G licenses for very low payments, had 11.1 percent, 11.4 percent, and 5.8 percent CAGRs. The six countries with the lowest per capita auction fees had an average CAGR of 8.7 percent, compared with 9.9 percent for the six with the highest fees. If anything, high auction expenditures have motivated operators

---

[99] The issue rages on. See, for example, "Europe Says 3G Auction Inflates UK Mobile Prices," *The Register,* November 30, 2006; available at http:www.theregister.co.uk/2006/11/30/3g_auction_inflates_mobile_costs/ .

[100] ITU, 2005.

[101] Over 60 percent of Japan's mobile subscribers had 3G accounts at the end of 2006. Some of these were new mobile subscribers but a majority previously subscribed to 2G service. With all of Japan's 3G success, its mobile subscriber growth during 2000–20005 was limited to 7.2 percent CAGR; Korea's was 7.4 percent. See WirelessWatchJapan; available at http://www.wirelesswatch.jp/modules.php?name=News&file=categories&op=newindex&catid=11 .

[102] IDATE, Benchmarking eastern European Telecom Markets, October 19, 2006, slide 10.

to enlarge their markets more than free (or almost free) licenses have, but the difference is marginal.[103]

In short, the "3G auction" effect is not very discernable.[104] Admittedly, the effects might have been different if 3G licenses had been auctioned one or two at a time in each country rather than four to six at a time, as was the case.[105] There is also the possibility that the high fees prevented entry by new 3G competitors and that this in turn affected overall market growth.[106] An alternative explanation is that the financial community reacted to the 3G auction bubble, which occurred more or less simultaneously with the Internet and fiber telecom crashes, by lowering its investment in the sector generally but not particularly discriminating between markets with expensive spectrum auctions and those where governments relied on beauty contests or where the auction fees were moderate.[107]

Another spectrum-related diffusion issue pertains to the amount of spectrum available for mobile service in different countries. In general, the levels available in Europe are greater than those available in the United States, although European urban and general population densities are much higher. Thus, evidence that Europe's higher adoption rate results from greater spectrum availability is mixed at best. The higher U.S. usage of mobile phones on a monthly minute basis may argue for greater spectrum parity, but also implies that U.S. spectrum allocations have been sufficient for most users. This does not minimize the need for more spectrum in very high-density U.S. cities, particularly New York.

The lack of a clear-cut relationship between spectrum allocation and penetration is underscored in a recent assessment of the Latin American market, where the average assigned spectrum is 102 MHz.[108] This compares with an average of 266 MHz in EU countries and a

---

[103] The two countries with the highest subscriber growth rates charged moderate amounts for 3G spectrum. These are New Zealand (18.0 percent CAGR) and Australia (16.6 percent). Both, however, were at the lower end of the developed country penetration scale (though not as low as the United States, Japan or Korea) in 2000 and both experienced higher economic growth rates in recent years than the European countries did.

[104] The United States and Canada have did not have 3G auctions per se c. 2000/2001. Both countries did have PCS auctions, with operators paying moderate amounts for the spectrum. (Their regulatory frameworks allow the PCS frequencies to be used on a 3G basis.) U.S. and Canadian subscriber growth rates have been relatively high during 2000–2005 (CAGRs of 13.0 percent and 13.7 percent, respectively), in part due to the low-penetration levels they had going into the period and in part due to the late introduction of prepaid service.

[105] Kelly, 2001.

[106] It is not clear that the auction-related drop out effect has been systematic. New 3G spectrum winners dropped out of the market in Germany and Italy (high auction fees) and Sweden (no auction). In Italy one of the incumbent mobile operators (Blu) dropped out of the 3G auction itself and later from the market.

[107] For the author's view on how these market trends converged, see Kas Kalba, *Telecom in the Time of Crash*, Harvard Program on Information Resources Policy, Cambridge, MA, November 2002 (available at http://pirp.harvard.edu/pubs_pdf/kalba\kalba-i02-2.pdf).

[108] See Judith Mariscal, "Market Structure and Penetration in the Latin American Mobile Sector," WDR Dialogue Theme 3rd cycle, Discussion Paper WDR0616, Draft, December 2006.

typical U.S. market figure close to midway between the two. Yet, as Judith Mariscal points out, countries such as Peru, with above-average mobile spectrum bands, have significantly lower penetration rates than countries with lower spectrum allocations, such as Venezuela.[109] Mariscal also presents data showing that the number of subscribers per MHz of spectrum in Latin America varies from 836,400 in Brazil to 18,300 in El Salvador.[110]

Operators can overcome shortages of spectrum by building more intricate cellular networks with a greater density of cells. This allows more intensive reuse of the same spectrum. At the same time, it can involve greater capital expenditures as well as operating costs (i.e., maintenance) on a per-subscriber basis. In addition, operators' spectrum requirements vary based on usage levels. Brazil can accommodate so many subscribers per MHz partly because it has one of the lowest ARPU levels (reflecting average usage) in Latin America. In India, on the other hand, the usage density is becoming so high that service quality has begun to suffer. This may reflect switching, coverage, and/or other limitations of the network, but spectrum shortages are also likely to be a factor.[111] Unless such shortages are alleviated, they may start to limit the country's dramatic growth in mobile usage.

5.10 Towers, Power, and Security

Cellular mobile transceivers are sited on some 2 million towers and other elevated structures around the world. This number continues to grow as networks are extended to previously uncovered areas and as new mobile infrastructure imposes different siting requirements, such as indoor cells.[112] For example, the use of higher frequencies typically requires smaller cells and denser networks of transceivers, which in turn calls for more antenna sites. The challenge for mobile network operators is finding appropriate antenna sites and securing permission to utilize them at reasonable rates.

In the case of business-oriented wireless networks, where the sites are best located on office buildings, this has placed significant bargaining power in the hands of building owners. The rents these landlords exact are often a larger cost element than the transmission equipment and

---

[109] Ibid.

[110] Ibid., based on data from Telecom CIDE (derived from regulator websites), company websites, and Thomas W. Hazlett and Roberto E. Muñoz, "A Welfare Analysis of Spectrum Allocation Policies," George Mason University Law and Economics Research Paper Series, 06-28.

[111] The above international comparisons by the author and by the referenced studies are generally made without distinguishing between "bandwidth" and "frequency." Not all bandwidth is created equal. For example, higher frequencies (e.g., in the vicinity of 1.8 or 1.9 gigahertz) have shorter-distance propagation properties than lower ones (e.g., 800 or 900 MHz). Cell re-usage potential is greater at the higher frequency levels. Nonetheless, most countries have followed roughly similar approaches to spectrum allocation for public mobile services, making available a combination of lower and higher frequency bands.

[112] These include relatively large cells in office buildings as well as the new household- or office suite-size *femto* cells, akin to WiFi access points. The link to mobile operators occurs over a broadband connection.

associated installation, and may have contributed to the bankruptcy of companies such as Winstar and Teligent in 2001. In cellular networks the sites often involve towers on private or public land, and require approval from local communities. U.S. and other communities have often withheld approval because of environmental, health and other community concerns, even though in the United States federal statute expressly prohibits the unreasonable withholding of such approval.[113] Lengthy delays in securing such approvals have become a relatively routine occurrence.[114]

Whether this factor also contributes to the U.S. lag in mobile penetration has not been systematically assessed. However, the general impression is that in Europe network rollout has occurred more speedily and coverage has been more complete, which would suggest a lower level of local government or community resistance to towers. Europe's denser cities may provide a larger variety of locations for siting mobile transceivers, or its relative lack of suburban communities, where much of the U.S. resistance appears to be concentrated, may make a difference.[115] In any case, it is ironic that European culture, so resistant to genetically modified food, has been relatively tolerant of mobile transceivers, whereas the reverse is true in the United States.[116]

Towers are sometimes less of a factor in developing countries, where laws requiring tower permits may have not been established or where such laws are either less procedurally demanding or are simply not enforced. The issue can be moot.

On the other hand, the security of towers and, especially, of the transceiver equipment is often a significant concern, requiring operators to hire formal or "gray market" security forces to protect the equipment. Similarly, the unavailability and/or unreliability of power grids is often a major problem in infrastructure deployment. Biofuel-powered base stations are emerging as an alternative in a number of countries, such as India and Nigeria,[117] although finding reliable local

---

[113] Telecommunications Act of 1996.

[114] In some cases, resistance to tower permits has also been stoked by incumbent operators with pre-existing tower locations or other antenna sites. This was a challenge for BellSouth, for example, when it entered New Zealand as the second mobile operator in the early 1990s. It was also a challenge for Daini Denden Pocketphone (DDI), one of Japan's PHS mobile operators, as its two competitors had access to public payphone enclosures and other locations for siting the micro-transceivers called for by PHS. DDI ended up choosing a U.S.-supplied variety of PHS transceivers which covered a wider area and therefore required fewer antenna cites.

[115] In a communication with the author (email, Sept. 3, 2007) Dimitri Ypsilanti noted that in Europe "there has been strong pressure on municipalities to allow investment in Towers – policies such as the sharing of towers have also been helpful." Similar pressure has been evident in the United States but it has often not been heeded. Some municipalities are also promoting the sharing of towers but, again, the practice has apparently been slower in taking hold in the United States than in Europe. See also note 117.

[116] An early reviewer of this report, Michael Short, Vice President of mobile operator o2 in the United Kingdom, asserts that the approval climate is changing in Europe, with the difficulty of securing towers now equaling the U.S. situation; email message, January 27, 2007.

[117] See Cassell Bryan-Low, "New Frontiers for Cellphone Service," *Wall Street Journal*, February 13, 2007, pp. B1 and B5.

biocrop sources can remain a challenge. At the handset level, alternative charging technologies are being introduced, including solar-powered chargers, wind-up chargers, and bicycle-powered chargers.[118]

[118] See Craig Ehrlich, "Mobiles can unleash waves of innovation," *Financial Times*, Digital Business section, February 12, 2007, 5.

Chapter Six

Summary and Implications for Adoption Research

Historians, economists, and sociologists have treated the diffusion of communications and other technologies to households and individuals at large as predominantly a supply-driven process.[1] Studies have generally emphasized invention and early commercialization—including cost factors and pricing—of the technologies and the institutional and regulatory mechanisms that have accelerated or impeded their mass market rollout. Yet the flip side of diffusion is adoption, in which the consumer and associated environments play key roles. Fewer analyses have focused on these aspects: for example, studies of the social acceptance of the telephone and of the cultural attributes of mobile phone usage in different societies.[2]

6.1 Interaction of Supply and Demand

As noted earlier, some hold the view that mobile phone adoption is primarily a supply-side issue. When markets in low-income countries achieve 70 percent penetration, how can demand be a significant factor? Yet, as this report has shown, the high penetration levels of some low-income markets are more than matched by others with relatively low levels of adoption, reflecting income, household structure, and other factors. At the same time, supply-related factors are fundamental to extending the opportunity to adopt mobile phones to vast areas of the world, particularly rural areas in low-income markets. They may also be important in increasing the value of mobile phone adoption in some developed markets where service coverage within homes and work places remains limited.

Importantly, key insights often stem from understanding both the supply and demand sides of the adoption process and the interactions between the two. For example, why did the number of households with telephone service in the United States decline more steeply and for a longer number of years during the depression of the 1930s than did the number with automobiles?[3] Similarly, why did the number of automobiles surpass the number of telephones during the 1920s,

---

[1] See, for example, Paul Starr, *The Creation of the Media: Political Origins of Modern Communications* (Basic Books: New York, 2004); also Debora L. Spar, *Ruling the Waves: Cycles of Discovery, Chaos, and Wealth from the Compass to the Internet* (Harcourt, Inc.: New York, 2001). For more recent, policy-oriented treatments see Charles Ferguson, *The Broadband Problem: Anatomy of a Market Failure and a Policy Dilemma* (Brookings: Washington, DC, 2004) and Paul W. MacAvoy, *The Unsustainable Costs of Partial Deregulation* (New Haven: Yale University Press, 2007).

[2] An example of the former can be found in Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, Calif.: University of California Press, 1992); for several country assessments of mobile phone use, see James E. Katz and Mark Aakhus, eds., *Perpetual Contact: Mobile Communication, Private Talk, Public Performance* (New York: Cambridge University Press, 2002).

[3] See Figure 2 in Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, Calif.: University of California Press, 1992), 44.

even though telephones had been introduced earlier and cost much less? A possible answer is that automobiles offered more functionality and value than did telephones, but another is that telephone use involved set monthly payments, which posed more of a financial burden in areas with low levels of full-time, salaried workers—and throughout the economy during economic down cycles.[4] Automobiles required expenditures for gasoline, but gave the adopter relatively more control over the size and timing of these expenditures.[5]

The analogy here is to postpaid mobile service (akin to telephones) and prepaid (akin to automobiles). Like automobile purchases, prepaid subscriptions call for a higher upfront payment, at least in countries where significant handset subsidies are embedded in postpaid subscriptions. They also impose higher usage costs in the form of air minute charges than do postpaid buckets and per-minute charge plans. Still the world as a whole has opted for prepaid, willing to sustain the higher airtime charges (or gasoline prices, in the automobile analogy) rather than facing set monthly payment commitments. As noted previously, prepaid made its effective debut during the "peso crisis" in Mexico and has since served the residents of the wider global economy, in which cash plays at best an irregular role on a day-by-day, or even month-by-month, basis.

6.2 Early- vs. Mature-Stage Factors

The lesson of the postpaid-prepaid example is that supply and demand factors interact across several dimensions: new product innovations, income levels, labor force structure, and geography, among others. They also appear to interact differently at different stages of the adoption process. As outlined in **Table 6-1**, the research reviewed in this report suggests that different factors affect the adoption process during the early and maturing phases. Both disposable income and legacy connections have been highly correlated with early-stage mobile phone adoption in developed and emerging markets. Extreme climate has been a factor in the early stage of adoption in developed markets from Sweden to Singapore, while household size has been correlated with early-stage adoption in low-income markets such as those of China, Egypt, and India. Income inequality may also have played a role in stimulating or facilitating early-stage adoption of mobile phones in Latin America and nonegalitarian societies elsewhere, including in North America.

---

[4] Also, telephone service could be discontinued relatively easily, while cars had to be sold at a time when demand was low—in the case of the Depression—and otherwise remained part of the "census" even if they were not used very much (akin to prepaid mobile where usage, especially outgoing, can be quite minimal).

[5] Telephone penetration was higher in farm areas until automobiles became more prevalent in rural areas; then urban areas came to reflect higher telephone use. Fischer, 1992.

Table 6-1
Factors Affecting Adoption in Early and Mature Stages

Early Stage	Maturing Stage
Income level (disposable)	Income equality
Legacy connections	Marketing/pricing
Household size	Prepaid and CPP
Extreme climate	Market size (small)
Income inequality	Competition (no. of operators)
	Access to towers/sites?

In contrast, in maturing markets income equality facilitates widespread adoption of mobile phones. Among other reasons, it fosters a large "mass market" that operators can approach with relatively uniform (and thereby relatively efficient) marketing and distribution strategies. Marketing and pricing become generally more important to securing new subscribers at this stage, as does the availability of attractive prepaid offerings, including widespread retail networks where the cards can be replenished. Surprisingly, however, this study has found that small markets experience higher levels of adoption than large markets in the maturing phase of the process, which suggests that some diseconomies of scale may be associated with large mobile phone operations.[6]

Some factors, such as network coverage, are important during both phases of adoption, but the ways in which coverage affects penetration can vary by stage as well. In the early days of a market, when network deployment is likely to begin with the core areas of the major city, extending the network footprint to surrounding suburban areas is likely to hasten adoption, particularly in an automobile-centric market with extensive urban-suburban commuting. At later market stages coverage can be instrumental in fostering adoption in other ways, for example, by extending the signal within office buildings, malls, and homes or to outlying rural areas. Moreover, if all the local operators compete on a coverage basis, it is highly likely that price competition stimulates adoption unless significant differences in coverage remain among the operators.

[6] As suggested earlier these may involve coordination costs across multiple urban markets and a reduction in management focus on network deployment and service offerings responsive to the makeup of the potential adopters of mobile phones. In other words, just as income inequality renders mass marketing less efficient so may be the case with large geographical areas and populations with heterogeneous characteristics. A relatively small, egalitarian and otherwise homogenous market may be ideal in terms of market penetration during the maturing stage of adoption.

6.3 Lessons of Mobile Phone Adoption

This report suggests a number of other lessons for adoption theory. They can be summarized with respect to the questions raised in **Chapter One**.

- *Has the worldwide spread of mobile phones involved a single diffusion and adoption process or multiple ones, given the different product and technologies involved?*

The evidence suggests that at least two phases of mobile phone adoption can be discerned: one involving postpaid service and the other prepaid (see **Table 6-2**). These involve partly overlapping diffusion and adoption processes. (Moreover, a third phase or process could be ascribed to the early stage of mobile adoption, when car ownership was a virtual prerequisite of mobile phone use.) The phases can be differentiated by the product offerings as well as by the "buying" and usage contexts of the adopters. They can also be differentiated by geography, as the table shows.

Table 6-2
Spheres of Mobile Diffusion—Prepaid vs. Postpaid

Prepaid Markets*		Postpaid Markets*	
China	308.9	United States	199.0
Russia	145.9	China	152.1
India	125.0	Japan	96.8
Brazil	80.8	Germany	40.3
Italy	72.9	Korea	38.8
Indonesia	59.5	France	32.4
Mexico	51.3	Spain	25.4
Pakistan	47.5	United Kingdom	24.0
United Kingdom	46.7	India	22.1
Turkey	46.1	Brazil	20.2
Ukraine	46.1	Taiwan	17.9
Germany	45.4	Canada	14.3
Philippines	41.2	Poland	14.1
Thailand	34.8	Australia	11.7
United States	32.4	Argentina	8.1

* millions of subscribing units

Source: Campbell and Chen, 2007

The prepaid phase of mobile evolution is dominated by the BRIC [Brazil, Russia, India, and China] economies, together with Indonesia, Mexico (where prepaid was initially introduced), Pakistan, and other emerging markets.[7] Among advanced economies Italy leads in prepaid subscribers, while the United Kingdom and Germany retain leading positions in both the prepaid and postpaid spheres. The United States, still the world leader in postpaid subscribers, is in fifteenth place on the prepaid side in absolute subscriber terms, and much lower in prepaid subscribers per capita.

One can also argue that the prepaid phase should be divided into "personal" and "shared" adoption, with the former being dominant in developed and most emerging markets and the latter in low-income markets such as the rural areas of Africa and India. However, as some recent evidence suggests, personal users of prepaid and postpaid phones in developed markets may be more willing to share their minutes than has been commonly thought.[8]

- *In addition to income per capita and fashion, what less obvious factors have driven the demand for mobile phones and service? To what extent do culture, climate, demographics or legacy phones and connections play a role?*

This study has documented a strong relationship between legacy phones and mobile phones in emerging markets. The correlation can probably be explained in large part by the common relationship of fixed and mobile penetration to a country's income level. At the same time, the correlation is much weaker in developed markets. This suggests other dynamics may be involved. The current report offers three possible factors: (1) the greater observability and awareness of phone value and status in countries with higher fixed phone levels, (2) the greater ability to make fixed-to-mobile calls (especially important in CPP and asymmetric interconnection markets), and (3) the functional value of a fixed network in providing backbone connections among mobile cells. These hypotheses could be examined through further research.

The report also offers a perspective on the role of demographic factors in mobile phone adoption. It highlights the correlation between household size and phone adoption in emerging markets as well as the potential role of income inequality. Emerging markets with large households and high degrees of income inequality tend to have low levels of mobile penetration. Conversely, markets with relatively small households and relatively low levels of inequality have comparatively high penetration levels. Also, countries with older demographic profiles (e.g., Eastern

[7] The BRICs alone have close to as many mobile subscriptions as there are Internet users worldwide.

[8] See Association Française des Opérateurs Mobiles, Discours & Pratiques, *Le téléphone mobile aujourd'hui—usages et comportements sociaux*, 2nd ed., Association Française des Opérateurs Mobiles, June 2007.

Europe, Argentina) have higher penetration levels, contrary to the popular concept that mobile adoption is driven by young people.[9] The report does not conclusively prove the driving effect of these demographic factors, but outlines hypotheses that could be tested through further research and analysis.

The report also examines the role of cultural differences in shaping the degree to which mobile phones are used. It concludes that usage prices have been a more determinative factor than culture. The range of "cultures" represented among high-penetration countries—for example, Scandinavians, Jamaicans, Ukrainians, Taiwanese, Chileans, and Italians—suggests that culture does not have robust explanatory power. The report does not address whether culture affects adoption, which does not appear to be the case. On the other hand, it provides suggestive evidence that climate may influence the pace of adoption, especially during the early stages.

- *What has been the role of supply-side factors, such as competition, technical standards, population density, interconnection charges, and spectrum availability? Does market size make a difference?*

Supply-side factors play an integral role in the diffusion and adoption process. However, the lack of comparative international data on key factors such as coverage and service quality has made the analysis of supply-side differences challenging. The report presents mixed evidence on the role of standardization and suggestive, though not conclusive, evidence on the relationship between competition and market enlargement. Specifically, it questions whether an unlimited number of mobile operators, rather than what could prove to be an *optimal* number of about four operators, is likely to result in more subscribers. Beyond this level competition may result in greater churn but not necessarily the infrastructure build-out and service development that can attract more subscribers. The report also addresses spectrum availability and the relationship between the number of operators and efficient use of the spectrum.

There are regulatory implications as well. In addition to the number of operators to be licensed and rules (if any) regarding technical standards, policymakers and regulators affect the adoption process through the interconnection regime they foster or allow, and through the selection of

[9] The report does not examine the role of these factors across developed markets. However, there is some casual evidence that income inequality may be related to mobile penetration in that Scandinavian markets have very high penetrations, while that of the United States Is relatively low. On the other hand, Canada and Japan are relatively low as well. (The United States has relatively large and relatively young households compared to other countries with similar GDP per capita levels.)

licensing territories. Here the report argues that asymmetrical interconnection has played a key role in mobile adoption in emerging markets. It also discusses whether, and to what extent, such interconnection, which favors mobile operators over fixed ones, can be justified. As for licensing territories, it presents data supporting the view that smaller territories, whether national or subnational, tend to foster higher penetration rates than larger ones. This challenges the view that larger territories should engender greater economies of scale.[10]

- *To what extent do mobile service prices drive adoption and usage? Are low prices responsible for the high adoption rates achieved in developed and emerging markets?*

Here one of the more unusual findings of the research appears. While usage prices appear to drive usage levels, the same pattern does not apply to adoption prices. The latter involve a mix of handset charges (subsidized in whole or in part in many markets) and service charges, often amounting to several hundred dollars (including a year or two of monthly fees) or even more if little or no handset subsidy is involved. Yet high penetration rates are often associated with no or low handset subsidies in developed markets (e.g., Italy, Sweden). Even more unusually, prepaid, which generally involves no handset subsidies and high usage fees, is associated with the increasingly high penetration rates found in emerging markets, such as those of Brazil, China, India, and Russia. No doubt these are unusual results. How can one interpret them?

One possibility is that there are two mobile markets, as has already been suggested, and that the calculus underlying purchase or adoption decisions differs significantly in the two situations. In the postpaid market adopters may be highly conscious of the basket of upfront and ongoing costs involved in mobile phone usage.[11] By contrast, in prepaid markets with CPP billing adopters may view the mobile phone as primarily providing access to free incoming calls and/or to low-cost texting. Consequently, once the price of basic mobile phones drops to the $50.00 level, high levels of adoption may occur even in low-income countries. But this explanation requires validation. It is equally, if not more, possible that consumers in low-income countries realize that mobile phone use will draw on a high portion of their income—as high as 5–10 percent, far more than the 1 percent level typical in developed markets.

[10] The report does not dispose of the economy of scale argument at a more general level, as it is conceivable that larger territories result in higher levels of profitability for operators. However, the smaller territories appear to result in higher penetration level, due to management efficiencies, easier regulatory oversight, or other factors.

[11] These baskets are relatively easier to calculate in markets like the United States where fixed-price bucket plans predominate than in Europe where variable usage charges prevail.

> If this the latter explanation proves valid we will need to search for other drivers of mobile adoption in prepaid markets. Does the value of mobile phones for employment or social reasons outweigh the heavy cost? Is imitation, driven by observability, siphoning off a large share of the adopters' revenues? Has the mobile phone, like the automobile in earlier American development, become a symbol of modernization without which upwardly mobile consumers cannot live? Is there a political—or, at least, civic—component of the adoption process that explains why Eastern European countries have adopted mobile phones so avidly despite the aging demographic profile of their populations?

The report does not answer these questions, but seeks to identify a broader range of factors that may contribute to an overall understanding of the mobile phone adoption process in a wide range of market settings. The report has also addressed some of the anomalies of mobile phone penetration—specifically, why Europe is ahead of the United States, why China has outpaced India (though India is catching up), and why aging Eastern Europe is well ahead of youthful Latin America. It has provided a mix of economic, regulatory, demographic, and geographic explanations, which we hope that other researchers will test with additional data and other methodologies.

Finally, the report raised the question of how rapidly the mobile phone diffusion process is likely to extend to the rural areas of the globe, particularly in low-income countries in Africa, Asia, and elsewhere. Development of cheaper phones, prepaid plans, and base stations may offer the only fundamental solution here, as described in the next chapter.

Chapter Seven

Reaching the Next Three Billion

The author's interest in the innovation diffusion process began in a graduate school class some forty years ago.[1] At the time virtually all diffusion studies focused on individual countries or on localities within countries. The emerging "rule of thumb" was that, virtually regardless of the product or location, diffusion was a process that took twenty to thirty years from the initial introduction of a new product to its widespread acceptance and use.

Now it seems that the same rule applies, only at a global level. Mobile phones appear to be everywhere. Our children use them, often by the time they reach grade school, as do their grandparents. So do the Europeans, the Chinese, the Indians, the Brazilians, and the Russians. Mobile phones have pervaded the streets of Africa, with one source stating that the service is already available to a majority of the continent's population.[2]

Is the cause globalization?

So it seems. Certainly mobile phones are as widespread as any human-developed technology, with the sole exception of clothing and, possibly, food bowls. The number of handhelds has recently surpassed the number of landline phones, TV sets, radios, and even bicycles.[3] Moreover, it has happened in a blink—admittedly, a twenty-five- or thirty-year blink, if one begins the count when the first commercial service was introduced in Tokyo. Still, relatively speaking, it is a blink— much faster than the 100 years it took to deploy the first billion telephone lines. Now there are more than 3.5 billion mobile phone subscribers and users,[4] including, possibly, some double counting for those with more than one subscription.[5]

---

[1] The class was at the Annenberg School for Communication at the University of Pennsylvania and was taught by Julian Wolpert, to whom the author remains grateful for stimulating his interest in innovation adoption, introducing him to the writings of Everett Rogers and other scholars in the field, and exposing him to a variety of diffusion models: gravity, Monte Carlo simulations, game theoretical, et cetera

[2] According to the GSM Association, as cited in *The Economist*, January 27, 2007, 48.

[3] See ITU, ICT Statistics, available at http://www.itu.int/ITU-D/ict/statistics/ (accessed 27 August 2008). About 100 million bicycles are sold a year vs. about 1 billion mobile phones.

[4] For some qualitative data on similarities and differences between mobile phone owners and mobile phone users (and between these subgroups and nonowners/nonusers) based on surveys in rural towns in South Africa and Tanzania, see Jonathan Samuel et al.. A companion paper in the same report by James Goodman, "Linking Mobile Phone Ownership and Use to Social Capital in rural South Africa and Tanzania," shows that a significant number of mobile phone owners (close to 50 percent) let family members and friends use their handsets for free. However, the survey was not representative of all rural users nor of the respective national markets, p

[5] And perhaps twice as many mobile phones; see note 2 above.

7.1 A Wireless Missing Link?

Can we assume that the "missing link" has been eliminated? When the Maitland Commission reported in late 1984 that over 2 billion people lived more than two hours' walking distance from the nearest phone, this raised an eyebrow or two.[6] Now it is generally assumed that this phone gap has been eliminated. Yet simple mathematics indicates that the situation has not changed as much as the industry and policy makers would care to believe. There are now 6.7 billion people on earth, compared to 4.8 billion in 1984. Subtract 3.5 billion from 6.7 billion and one is still left with 3.2 billion.

As recent research has suggested, access to mobile phones and public payphones in low-income countries may be greater than has been previously assumed.[7] Undoubtedly in countries with large households, such as India and Pakistan, a multiplier effect of mobile phone ownership results from shared use of mobile phones. Family members and friends share not only mobile phones but also individual calls, to the point that it can be considered antisocial not to include someone nearby when taking a call.[8] The multiplier also extends to by-the-minute mobile rental services in Africa, Bangladesh, and elsewhere, although it is also difficult to estimate how many of the users of these services are nonsubscribers versus subscribers who have been unable to "top-off" their prepaids, left their phones at home, or were unable to charge their phones.[9]

All these additional "user-but-not-owner" segments, however, are not likely to add up to more than 500 million individuals, leaving a residual nonadopter population on the order of 2.7 billion. This population, in turn, can be segmented into those who are aware of mobile phones and those who are not. The "aware" group (presumably the far larger one) can be further separated into those who have tried a mobile phone and want to obtain one (or at least to use one occasionally), those who have no means of using one even occasionally, and those who have no interest in becoming users. It would be useful to know how many individuals in a cross-section of low-income countries, particularly those living in rural areas that are not at the periphery of urban centers, fall into these different categories, and to what extent they would be willing to pay (by

---

[6] ITU, *The Missing Link: Report of the Commission for World-Wide Telecommunications Development*, December 1984.

[7] Some of this research, however, may not be fully representative of the low-income and rurally remote population segments; some has been based on the keeping of diaries, which adds precision but may not reflect the connectivity of the largely illiterate populations being surveyed.

[8] Katja Konkka, "Indian Needs: Cultural End-user Research in Mombai," in Christian Lindhom et al., eds., *Mobile Usability: How Nokia Changed the Face of the Mobile Phone* (New York: McGraw Hill, 2003),104–105.

[9] Public charging kiosks are now starting to appear in China and in other countries where electricity cannot be taken for granted, but very little information is available as yet whether these are catching on.

means of cash or barter) for access to mobile phone service in the future. All these aspects call for research.[10]

Overall, it is not impossible, or even improbable, that a billion people today have not used a mobile phone (or even held one in their hands in many cases) or have used one but lack the economic or social means to become occasional users.[11] Many people still live two hours' walking distance from the closest mobile service area. The reach of mobile phone infrastructure remains more limited in some countries than that of the landline network. In fact, in developing countries about 3 billion people live in rural areas today, up from 2.5 billion in 1985.[12] With few exceptions (notably China) developing countries have made very little progress in bringing telephone access to rural areas by wire *or* wireless, not only because of the heavy costs involved and the poor inhabitants but also because of the absence of electricity.[13]

As noted earlier, over 30,000 villages in Russia (a relatively high-end emerging market) have no access to telephone lines, fixed or mobile. In Brazil, the 2500 "cities" that still lack mobile service call for an investment of $1.5 billion, according to Anatel, Brazil's regulator.[14] Another study of eleven Latin American countries has found that 15 percent to 35 percent of their populations will not be able to adopt mobile phone service on a market basis, with Brazil falling into the middle of the range.[15] This same study concludes that making mobile phone service available in the areas not likely to be served by the market would require a subsidy of

---

[10] In the early stages of mobile phone diffusion many surveys focused on nonsubscribers as much as subscribers. This focus must be re-established with respect to countries and areas (largely rural) where mobile phone penetration remains low.

[11] According to Tim Kelly, "ITU estimates, based on the number of households and villages that have telephone access, suggest that close to one-fifth of the world's population currently have no telephone access." This works out to about 1.3 billion people as of mid 2006. See Tim Kelly, "Twenty Years of Measuring the Missing Link," in Gerald Milward-Oliver, ed., *Maitland+20: Fixing the Missing Link* (The Anima Centre Limited: Bradford on Avon, UK, 2005), 26.

[12] United Nations, World Population Prospects: The 2004 Revisions, available at http://esa.un.org/unpp/p2k0data.asp

[13] Access to electricity is, of course, critical to re-charging mobile phones. The ingenuity of mobile phone users in coping without local electricity cannot be underestimated, however. In South Africa, recharging by means of car batteries is a common practice; in Tanzania periodic collection of the phones in a rural town without electricity and transporting them to the closest electrified town for re-charging is not uncommon. See Jonathan Samuel, Niraj Shas and Wenona Hadingham, "Mobile Communications in South Africa, Tanzania and Egypt: Results from Community and Business Surveys," in *Africa: The Impact of Mobile Phones*, The Vodafone Policy Paper Series, Number 3, March 2005. .

[14] See note 90 in Chapter 5.

[15] Peter A. Stern and David N. Townsend, New Models for Universal Access to Telecommunications services in Latin America: Lessons from the Past and Recommendations for a New Generation of Universal Access Programs for the 21st Century, Regulatel (Forum of Latin American Telecommunications regulatory Entities, November 2006.

$44 billion.[16] The commensurate numbers for Africa and Asia are undoubtedly higher; the number for Russia and the rest of the developing world may be higher as well.

Mobile phones offer hope but also require infrastructure. Such infrastructure is difficult and expensive to deploy in poor, often geographically challenging, rural areas because of sparse population, economics (including maintainability), and often rugged topography or dense vegetation, as well as the absence of opportunity costs. The effort and investment allocated to rural areas would have to be diverted from urban ones, where the market opportunities are much greater and where loss of market share to competing operators could stunt a mobile company's overall growth. Conversely, the investment required to install mobile coverage in relatively low-density rural areas may be better spent on water, public health, housing, or education facilities. Some governments, including those of Peru and Cambodia, have started to focus on how to create incentives for operators to deploy rural wireless service, but overall poor and remote rural areas remain in the early adoption stage.

In sum, despite globalization, massive urbanization, and the rapid spread of mobile phones, we are now completing what Everett Rogers would call the "early majority" phase of the global adoption process.[17] The innovators and early adopters have entered the market, as has most of the second quadrant of the world's population. As noted above, another 3.5 billion people do not subscribe to mobile phone service, including some in the developed world, where laggard countries such as the United States are still catching up with the likes of Sweden, Italy, Israel, and Hong Kong. Of these a half billion or more use mobile services via family, friends, and mobile payphones, which brings the number of nonadopters to about 2.7 billion. A significant portion of these, in turn, are children or others who are restricted by age, infirmity, or incarceration from becoming regular mobile phone users. This still leaves on the order of 2 billion potential adopters.

Thus, at a global level the mobile phone diffusion process is taking, paradoxically, longer than might be expected, in part because of population growth. Most adoption studies assume fairly constant population, yet the globe has had a net gain of almost 2 billion people since 1984, many of whom were born—and still live—in poor (or at least cash-poor) rural areas. Full global adoption, in other words, will take more than the thirty years contemplated in the classical diffusion literature.

7.2 Prices, Spectrum, and Infrastructure Sharing

The question is whether full adoption will take a few years longer—as few as four years if 20–25 percent per year subscriber growth were to continue—or ten or more years if the diffusion

---

[16] Ibid., Executive Summary, 5. About 44 percent of the unservable population lives in towns of 300 or more and could be reached relatively inexpensively (with a subsidy of $126 per capita). The remainder represents a much bigger challenge, requiring an average subsidy of $736.

[17] Everett Rogers, *The Diffusion of Innovations*, Fifth Edition *(*New York: Free Press, 2003).

curve lapses into a relatively long tail.[18] Rogers notes that traditionally late adopters have taken several times as long as early ones to accept an innovation.[19] This longer time begins when exposure to the innovation first occurs. Accordingly, it would be useful to know if (and when) the "last billion" potential mobile subscribers have seen, handled, and used a mobile phone or if, alternatively, most of them are at point zero in the diffusion process.

Barring a major technological breakthrough or a radical (and sustainable) change in the business model, the time needed to complete the mobile phone diffusion process depends as much on these underlying aspects of diffusion as on further reductions in the wholesale price of mobile phones (a sub-$10.00 phone is sure to come, as is sub-$1.00 ARPU) and further reductions in operating costs.[20] An even more important technological trend line is the declining cost of the infrastructure per subscriber (especially per rural subscriber), along with allocations of wider spectrum bands for mobile service. These are the critical elements of extending coverage into rural areas where initial subscriber take-up may not be very high. Looking forward, the main challenge is in rural India, Russia, Pakistan, Indonesia, Brazil, parts of rural China, and much of rural Sub-Saharan Africa.

Operators need a large amount of spectrum for a few initial users to ensure that they can provide coverage and capacity without having to deploy costly, more intricate (i.e., with smaller cells) infrastructure. This spectrum will be indigenous; it need not be "stolen" or borrowed from urban areas. Nonetheless, a fair degree of spectrum planning is necessary. For example, in many countries the military is the primary holder of relevant spectrum and is reluctant to part with it.[21] Auctions, with some of the proceeds reverting to current spectrum holders, are one of the mechanisms being used to deal with this issue.

---

[18] One of the most recent global forecasts of mobile phone subscriptions projects the recent 25 percent annual level dropping to 12.8 percent in 2007 and 5.7 percent by 2010. (The projection is by iSuppli, as cited in Stephen Wellman, "Wireless Agenda," Information Week, Feb. 19, 2007, pp. 40-45.) Nokia Siemens Networks has projected five billion subscribers in 2015, which assumes a CAGR of about 6.5 percent; see http://www.nokiasiemensnetworks.com/global/Press/Press+releases/news-archive/Pressrelease1.htm. However, except for the 3G forecasting euphoria in the 1998–2002 period, virtually all projections of mobile subscriber growth have fallen short of actual market results. So, again, the question at the world level is whether the market will continue to outperform the forecasts or whether a penetration wall—of "laggards" on the demand side and/or infrastructure limits on the supply side—will soon be reached.

[19] Rogers, 214–215.

[20] Many mobile operators have reduced operating costs by an order of magnitude in recent years in markets such as India in order to sustain calling fee reductions from $0.20 per minute to $0.02 per minute. See, for example, Jo Johnson, "Entrepreneur sows his mobile millions in the fields," Special Report on India and Globalization, *Financial Times*, January 26, 2007, 6.

[21] This is the case in India, for example. However, the government is expected to release 45 MHz of spectrum for mobile service later this year. See Amy Yee, "Villages Remain the Challenge," *Financial Times*, Special Report: India & Globalization, January 26, 2007.

Whether the operators serving the urban areas should also be expected to serve the rural areas, or whether countries will need to develop rural specialists, is a corollary issue. Even in the United States landline rural phone operations are being sold off to a new cadre of private equity firms. Perhaps something similar will be needed for rural Asia and Africa, with development supported by microfinance institutions, multilateral institutions, or both. Barter payments are also likely to play a growing role in the adoption of mobile phones and the use of associated mobile service in the low-income rural areas of the developing world.

The majority of the world's population does not currently have the means to support mobile phone service. Even $5.00 per month can represent 10 percent to 25 percent of the income of a person making $1.00 or $2.00 a day.[22] Other than the occasional call to coordinate a remittance payment, stay in touch with a family member who has moved away, or arrange the annual visit to another village, the need for a phone may be unclear to many of the world's poor who live in traditional societies. At the same time, awareness of the benefits of staying in touch for functional reasons (e.g., checking whether eggs are available at the neighboring village market) or social ones (talking to a friend who is working in the field) is spreading around the globe. Spurred by observability and imitation, by cultural and lifestyle changes, and by the sheer retail presence, product, and pricing innovations of the mobile industry, the adoption process continues to gather steam in ever more remote portions of the globe.

Could the introduction of new technology or a new business model change the pace of adoption? Certainly the answer is yes, at least in theory. A new wide area technology—for example, one that allows a single antenna powered by inexpensive solar energy to serve an area of 100 km. radius (possibly with WiMAX) or 1000 km. radius (possibly with short-wave communications)—could reduce the deployment costs dramatically. Similarly, a business model based on advertising or greater government- or vendor-based subsidies of service, handsets, or infrastructure deployment could lower barriers to adoption significantly. At the same time, such approaches embody their own adoption cycles. The new technology must be proven. Learning economies must have time to permeate the production and deployment process. New frequencies must be allocated, and must include international coordination. The new business model must be tested and perfected before investors will support it on a widespread basis, especially in the rural areas of low-income markets.

A more viable approach in the near term is to allow, possibly even mandate, mobile operators to share infrastructure so that rural areas can be covered more rapidly and at a lower unit cost. The sharing should extend to passive elements (towers and other antenna sites), active elements (electronics), and support elements (electricity, security, et cetera). Infrastructure sharing in rural areas and public spaces (e.g., subways, tunnels, bridges) has become commonplace in

[22] The $5.00 figure is not intended as an absolute limit. Operators in Bangladesh, Pakistan, and elsewhere are experiencing ARPU below this, though the sustainability of, say, $3.00 ARPU remains to be proven.

markets from the United Kingdom to Singapore. What remains is for these concepts to be extended to emerging markets, as is being planned by governments in India, Africa, and elsewhere.[23] In the process operators will test innovative ideas, such as allowing local entrepreneurs to own and operate individual base stations as a means of extending service to their villages[M1].

Meanwhile, the tension between the emerging communication culture and the traditional subsistence economy is manifesting itself across the agrarian villages of the world. A resolution will occur sooner or later, not only as cheaper phones and prepaid plans are developed but also as base stations capable of serving the low-volume, wide-area needs of small villages become available at a relatively nominal cost (perhaps under $500). Until this, or another widespread revolutionary wireless rollout, occurs, the diffusion of mobile phones in the rural areas of the developing world remains the outlying frontier of connectivity.

[23] See, for example, the Recommendations section of Richard P. Adler and Mahesh Uppal, *m-Powering India: Mobile Communications for Inclusive Growth, Report of the Third Annual Joint Roundtable on Communications Policy*, Aspen Institute India and Confederation of Indian Industry, February 7–9, 2008, forthcoming.

Chapter Eight

Concluding Perspective

The mobile phone diffusion process has evolved through several waves of product development, adaptation, and deployment, and at least three phases of diffusion.[1] At the "innovator" phase the target customers were middle-to-high-end automobile owners in developed economies, who (globally speaking) had high incomes. The initial lead markets were Chicago, Baltimore–Washington, and London as well as Stockholm, Oslo, and Toronto, where the relatively cold climate may have contributed to the rapid take-off of mobile phones. Tokyo, one of the locations where mobile service was initiated early, took far longer to reach the take-off point because of higher prices and, possibly, the lower reliance on automobiles, a milder climate, and a more egalitarian society.[2]

In the second phase, with prices dropping and phone miniaturization setting in, "early adopters" joined the market in places such as Hong Kong, the cities of continental Europe, and the higher income offices and neighborhoods of Eastern Europe and Latin America. These adopters, whether or not they had cars, had pockets or purses and salaries. A fair number lived in very warm places such as Atlanta, Bahrain, Lisbon, Singapore, and Tel Aviv. They used the phones as much on the street as during commutes to work, with the latter as likely to occur on public transit as in automobiles. Handset subsidies became a common feature of some marketing programs; whether they had more than a tactical effect on diffusion is unclear.[3]

In the third stage, which diffusion researchers refer to as the "early majority," the product offering was transformed by prepaid and CPP billing and, in many developing markets, by asymmetrical interconnection rates. This allowed mobile operators to focus on a wider market of consumers with irregular incomes, those on fixed incomes with a need to control expenses strictly, and those avoiding credit checks or seeking anonymity. This phase has also allowed operators to target users with low incomes but a moderate-to-high need for (largely inbound) connectivity for work or family purposes. The mobile phone as an incoming calling device has been enlisted in supervising workers (construction laborers, hotel maids, et cetera), teenagers, and elderly relatives.

---

[1] Everett M. Rogers, *Diffusion of Innovations*, Fifth Edition (New York: Free Press, 2003).

[2] Japan has its share of small businesses that lead mobile phone adoption in this early phase. However, businesses in Japan generally run on tighter margins than in the United States. They had comparatively less disposable income to spend on IT innovations like mobile phones.

[3] Countries with low reliance on handset subsidies, such as Italy and Sweden, have exhibited high penetration levels, as have subsidy-prone ones like the United Kingdom. The United States, where handset subsidies are used to market two-year service contracts, remains a relative penetration laggard.

The last two phases of the classical diffusion curve lie ahead. The “late majority” and the “laggard” segments of the global population must still addressed. For the industry there are still billions of phones to be sold and billions of subscribers to be activated, in addition to the pets and machines (automats, robots, security cameras, cars, et cetera) that may become “subscribers” through corporate and human proxies. Some of these new targets will be easy to reach, others not. The greatest challenge will remain reaching and recruiting the billions of inhabitants of low-income rural areas in Africa, India, and other parts of the world.

The supply-side aspects of this last challenges are relatively obvious. At the regulatory level they include determining the rural coverage framework, setting the optimal number of operators, and formulating the appropriate interconnection and subsidy regimes. As regulators such as Anatel in Brazil are striving to rebalance asymmetrical interconnection rates in favor of fixed operators (possibly to foster landline broadband service growth), they may need to develop new formulas for encouraging wireless operators to extend coverage to small cities and rural territories. At the operator level the challenges will involve adapting and deploying existing and new technology to cover wider service areas, keeping assets secure, and finding ways to store and monetize barter payments, among many others.

Operators will also have to enlist the help of existing users in converting the natural skepticism of “laggards.” Laggards, as Rogers, points out, are “the last in a social system to adopt an innovation. They possess almost no opinion leadership. Laggards are the most localite of all adopter categories in their outlook.” Rogers adds that, “The laggard’s precarious economic position forces the individual to be extremely cautious in adopting innovations.”[4] Fortunately for the industry most of the remaining nonadopters are young and, therefore, not as susceptible to these classically conservative attitudes.

In a sense the two ends of the diffusion curve have some similarity. The very late adopters are skeptical of an innovation because their economic situations oblige them to be, while the early ones are skeptical because of the risks inherent in a novel product, not to mention the high price often associated with it. Identifying the appropriate target segments and marketing channels for reaching the last 25 percent may be as daunting as it was for Japan, the United Kingdom, and the United States to reach the “innovators”—the first 2.5 percent—in the early 1980s.

The situation, some might argue, calls for world government to ensure the availability of coverage. Yet this report shows the amazing progress accomplished by a de facto coalition of major suppliers and entrepreneurial operators, aided and abetted by proselytizers of regulatory liberalization on the one hand and by early adopters on the other. These early users stood to benefit from the increased connectivity they generated by enticing friends and coworkers to become adopters themselves. Mobile phone diffusion, spurred by R&D and financial,

[4] Rogers, 284–285.

manufacturing, and marketing initiatives on virtually all continents, has exceeded—and continues to exceed—expectations.

Some developments have delayed the diffusion of mobile phones. The slow adoption of prepaid and delays incurred in securing tower permits have undoubtedly had this effect in the U.S. market, as has, possibly, the over-licensing of operators. Diffusion delays may also have resulted in countries where insufficient spectrum has been made available for public mobile use or where low-cost financing has been temporarily unavailable for network deployments and expansions. Overall, the diffusion process has moved at a precedent-breaking pace, driven by our rapidly growing reliance on mobile phones and the underlying infrastructure and systems that make them work.

It remains to be seen whether the overall industry structure and government-industry relationships will have to change if global mobile phone diffusion should slow to a trickle and not be replaced by a commensurate surge for new 3G and 4G services. The post-urban diffusion challenge in low-income markets and the recent financial crisis in high-income ones may prove too daunting for the mobile industry. However, so far everyone betting on such a slowdown has been proven wrong. Even at, say, $3.00 ARPU levels, the next billion subscribers would generate $36 billion a year, not counting an additional $30 billion for the associated handsets. Whether this will be incentive enough to support the extension of mobile infrastructure to outlying rural townships in the developing world, one operator at a time, is the salient question.

Acronyms

1G	first generation
2G	second generation
3G	third generation
4G	fourth generation
ARPU	average revenue per unit
BRIC	Brazil, Russia, India, and China
CAGR	compound annual growth rate
CDMA	code division multiple access
CLEC	competitive local exchange carrier
CMOS	complementary metal oxide semiconductor
CPP	calling party pays
DDI	Daini Denden Inc.
DMB	Digital Multimedia Broadcasting
DVB-H	Digital Video Broadcasting-handheld
DVD	digital video disk
ESMR	enhanced specialized mobile radio
EU	European Union
FCC	Federal Communications Commission
FM	frequency modulation
GDP	gross domestic product
GPS	Global Positioning System
GSM	Global System [for] Mobile Communications
HSDPA	High Speed Data Packet Access
iDEN	Integrated Digital Enhanced Network
ITU	International Telecommunications Union
km	kilometer
LTE	long-term evolution
MHz	megahertz
MOU	minutes of use

OBA	output-based aid
OECD	Organisation for Economic Cooperation and Development
PCS	personal communications services
PHS	Personal Handy-phone System
PPP	purchasing power parity
PTT	push to talk
RF	radio frequency
RPP	receiving party pays
SCDMA	synchronous code division multiple access
SDR	software-defined radio
SIM	Subscriber Identity Mobile
SMS	Short Message Service
TDMA	time division multiple access
TD-SCDMA	time division-synchronous code division multiple access
TV	television
UAE	United Arab Emirates
UK	United Kingdom
UMTS	universal mobile telephone service
VCR	videocassette recorder
VoIP	voice over Internet Protocol
W-CDMA	wideband code division multiple access
WiMAX	Worldwide Interoperability for Microwave Access