REVISITING DIGITAL DIVIDE:

AN ANALYSIS OF MOBILE TECHNOLOGY DEPTH AND SERVICE BREADTH IN THE BRIC COUNTRIES

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ABSTRACT

Can mobile communication technologies bridge the digital divide between developing and developed countries? This paper shows that the divide looks differently than previously thought for the fastest growing developing countries – Brazil, Russia, India and China (BRIC). Mobile technology depth (penetration, as population percentage), is rapidly growing for BRIC countries and for some (Russia) already equals developed country levels. BRIC countries also lead developed countries in mobile technology breadth (service variety) by introducing more innovative products and services. Out of 34 individual and five categories of mobile services available worldwide, BRIC countries have leapfrogged on data services, transaction services, media – video services, as well as several information services (directions, general and financial news, advertising, and travel information). In addition, mobile technology growth in BRIC countries is strong for both technology depth and service breadth. This suggests BRIC countries can and do indeed leapfrog using mobile technology, narrowing, equaling or even reversing the digital divide. This also indicates BRIC countries can serve as front-runners whose lessons on technology adoption and diffusion can be applied in other developing countries. The paper also presents implications for marketing research, policy making, and business practice in BRIC and other developing countries.

INTRODUCTION

Digital divide is defined as the gap between individuals, households, businesses and geographic areas in accessing and using information and communication technologies (ICTs) such as telephones, PCs, mainframes, and the Internet (Dewan et al. 2005). Digital divide research focuses on the gap that exists in ICT access and use between developed and developing countries (defined as countries with a gross domestic income (GNI) per capita of $10,000 or less (Mahajan and Banga 2006; Ohmae 1996)) as well as on the internal gaps that may exist in each country irrespective of its development level. Understanding how to correctly define and measure digital divide is still an open research question (Dewan and Riggins 2005), especially for emerging, fast-growing ICTs such as mobile communications (Galperin 2005; Knowledge@Wharton 2004). Understanding digital divide is also important for identifying differences in competitive capabilities and barriers of entry for new ICT-based products and services in the 86% of the world represented by developing countries (Mahajan and Banga 2006). This can inform both international marketing research, which has traditionally focused on developed countries, and practice (Burgess and Steenkamp 2006; Mahajan and Banga 2006).

Can mobile communications bridge the digital divide between developed and developing countries? In this paper, we attempt to answer this question by defining and analyzing the digital divide for mobile communication technologies between the four fastest growing developing countries - Brazil, Russia, India, and China (a group called the BRIC countries) and a subset of matching developed countries. We focus on the four BRIC countries because of their designation, by an influential 2003 Goldman Sachs report, as the fastest growing emerging economies, poised to overtake today's largest developed

countries by 2050 (Goldman Sachs 2003). In the future, most of the growth opportunities of established companies in the developed world are likely to come from BRIC countries, which are ready to receive technological innovations despite their still lower (but rapidly growing) income levels. BRIC countries can also act as torch-bearers for new products and services, and are likely to influence other developing countries through trade and technology and expertise transfer (Goldman Sachs 2003; Mahajan and Banga 2006). If these predictions hold true, then understanding the digital divide between BRIC and developed countries becomes important for both policy making and business decisions in BRIC countries, and can suggest technology growth paths for other developing economies.

Furthermore, we focus on mobile technology because of its novelty, predicted growth and specific characteristics. *First*, mobile communication technology is one of the newest, fastest growing ICTs (Boretos In Press) and has not yet received as much attention from researchers (Dewan and Riggins 2005) as other, more established ICTs such as telephones, mainframes, PCs, and the Internet have (Dewan et al. 2005). *Second*, mobile technology is promoted as a solution for narrowing of the digital divide due to its high rates of growth and significant impacts on gross domestic product (GDP) growth ("The Real Digital Divide" 2005; Waverman et al. 2005). Mobile phone subscriptions in the developing word have grown fivefold since 2000 (Foster 2007), and today there are more mobile phones in developing countries(1.65 bn) than in developed countries (1 bn) (Ehrlich 2007). Using mobile communication, people living in remote villages in Bangladesh connect with the outside world, health workers in Rwanda track the spread of disease epidemics, and millions of people in Kenya, the Philippines and South Africa perform financial transactions without having access to traditional banking infrastructure

(Ehrlich 2007). And according to industry visionaries and executives, while traditional ICTs remain inaccessible to most of the developing world, mobile phones bring a variety of digital and web content in reach of most of the world's population (Penna 2007; Roberts 2007). *Third*, mobile technology may be different (in terms of costs for adopters and technology providers and in terms of underlying infrastructure requirements) than mainframes, PCs, and the Internet (Galperin 2005; Knowledge@Wharton 2004). Therefore mobile technology may not conform to the conclusions of studies based upon previous ICTs (Crenshaw and Robison 2006).

In this paper, we argue there is a need to revisit the digital divide, in general, and the digital divide for mobile technology in particular for the following reasons. *First*, past research has focused on monolithic measurement of digital divide along only one dimension – ICT penetration. Our research follows the recommendations of recent analyses of emerging digital divide topics (Dewan and Riggins 2005) regarding the need to clarify the definition and measurement of digital divide and guide future research on the topic for new ICTs such as mobile technology. *Second*, existing studies assume digital divide exists due to structural differences across countries (such as income, infrastructure and education levels), implying developing countries can never bridge the digital divide unless they eliminate these differences. By revisiting the debate, we show emerging mobile technologies can, in fact, create leapfrogging opportunities for BRIC countries despite existing structural differences between BRIC and developed countries.

We propose that digital divide for mobile technology should be investigated using more diverse and detailed metrics. To this end, we argue that the most widely used digital divide metric, penetration, has to be analyzed through multiple lenses related to relevant

adopters – both at the individual and group adoption level. We also argue a second measure, mobile technology service variety, is useful in understanding the availability of mobile services that can become substitutes of more costly ICTs and thus lower digital divide. Focusing only on technology penetration is akin to studying the adoption of TV sets that only display one channel or of PC that run only one software application. What also counts, beyond the technology penetration level, is the variety of its possible uses.

Our results indicate that the mobile technology digital divide between BRIC and developed countries is rapidly narrowing when viewed through these two lenses, with some BRIC countries already equaling or exceeding mobile technology developments in many developed countries. Our analysis also suggests BRIC countries can leapfrog developed countries on mobile technology.

The paper is organized as follows. In the next section we review past research on digital divide on many ICTs and identify this literature's main assumptions, theoretical underpinnings and findings. Then we analyze the characteristics of mobile technology and their implications for digital divide research. We then theoretically justify a framework for measuring digital divide for mobile technology and present empirical evidence to support it. We conclude with a discussion of implications and future research directions.

DIGITAL DIVIDE – PAST RESEARCH

Digital divide research investigates the gaps in access to and use of ICTs between and within countries and regions. The most widely used metric for digital divide is ICT penetration, or adoption level (usually per capita or per GDP) (Dewan and Riggins 2005), measured for various generations of ICTs such as telephones – both fixed and mobile (Mariscal 2005; Rouvinen 2006), mainframes, PCs, or Internet users (Dewan et al. 2005).

As shown in Table 1, researchers have proposed ICT penetration differences across countries or regions can be explained by structural differences across countries (See Table 1). The most important structural differences are economic: the ability to pay for ICTs, such as GDP per capita and low technology costs such as low phone calls costs, positively impact ICT penetration (Dekimpe et al. 2000a; Dewan et al. 2005). Other structural factors positively related to ICT penetration include demographic factors related to the ability to learn about, access and evaluate ICTs (percentage of population living in urban areas, education, population homogeneity and concentration, and low death rates) (Dekimpe et al. 2000a; Dewan et al. 2005) and environmental factors related to the requisite technical infrastructure (such as the number of telephone land lines per capita) (Dewan et al. 2005; Kauffman and Techatassanasoontorn 2005; Rouvinen 2006) and business and political infrastructure (such as political and technology openness and market competition) (Crenshaw and Robison 2006; Mariscal 2005; Rouvinen 2006). Furthermore, penetration is positively influenced by the stability of mobile standards (Kauffman and Techatassanasoontorn 2005; Rouvinen 2006). A large installed user base and the associated network effects also contribute to higher penetration levels (Boretos In Press; Rouvinen 2006). Last, but not least, digital divide research recognizes that countries exist in a geo-political context that shapes the diffusion processes of ICTs across countries through the flow of goods, money and people between countries (Crenshaw and Robison 2006), regional contagion effects (Kauffman and Techatassanasoontorn 2005) and demonstration effects flowing from adopting countries to countries that are similar to them (Dekimpe et al. 2000a).

------ Include Table 1 here ------

Recent studies also provide encouraging insights about the narrowing of the divide: in developing countries, penetration of PCs, mainframes and the Internet is increasing at a higher rate (Dewan et al. 2005), and penetration of mobile technology is increasing at an equal (Rouvinen 2006) or possibly higher rate (Kauffman and Techatassanasoontorn 2005) with late adopters experiencing faster diffusion (Rouvinen 2006). However, all these studies assume that, apart from different structural variables and cross-country influences, no other differences exist between developed and developing countries.

Marketing research offers similar insights on the digital divide from studies of new product adoption and diffusion across countries. This research is mostly focused on the adoption of consumer durables (Hauser et al. 2006; Mahajan et al. 2000) and emphasizes the role of cross-country influences on new product adoption (Kumar and Krishnan 2002; Mahajan and Muller 1994). Furthermore, this research investigates only product penetration, mostly in developed countries. Few studies focus on the differences in diffusion processes across countries (Mahajan and Muller 1994). Instead, most studies do not differentiate between countries beyond country-level structural differences such as income, infrastructure and culture (Burgess and Steenkamp 2006; Mahajan et al. 2000). Global diffusion studies are also characterized by a proliferation of structural variables used to explain new product penetration (Dekimpe et al. 2000b).

In conclusion, the set of independent variables that capture cross-country differences and their operationalization varies across studies, even when they attempt to explain penetration of the same technologies, resulting in the proliferation of idiosyncratic, study-specific structural variables. Furthermore, while existing research is trying to explain differences across developed and developing countries, it makes the assumption that

individuals adopting the technology behave the same in both developed and developing countries. Clearly, a more in-depth understanding of differences among developed and developing countries is required to advance the study of this complex topic. We attempt to address these issues in the context of mobile technology in the next sections.

MOBILE TECHNOLOGY IN DEVELOPING COUNTRIES

Mobile technology (also called wireless or cellular) represents a new breed of fast-growing telecommunication technology that relies on wireless signals transmitted among cells (small geographic units) with the help of wireless towers rather than with costly wires or cables. The first generation (1G) of mobile technology, introduced in the 1980's, was only capable of supporting voice communication. Subsequent generations (2G, 3G) have provided increasing capabilities for digital voice and data transmission such as text messaging, e-mail access and web browsing, file downloads, streaming media, and a variety of stand-alone applications traditionally available only on Internet-connected PCs such as news, stocks and weather information, calendars, alerts, games, and the like (Ehrlich 2007; Kauffman and Techatassanasoontorn 2005; Penna 2007; Rouvinen 2006).

The number of mobile accounts is expected to grow worldwide from 1.7 billion in 2004 to around 2 billion in 2008, reflecting an overall worldwide penetration level of 29.2% (Boretos In Press) and dominating worldwide usage of telephony services (Rouvinen 2006). While growth in developed countries, especially in Western Europe, is slowing as these countries reach over 90% adoption levels, some of the most aggressive growth rates can be found in the developing world (Boretos In Press). Mobile phone accounts could reach over 100 million in India by 2008 (Knowledge@Wharton 2004),

over 500 million in China by 2008 (Boretos In Press), and 123 million in the Middle East and Africa by 2009 (Mahajan and Banga 2006).

Mobile technology reduces the cost of developing an ICT infrastructure, especially the traditionally high cost of last-mile connectivity for low-density, rural and remote areas (Bowonder and Boddu 2005; Galperin 2005). Because expensive, previously-built infrastructure (such as land lines or cable connections) and specific environmental conditions (such as proximity to urban centers or physical accessibility) are not required (Bowonder and Boddu 2005; Galperin 2005; Knowledge@Wharton 2004) as for other ICTs (Dewan et al. 2005), mobile technology can become more rapidly accessible to a larger share of a country's population. Recognizing their potential, governments in some developing countries are also aggressively investing in technological infrastructure, promoting intense competition for telecom providers (Kshetri and Cheung 2002) and encouraging the development of value-added services using this infrastructure. The cost of acquiring a mobile communication device – a mobile phone – is also significantly lower than the cost of investing in other, more advanced ICTs such as PCs and separate Internet access (Zhang and Prybutok 2005) , especially in some of the poorest regions of the world (Galperin 2005; Hodge 2005).

The lack of sunk costs, user resistance and path-dependency facilitates the introduction of a variety of mobile services for developing countries that could substitute the existing ICTs (Hamilton 2003) and compensate for the lack of high PC or Internet adoption rates (Knudsen 2007; Zhang and Prybutok 2005). As a result, digital divide for mobile technology may take a different shape than predicted by past research on other ICTs (Crenshaw and Robison 2006). While cross-country adoption of mobile technology

has been investigated before, few studies focus on specific differences between developed and developing countries (Kauffman and Techatassanasoontorn 2005; Rouvinen 2006). This suggests a need to develop a more in-depth framework for investigating the mobile digital divide between developing and developed countries. We present the development of such a framework in the next section.

A NEW FRAMEWORK FOR THE MOBILE TECHNOLOGY DIGITAL DIVIDE: MOBILE TECHNOLOGY DEPTH AND SERVICE BREADTH

To bring matters into focus, we develop a two-factor framework for measuring digital divide. We propose digital divide can be better understood by focusing on two distinct divide factors: *mobile technology depth* (which measures the level of adoption, or penetration, for mobile phones, or subscriber accounts) and *mobile technology service breadth* (which measures the variety of mobile technology services available for adoption). As the reader will shortly see, mobile technology depth and mobile technology service breadth paint two different pictures of digital divide, and should be considered together when trying to understand differences between developed and developing countries.

We define mobile technology *depth* as the penetration of mobile technology (irrespective of the technology provider or brand) in a given country. Depth is the metric of choice when measuring digital divide across countries (Dewan and Riggins 2005) and has traditionally been used in diffusion studies of many innovations across countries (Dekimpe et al. 2000b).

We define the mobile technology *service breadth* as the service variety, or number of different services (such as voice, messaging, news, informational services, banking and other transactional services, etc.) available to mobile phone users. Technologies such as

computers, the Internet and mobile phones are not single-purpose, but can be used for a variety of tasks depending on the needs and skills of users. By explicitly considering technology service breadth we can enrich the adoption-diffusion perspective that focuses on technology depth with a deeper understanding of the technology use variety (Ram and Jung 1990), and therefore its use-diffusion (Chuan-Fong Shih and Venkatesh 2004).

The growth of mobile technology depth and service breath in developing countries is encouraged by several factors: competition, service availability and handset developments. *First*, developing countries experience strong levels of competition among service providers, which is sometimes encouraged by government incentives or aggressive investment in infrastructure (Kshetri and Cheung 2002) and leads to higher mobile technology depth levels (Kauffman and Techatassanasoontorn 2005; Rouvinen 2006). *Second*, the competition among mobile service providers is a catalyst for offering value-added services on top of the basic mobile communication infrastructure (Kshetri and Cheung 2002). *Third,* the adoption of mobile phones and the development of a variety of mobile communication services in developing countries benefit from the introduction of low-cost mobile devices. These include a sub-$40 mobile phone that appeals to emerging markets (Limbach 2006), powerful and cheap mobile devices with computer-like capabilities, and add-ons that connect standard keyboards and TV monitors to mobile phones that can be thus used as simple computers ("Splitting the Digital Difference" 2006).

Mobile technology service breadth can also shed light on the availability of mobile technology as a substitute of other ICTs, such as fixed lines, computers or the Internet. For example, mobile messaging is popular in many developing countries in Asia and Africa and developed countries in Europe, but not in the USA, probably due to the wider

availability of PCs, Internet connections, and email and the incompatibilities among mobile communication networks in the USA (Knudsen 2007; Limbach 2006; Zhang and Prybutok 2005). Mobile technology is also adopted at higher rates in developing countries, becoming a substitute for fixed phone lines, which can only be installed with delays and at higher costs (Hamilton 2003; Hodge 2005). Thus, mobile technology service availability could lower digital divide in a way not captured by existing ICT depth measures.

Data and Methodology

To understand how emerging mobile communication technologies affect the digital divide between developed and BRIC countries we conduct a country-level case analysis, focusing on mobile technology depth and service breath in several countries in each group. Because detailed mobile technology service breadth data are only available for a small group of countries at present, we choose for our analysis a case-based method, which is well suited for understanding contemporary events such as the digital divide (Yin 1984).

We select relevant developed and developing countries using theoretical sampling (Yin 1984). For the developing countries group we select the four BRIC countries (Brazil, Russia, India, and China) identified in a 2003 Goldman Sachs report as the fastest growing emerging economies and the best candidates to surpass today's largest developed countries by 2050 (Goldman Sachs 2003). We select the BRIC countries as exemplary cases of mobile technology developments that can enhance our understanding on how mobile growth may successfully take shape in developing countries. Also, because BRIC countries represent 42% of the world's population and 49% of the developing world's population, they can provide a good indicator of mobile technology adoption for the developing world. We compare mobile technology developments in these countries with the ones in several

developed countries in Europe (France, Germany, United Kingdom, Spain), North America (USA, Canada), and Asia-Pacific (Australia, Japan, Korea Rep. – also known as South Korea or Korea for short, Hong Kong Special Administrative Region of China – also known as Hong Kong for short, and Singapore). We select USA, Japan, United Kingdom, Germany and France because, as the top 5 major industrialized economies in the world, they are in the comparison set for the BRIC countries (Goldman Sachs 2003). We also select Canada because it belongs to the Group of Eight (G8) countries that represent 65% of the world's economy (the only other G8 country is Russia, which is included in our developing countries list). The additional countries were selected for ensuring adequate coverage for each region of the world (Australia) and for including a lower-income developed country (Spain) that is also a later adopter of digital mobile technology, exhibits a higher growth rate in mobile technology adoption, and was omitted from some previous studies (Kauffman and Techatassanasoontorn 2005; Rouvinen 2006). Similarly, we choose Korea, Hong Kong, and Singapore to augment the Asia-Pacific group because they are at the forefront of mobile technology development and can also provide more diversity in income levels in the developed countries group, enabling a better comparison with the BRIC countries. Taken together, our group of developed countries represents 87% of the population living in the developed world and 12% of the world's population. Overall, the entire sample covers more than half of the world's population. Descriptive statistics for all countries are presented in Table 2.

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For each country, we collect data from the World Bank, International Telecommunications Union (ITU) and Gartner Research, as well as numerous news reports,

as described in detail in Table 3. Mobile technology depth is measured by dividing the number of mobile technology adopters in each country by that country's total and relevant population, as explained in detail in the next section. Mobile technology service breadth is measured through the ratio of mobile services available in each country to the number of total services offered worldwide, overall (for 34 services available worldwide) and in five service categories (voice, data, media, information, and transaction services categories), as described in Table 3. Our main analysis is based on 2005 mobile technology depth and service breadth data, since 2005 is the year for which a complete set of country and mobile technology variables is available. To analyze the 2005-2006 growth of mobile technology depth and service breadth, we estimate 2006 values of mobile technology depth based on 1996-2005 mobile subscriber data (Boretos In Press) and collect 2006 mobile technology service breadth data from 2006 breadth reports, as detailed in Table 3. To eliminate potential biases, we ensure triangulation by using multiple sources of information (such as reports and additional web searches) and multiple data coders (such as independent data collection by three research assistants and subsequent verification of all data points against original reports by one research assistant) (Yin 1984).

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Findings

Mobile technology depth analysis

The analysis of mobile technology depth data for our sample reveals that the BRIC countries have, on average, lower mobile technology depth levels (42%) than developed countries (88%) (See Table 2 and Figure 1). However, one BRIC country, Russia, has a similar mobile technology depth level (84%) as some developed countries (such as Japan

74%, France 79% and Korea 79%) and a higher level than a developed country such as Canada (51%). While the remaining BRIC countries have smaller mobile technology depth levels (Brazil 46%, China 30%, India 8%), their mobile technology depth is still higher than their fixed-line phone depth (Brazil 30%, China 27%, India 5%), indicating mobile technology is more accessible than older ICTs such as land lines.

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While today's mobile technology depth measures still show a significant digital divide between some developing and developed countries, several factors may contribute to an underestimation of the mobile technology depth in developing countries.

First, mobile technology depth in developing countries may be underestimated because this measure is computed relative to the total population of a country, rather than to the relevant population (the number of people who qualify as potential adopters) (Boretos In Press; Dekimpe et al. 2000b). According to some estimates, only 77% of the world population (namely working-age population) is a good candidate for becoming an individual adopter of mobile communication technology (Boretos In Press). For example, because 40% of Egypt's population is under the age of 10, mobile technology depth measures should look at the number of mobile adopters divided by 60% of the country's population, rather than the total population (Limbach 2006). Considering the number of mobile adopters relative to the working-age population (people ages 15-64) does significantly improve the mobile technology depth metric for all BRIC countries, as shown in Figure 1 (See Figure 1). Counting people who are too young and financially dependent on their parents as adopters can skew the mobile technology depth measures in favor of developed countries, which tend to have a more mature population (See Table 2).

Second, mobile technology depth may be underestimated because the timing of adoption differs among countries (Dekimpe et al. 2000a), making cross-sectional comparisons of mobile technology depth problematic as different countries are likely to be in different stages of their adoption curve (Dekimpe et al. 2000b). BRIC countries tend to adopt later than developed countries: For example, based on digital (2G) technology data (Rouvinen 2006), mobile technology was first adopted in most developed countries in our study (with France, Germany, UK and Hong Kong adopting in 1992, Australia, USA, Japan, and Singapore in 1993, Spain and Canada in 1995, and Korea in 1996) and only later in BRIC countries (with China and Russia adopting in 1994, India in 1995, and Brazil in 1996). Thus, BRIC countries benefit from a more stable technology and better standards already developed by the early adopters (Dekimpe et al. 2000a; Rouvinen 2006).

Third, developing countries also seem to adopt mobile technologies at a higher speed (Kauffman and Techatassanasoontorn 2005), consistent with the rapid growth stage of the adoption curve and their late entrant status (Rouvinen 2006). This is especially visible for the BRIC countries, which, at lower levels of current adoption, are growing rapidly. All BRIC countries have growth rates higher than the sample average, and higher than growth rates in any of the developed countries in our sample, as shown in Figure 2.

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This difference in growth rates reflects already high adoption levels and market saturation in developed countries, which are reaching the limits of their growth curves (Boretos In Press). In contrast, BRIC countries are at the beginning or rapid adoption level of their respective growth curves for mobile technology depth, as illustrated in Figure 3. If their adoption pattern matches the usual S-shaped adoption curve (Mahajan et al. 2000), all

BRIC countries and especially China and Brazil are poised for exponential growth in the next few years.

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Fourth, this rapid pace of adoption of mobile technology is encouraging rapid GDP growth in BRIC countries. Researchers estimate GDP grows in developing countries adopting mobile technology at twice the rate of developed countries, yielding a 0.6% increase in GDP for every additional 10 mobile telephones per 100 people in a typical developing country (Waverman et al. 2005). Mobile industry analysts argue that mobile technology impacts on GDP come not only from mobile operator profits, but also from profits of auxiliary players such as handset manufacturers and content providers, and from additional end-user value estimated to be as much as $37billion in China and $4.7 billion in India based on 2005 figures (Enriquez et al. 2007). These increases are likely to translate in an increased future buying power, further supporting the rapid growth predictions of mobile technology in developing countries.

Fifth, the age distribution difference between developing and developed countries, as illustrated in Table 2, is also likely to contribute to further rapid adoption of mobile technology. As children in developing countries become teenagers and young adults, in charge of their own finances and technology choices, they may be more likely than their older parents to adopt new technologies such as mobile communications or act as a source of social influence for older adults in the home (Kiesler et al. 2000).

Last, but not least, mobile technology depth in developing countries may be underestimated because this measure considers individual adoption, rather than household or group adoption, which may be more prevalent in developing countries (Kauffman and

Techatassanasoontorn 2005; Mahajan and Banga 2006). Even in developed countries context, scholars have started to recognize that ICTs such as PCs and the Internet are jointly adopted and used in households, rather than individually by users. As a result, household, rather than individual, characteristics impact how technology is evaluated, adopted and used (Brown and Venkatesh 2005). In addition, teenagers, who may be exposed to mobile technology earlier than they parents, are a source of social influences that can further fuel household adoption of mobile technology (Kiesler et al. 2000). In developing countries, the pattern of social influence could flow from the head of household to household employees, or from trusted village leaders to others in the community, who may view the mobile technology as a status symbol (Mahajan and Banga 2006). As in the case of Internet demand pooling through Internet cafes, one mobile device can also be shared among many users as demand is pooled, for example when a local entrepreneur rents one mobile phone to others on a transaction (or call) basis ("Calling an End to Poverty" 2005; "Splitting the Digital Difference" 2006; Jordan 1999; Mahajan and Banga 2006; Rash 2007).

Mobile technology service breadth analysis

The mobile technology service breadth is similar[3] in the two country groups: BRIC countries have access to 68% of all possible mobile services, while developed countries in our comparison group have access to 74% of all mobile services, as shown in Table 2. Within the BRIC country group, India exhibits the highest level of mobile breath, 94%, which is also higher than levels found in all other developed countries - only Japan and

[3] A nonparametric Kruskal-Wallis test (recommended for comparison of means in small samples) indicates no significant differences exist between developed and BRIC countries in terms of overall breadth or individual breadth categories.

Korea come in close, with a 91% mobile technology service breadth level. China's mobile technology service breadth level is, at 79%, higher than the average for the developed countries as well. From a mobile service variety perspective, China ranks as high as Australia and the United Kingdom, and higher than the United States, France, Canada, and Hong Kong. An even though Brazil has a lower variety of mobile services (59%), it still offers more services than developed countries such as France and the USA. Only Russia has a mobile technology service breadth lower than any other country in our analysis.

As Figure 4 shows, a detailed analysis can provide more insights into mobile service developments for each country within each of the five information services categories: voice services, data services, media services, transaction services and information services. In 2005, most countries have basic voice services such as caller id and voicemail (see Figure 4). India and China offer 100% of services, their voice service breadth being higher than that of some developed countries. Brazil and Russia and developed countries such as France, Germany, UK and the USA are lacking voice services (such as conferencing, call blocking, or personalization) beyond basic communication.

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Interestingly, BRIC countries have higher data services breadth in 2005, with India and China again offering 100% of all available business services, while some developed countries (USA, HK, and France) were still lacking some data services such as business access and fax (USA only) (See Figure 4). Thus, BRIC countries have a slightly higher data services level (95%) than developed countries (93%). One widely used data service across all countries seems to be text messaging, which is adapted to each country's culture. For example, 15.2 billion holiday messages were sent for Chinese New Year alone (Yuan

2007). And in Japan, a 1,300-year old form of traditional poetry is composed and exchanged on cell phones (Dvorak 2005).

BRIC countries also show a high media services breadth (70%), close to the level exhibited by developed countries (84%) (See Figure 4). No gaps can be identified between developed and BRIC countries in terms of entertainment (such as music and audio downloads) and images (such as photo and image files) services. BRIC countries offer less games and humor services. BRIC countries have a 75% video services breadth average (all but Russia offer video services). This exceeds the 73% video services breadth in developed countries (where these services are not yet available in 2005 in France, UK or USA). Therefore, while BRIC countries have somewhat lower overall media services levels they equal and even leapfrog developed countries on some service components.

Transaction services follow a similar pattern, with Brazil, India and China leading with 100% transaction services breadth in 2005, while Russia and developed countries such as Canada, France and USA offered no transaction services (See Figure 4). Thus, BRIC countries have, individually and on average, higher levels of transaction services breadth (75%) than developed countries (50%) This finding is consistent with reports that developing countries are experiencing a higher use of financial applications such as cash withdrawals, payments, and money and airtime credit transfers (Foster 2007) than developed countries, where such services are performed using traditional banking channels.

Our research also indicates a slight gap between the two country groups for information services (See Figure 4). On average, BRIC countries have a 52% information services breadth, while developed countries have a 55% breadth. India and China have the most information services in 2005 (86% and 64%, respectively), and India's information

services breadth is higher than that of most developed countries. Services still lacking from both BRIC and developed countries in 2005 include directory and emergency assistance, as well as betting, organization and in some cases advertising, lifestyle, and weather and traffic information. Among developed countries, USA, France and Canada have the lowest information services breadth, and all developed countries lack at least some information services. BRIC countries have, on average, higher information services breadth for directions, general news, specialized financial news, advertising, and travel information. Unlike developed countries, some BRIC countries have information services targeted to specific population segments. For example, China Mobile offers news and sports information services to the general population and specific information services on farming best practices and crop prices to farmers (Roberts 2007).

Taken together, these results indicate that mobile technology services breadth in BRIC countries almost equals, and in some cases exceeds, the variety of mobile services in developed countries. In 2005, BRIC countries have higher mobile technology services breadth than developed countries for data, transaction, and media services, as well as for several information services (directions, general and financial news, advertising, and travel information). Clearly, the mobile technology services breadth measure indicates the digital divide between BRIC and developed countries does not exist for most mobile technology services, and is even reversed in favor of BRIC countries for some services. This finding adds to the picture of digital divide obtained from studying mobile technology depth.

DISCUSSION

Our theoretical review and data analysis for BRIC and developed countries shows that digital divide looks differently when viewed with our dual metrics. As shown in

Figure 5, while developing countries have lower levels of mobile technology depth, they have similar or higher levels of mobile technology service breadth. While India leads all and China and Brazil lead several developed countries on mobile technology service breadth, Russia leads several developed countries on mobile technology depth. Instead of being stuck in the lower-left quadrant of the depth-breadth matrix, BRIC countries are closer to developed countries than their structural characteristics would predict.

------ Include Figure 5 here ------

The geographical distribution of mobile technology depth and service breadth dimensions, illustrated in Figure 6, provides additional insights on the global diffusion of mobile technology. Russia has similar mobile technology depth levels as Western European countries, well ahead of other regions of the world. India and China are leaders in mobile technology breadth, together with some Western European countries and Australia, while Brazil is in the same mobile technology service breadth category as Canada, ahead of other developed countries, including USA.

------ Include Figure 6 here ------

An even more striking picture of leapfrogging by BRIC countries can be obtained by analyzing the geographical distribution of mobile technology service breadth in each one of the five service categories: voice, data, transaction, information and media services (See Figure 7). The digital divide mostly disappears for voice and data services, with similar levels of service available all over the world. India and China are worldwide leaders in transaction services availability, with Russia and Brazil close behind. Similarly, Brazil and India are among the leaders in media services availability, and India is among the few countries leading in information services availability. Thus, instead of showing the

gap predicted by existing digital divide studies, our analysis of mobile technology service breadth provides evidence of BRIC countries leapfrogging, overall and in most of the five mobile technology service categories.

------ Include Figure 7 here ------

Clearly, as Figure 6 and 7 show, the mobile digital divide between developed and BRIC countries still exists when we consider mobile technology depth, but it narrows and disappears when we look at mobile technology service breadth.

Our analysis also suggests BRIC countries evolve over time towards higher levels of mobile technology depth and service breadth (See Figure 8). When considering the evolution of mobile technology depth and service breadth from 2005 to 2006, all BRIC countries show an increase along at least one dimension. Some, like China and India, seem to focus first on achieving sufficient mobile technology service breadth levels that can then fuel their depth growth. Others, like Russia and Brazil, are characterized by rapid growth of both mobile technology depth and service breadth (See Figure 8). This suggests that BRIC countries experience significant growth in mobile technology over time, but not all of them follow the same growth pattern. Thus, considering both mobile technology depth and service breadth provides a more complete picture into how growth happens, and a better understanding of the mobile technology adoption dynamics in each country.

------ Include Figure 8 here ------

It is also interesting to note that GNI per capita (and similarly GDP per capita) is significantly and positively correlated with mobile technology depth levels for our entire sample ($p=0.05$), as expected based on previous digital divide research. GNI per capita is not correlated with mobile technology service breadth overall but it is strongly and

negatively correlated with this measure for the BRIC countries group only. These results need to be interpreted with caution due to the small sample, and should be tested in larger samples as more mobile technology services data becomes available. However, they suggest the highest mobile technology services breadth may be found in poorer countries – possibly because BRIC countries view mobile technology service breadth differently, as a way to leapfrog without investing in more expensive ICTs to offer similar services. Despite the small sample, these results provide a glimpse of the potential future where developing countries could break free from the path-dependency of low income, infrastructure and education levels and leapfrog with mobile technology.

As more data on mobile technology services breadth becomes available in the next few years, future research should study mobile technology depth and service breadth in regions that show significant development potential in Asia, Eastern Europe, and Africa. In addition, longitudinal analyses could shed more light on the rate of mobile technology depth and service breadth growth in both developed and developing countries. We measure mobile technology service breadth using the only available source at present: country-level reports on mobile service availability, rather than actual usage. Future research should investigate the possibility of collecting more granular data by interviewing individuals or contacting mobile operators regarding mobile service use variety.

IMPLICATIONS AND CONCLUSIONS

This paper suggests that looking at technology penetration alone is misleading. While rapidly growing in terms of mobile technology depth and sometimes equaling developed countries, BRIC countries appear to lead in mobile technology service breadth through innovation and responsiveness, and through the introduction of a greater number

of mobile services than some developed countries. We discuss the implications of these findings in the next sections.

Implications for Research

Our paper has several important implications for international marketing, innovation adoption and diffusion, and digital divide research.

For international marketing, this research suggests a change in the developed-country-centric paradigms regarding marketing and new product development. (Burgess and Steenkamp 2006). Future research should focus not only on different demographics and incomes, but also on emerging research challenges such as different value definitions and consumer behavior patterns (Burgess and Steenkamp 2006), resulting in different growth patterns across countries (Hauser et al. 2006; Mahajan and Muller 1994). For example, our research suggests that users in different countries place different valuations on bundles of mobile technology hardware and services. While developed countries place a great emphasis on state-of-the-art devices, BRIC countries achieve rapid growth with lower-cost, less-sophisticated devices bundled with the right services for their target markets. Future research can investigate if the diffusion patterns in BRIC countries can be replicated in other developing countries through cross-country interaction (Dekimpe et al. 2000a; Hauser et al. 2006). Additional research is also needed to understand how differences related to incomes and living standards within countries (Burgess and Steenkamp 2006) affect mobile operators' new product development and introduction strategies for both handsets and services. In addition, technology adopters in developing countries may exhibit unique product and service use behaviors such as communicating through free short ring tones or "beeps" (rather than completing a costly call), or buying

only the less expensive mobile phone SIM card (which stores one's personal information) while sharing the more expensive handset among several individuals. Studying these "lead users" from BRIC countries can offer insights on the possible range of consumer behaviors and on adoption differences across countries (Hauser et al. 2006).

For innovation research (Rogers 1995), our paper suggests a paradigm shift into the definition of adoption. We argue technology adoption should be measured not only in terms of depth, but also service breadth in order to capture the evolution of value-added services offered on a certain technology platform. We also suggest the definition of the adoption unit – the individual in existing research - should be revisited in order to include shared usage of technology in groups and social networks, as it occurs for households, villages, or small entrepreneurs that resell technology on an individual transaction basis.

For digital divide research (Dewan and Riggins 2005), our findings suggest we cannot assume technologies available in developed countries cannot be useful for or desirable to poor people. In fact, developing countries adopt these technologies at increased speed, and in innovative ways that support economic growth and further fuel technology adoption levels. Our finding that developing countries leapfrog on mobile technology service breadth also brings up unanswered research questions. As mobile technology service breath increases, will mobile technology become a substitute of other higher-cost ICTs such as computers and computer-based Internet connections (as growing evidence seems to suggest), or a complement (as existing research has assumed)? The framework we propose in this paper could also be extended to the study of digital divide for other complementary ICTs, such as hardware and software applications.

Implications For Business

Product and Service Innovations. As mobile phones are adopted at high rates in developing countries, mobile operators around the world are working together to develop innovative mobile handsets and services geared towards the specific needs and constraints of developing countries (Ehrlich 2007), such as pre-paid cards as low as 35 cents and handsets under $30 (Foster 2007). Large handset manufacturers, such as Motorola, are also introducing innovative mobile devices designed specifically for developing countries, such as China (where finger-writing recognition makes text messaging using Chinese characters possible) and India (where high illiteracy rates demand icon-based browsers) (Sellers 2006). Mobile operators in BRIC countries seem to view expanding mobile technology service breadth as an important growth strategy, designed to bring in new adopters who do not have access to alternative channels for obtaining such services. For example, China Mobile expects to more than double its 2006 revenues of $10.4 billion from media and information services (Roberts 2007).

Our research supports developments in mobile technology depth and service breadth and suggests several other possible avenues for future product and service innovations in developing countries. Mobile operators and content companies could, for example, develop multi-functional handsets and added-value services that replicate, at a lower cost, the type of information services available on costlier ICTs such as PCs. Another opportunity is to develop more location-based services adapted to local country or region needs. Mobile phones could also serve as the basis for a low-cost electronic banking and payment network and enable financing options (such as store credit) and store promotions (such as coupons).

Technology Transfer. Mobile technology and service providers can also benefit by transferring their mobile technology and service innovations to other developing countries and even to developed countries. Increasingly, developing countries are able to innovate in diverse areas such as power generation, pharmaceuticals, cars, healthcare, water distillation or stem cell therapies (Mahajan and Banga 2006). For example, Renault has developed a low-cost car now produced and profitably sold in Romania, Russia, Morocco and Colombia, which it will further introduce to India, Iran and Brazil (Reed 2007). Brazilian aircraft manufacturer Embraer (see http://www.embraer.com/) has successfully exported its commercial and executive jets worldwide, including to the U.S. market. And on the services side, anti-virus software built by a small developing country company, GeCAD of Romania, ranks first in the world, above security software packages offered by firms in developed countries ("Why Security Software Is Increasingly Labeled 'Made in Romania' " 2006).

Such innovation transfers can introduce paradigm shifts into these new markets that firms can further exploit to gain competitive advantage through lower prices, innovative value-added services, and alternative infrastructures that were first tested in developing markets. For example, as companies find solutions to the unique problems of the 86% of the world (younger audiences, smaller homes or harsh environmental conditions), developed countries are also likely to benefit from their advances in technology convergence, product reliability and service variety (Mahajan and Banga 2006).

Investing. Our results provide support for the financial markets' enthusiasm for mobile communication in the BRIC countries that has rewarded mobile operators in these countries with huge market capitalizations. For example, at the end of 2006 China Mobile

became the largest mobile communications company in the world, with over 300 million subscribers and a market capitalization of $198 billion (Roberts 2007). In India, a 67% controlling stake into the 4th largest mobile operator in the country was recently valued at $11 billion ("Britain's Vodafone, India's Essar to Jointly Run Mobile Operator" 2007), while a mobile start-up in what is becoming a crowded market is expected to raise close to $500 million in its upcoming IPO ("Idea IPO Rides on India Telecom Boom" 2007). While China and India are clearly the leaders in terms of both investments and market potential, we expect more developing countries to achieve increasingly higher levels of mobile technology depth and service breadth and attract similar investor interest.

Implications for Policy Making

Our analysis of mobile communication technology indicates developing countries can indeed leapfrog developed countries on mobile technology service breadth (by providing innovative mobile services) and innovate ahead of developed countries (by developing low-cost mobile handsets). The mobile technology service breadth in developing countries may also lower the need for at least some, if not all, higher-cost ICTs such as PCs. It is also possible that emerging technologies such as mobile communication and Internet kiosks, together with business practices such as microfinance and door-to-door selling on credit, will enable rapid economic growth even in the poorest areas of the world ("The Real Digital Divide" 2005; Beshouri 2006; Ehrlich 2007; Hempel 2007; Waverman et al. 2005). This could lead to a new kind of development in poor regions – one that does not need to rely on large amounts of aid. In light of some experts' opinions that the West's aid policy for the developing world has largely failed (Easterly 2007), mobile technologies and other emerging technologies and business practices appear well

positioned for supporting the kind of locally-built, ground-level development solutions that are called for in developing countries. This suggests public policy makers in developing countries as well as international institutions such as the World Bank or the International Monetary Fund should support and encourage investments in technologies with leapfrog potential.

The discussion of what role public policy should play in mobile technology development can also be helped by obtaining more data about both mobile technology depth and service breadth developments and outcomes. Mobile technology depth data should be collected not only at the individual, but also at the group level, by investigating adoption by groups such as households and villages as well as other forms of shared adoption such as re-selling of mobile minutes for individual calls by small entrepreneurs. Mobile technology data collection should include the adoption of various mobile services, not just that of handsets or provider contracts. These data can inform public policy decisions for promoting mobile technology growth for both basic communication and value-added services in order to reduce digital divide.

Conclusions

Previous research has found that developing countries have lower technology adoption levels than developed countries, a finding termed digital divide. In this paper, we argue that the digital divide discussion needs to be revisited in order to provide a different, more accurate lens that in previous research. Instead of assuming a single one-dimensional divide measure correlated with cross-country structural differences that are slow to overcome (such as income, infrastructure and education levels), we propose researchers should focus on both the depth and the service breath of mobile technology adoption.

Analyzing these multiple measures shows that BRIC and possibly other developing countries can leapfrog on digital divide measures with new technologies such as mobile communications. We find little evidence of a digital divide in terms of mobile technology service breadth, with one BRIC country (India) ranking first and other BRIC countries leapfrogging with innovative mobile services. We observe the fast narrowing of the mobile technology depth gap and a high mobile technology depth level for at least one BRIC country (Russia). We also identify factors that can contribute to the under-estimation of mobile technology depth.

We offer the example of BRIC countries as front-runners for mobile technology adoption in the developing world. The mobile communication technology lessons of the BRIC countries can be further diffused to other developing countries in several ways. For example, mobile adoption in other developing countries may be encouraged by potential "demonstration effects" (Dekimpe et al. 2000a), external contacts (Kumar and Krishnan 2002) and regional contagion (Kauffman and Techatassanasoontorn 2005) generated by previous BRIC countries adoption. BRIC firms could also invest in other developing countries and transfer their mobile technology depth and service breadth know-how.

Our research suggests that developing countries can break free from technology path-dependency and leapfrog with mobile technology, creating the infrastructure required for tomorrow's mobile technology-enabled products and services. We expect that, as mobile phones and embedded wireless devices begin to play a central role in the lives of individuals all over the world ("A World of Connections" 2007; Knudsen 2007), BRIC and other developing countries will take advantage of and improve upon these emerging ICT paradigms.

Study	Technology	Context	Digital Divide Research Findings
(Dekimpe et al. 1998).	Mobile	Across 184 developed and developing countries	Diffusion of technology is associated with high economic development, population homogeneity, and low death rates.
(Dekimpe et al. 2000a)	Mobile	Across 184 developed and developing countries	Countries with homogenous and concentrated populations and high economic development adopt technology earlier. Countries are more likely to adopt as the number of similar countries that have adopted the technology increases ("demonstration effect").
(Dewan et al. 2005).	Mainframes, PCs, Internet	Across 22 developed, and 18 developing countries	Digital divide exists due to the path-dependency of ICTs, which require a strong economy and sufficient levels of infrastructure, education and political development for widespread adoption.
(Kauffman and Techatassanasoontorn 2005)	Mobile	Across 43 developed and developing countries	Penetration is associated with telecom infrastructure, standards, and competition, as well as cross-country contagion due to geographical proximity to other adopting countries
(Mariscal 2005)	Fixed line telephony Mobile	Developing country (Mexico)	Observed digital divide for fixed and mobile phone services in a developing country is higher than predicted by an economic market perspective (which encourages economic growth and regulatory policies). Narrowing the divide may require a social capital, or community-based approach to universal access.
(Rouvinen 2006)	Mobile	Across 75 developed and 90 developing countries	Diffusion is encouraged by market competition and slowed by standards competition. A large potential user base, network effects, openness, technological level, and complementary innovations are more important for diffusion in developing countries. Late adopters experience faster diffusion.
(Crenshaw and Robison 2006)	Internet	Across 58 developing countries	Structural characteristics such as infrastructure (fixed line telephones) and institutional environment (service sector employment, political openness, urban concentration) and globalization characteristics such as economic globalization (foreign direct investment, trade, and aid) and social globalization (tourist arrivals) impact Internet adoption in developing countries.
(Boretos In Press)	Mobile	Across regions (Worldwide, Europe, China)	Mobile technology will reach 29.2% adoption level worldwide by 2008, with GSM likely to remain the leading mobile technology. Europe has already reached adoption peak. The number of mobile subscribers in China will be at least 500 million by 2008.

Table 1.
A summary of digital divide studies

Region	Country	Develop-ment stage[1]	GNI per capita (current US$)	GDP per capita (current US$)	GDP growth (annual %)	Popula-tion total (mil)	Popula-tion growth (annual %)	Popula-tion ages 0-14 (% total)	Fixed lines depth - (% total pop.)	Mobile tech. depth (% total pop.)	Mobile tech. service breadth (% all serv.)	Mobile tech. depth growth (2000-2005 CAGR)
North America	USA	Developed	43,740.00	42,007.46	3.50%	296.50	0.96%	20.94%	66.40%	67.62%	44.12%	16.20%
	Canada	Developed	32,600.00	34,557.62	2.90%	32.27	0.92%	17.92%	56.63%	51.44%	64.71%	16.70%
Europe	France	Developed	34,810.00	34,739.78	1.50%	60.74	0.60%	18.24%	58.72%	79.44%	47.06%	15.80%
	Germany	Developed	34,580.00	33,725.99	0.90%	82.49	-0.04%	14.55%	66.72%	95.78%	76.47%	24.90%
	Spain	Developed	25,360.00	25,898.31	3.40%	43.39	1.62%	14.30%	42.20%	96.81%	88.24%	20.80%
	UK	Developed	37,600.00	36,419.57	1.80%	60.20	0.56%	18.18%	56.10%	102.16%	79.41%	17.60%
Asia-Pacific	Australia	Developed	32,220.00	34,480.34	2.60%	20.32	1.04%	19.95%	56.51%	91.39%	79.41%	21.10%
	Japan	Developed	38,980.00	35,214.54	2.70%	127.96	0.15%	14.08%	45.96%	73.97%	91.18%	10.00%
	Singapore	Developed	27,490.00	26,833.59	6.38%	4.35	2.59%	20.17%	42.37%	103.41%	85.29%	19.60%
	Hong Kong	Developed	27,670.00	25,595.08	7.27%	6.94	0.88%	14.80%	54.69%	123.47%	70.59%	14.00%
	Korea (Rep.)	Developed	15,830.00	16,308.90	3.96%	48.29	0.44%	19.08%	49.07%	79.39%	91.18%	9.30%
BRIC	Brazil	Developing	3,460.00	4,260.07	2.30%	186.40	1.35%	28.13%	29.82%	46.25%	58.82%	34.30%
	Russia	Developing	4,460.00	5,335.05	6.40%	143.15	-0.49%	15.67%	27.94%	83.62%	38.24%	121.90%
	India	Developing	720.00	717.60	8.53%	1094.58	1.37%	32.49%	4.55%	8.16%	94.12%	90.50%
	China	Developing	1,740.00	1,708.59	9.90%	1304.50	0.64%	22.04%	26.85%	29.90%	79.41%	50.50%
Averages		*Developed*	*31,898*	*31,435*	*3.36%*	*71.22*	*0.88%*	*17.47%*	*54.12%*	*87.72%*	*74.33%*	*16.91%*
		BRIC	*2,595*	*3,005*	*6.78%*	*682.16*	*0.72%*	*24.58%*	*22.29%*	*41.98%*	*67.65%*	*74.30%*
Statistically significant differences between developed and BRIC countries?[2]							*No*	*Yes**	*Yes***	*Yes**	*No*	*Yes***

Table 2.
Countries included in the study (based on 2005 data)
(1) *Country classification based on gross national income (GNI) per capita (developed: over $10,000; developing: $10,000 or less)*
*(2)Statistical significance (Kruskal-Wallis nonparametric test): *=0.05 **=0.01 ***=0.001*

Source	Description
World Bank	Descriptive data on each country (the most recent available data: 2005 for GDP and total population, and 2004 for population age distribution)
International Telecommunica-tions Union (ITU):	Mobile subscriber reports, 1996-2005 (number of adopters for both mobile and fixed-line phones and their respective growth rates over time)
Gartner Research:	Mobile service lists, service categories, and service levels for 2005 and 2006 (Gartner Research reports collect data about over 200 major mobile operators and vendors worldwide through a combination of interviews, end-user surveys and from industry, government and trade associations published data). The collection procedures were as follows: (1) All possible mobile services were identified from Gartner reports by the authors, analyzed in depth by three research assistants in order to ensure accurately captures all possible services across countries over time, resulting in 34 mobile services that were grouped in five service categories reflecting the major functionality provided by mobile communication technology: • Voice Services (8 services: caller id, call waiting, call forwarding, call blocking, conference calling, roaming, ring tone personalization and voicemail) • Data Services (5 services: fax, messaging, email, general web access, and business access through a private network/VPN/Intranet) • Media Services (5 services: games, entertainment such as music and other audio entertainment, photos, video, and humor such as jokes and animation) • Information Services (14 services: entertainment information, directory services, emergency services, location and navigation services, general news, advertising, financial information, personal organization information such as appointments and calendars, travel information, sports news, lifestyle information, gambling information, weather information and traffic alerts) • Transaction Services (2 services: banking transactions, shopping transactions). (2) Three research assistants collected the data on mobile service levels in each country on mobile and wireless technologies for 2005 and 2006. The data was double-checked by one research assistant against the same reports. The assistant also checked the mobile service levels for 2006 against the results of extensive online searches of service providers and industry news websites conducted during 2006 for each country in the data set, confirming all services obtained from the Gartner reports analysis and adding information obtained from the web as needed. Only 7% of the 2006 data on mobile services were newly obtained using these web searches.
Public reports	Extensive database of major newspapers and business magazines news reports related to mobile communications developments worldwide and in the countries in the data set.
Estimation	Mobile technology depth values for 2006 and beyond were unavailable and were therefore estimated by using SPSS 14.0 statistical analysis software to fit the 1996-2005 mobile subscriber data from ITU to logistic growth curves (Boretos In Press) for all countries in the data set (resulting in a 97.9% overall fit), as described in Equation (1) (See Equation (1)). (1) $\text{Depth}_t = \frac{L}{1+ce^{at}}$, *where L = limiting population and t is the time*

Table 3.
Data sources and data collection methodology description

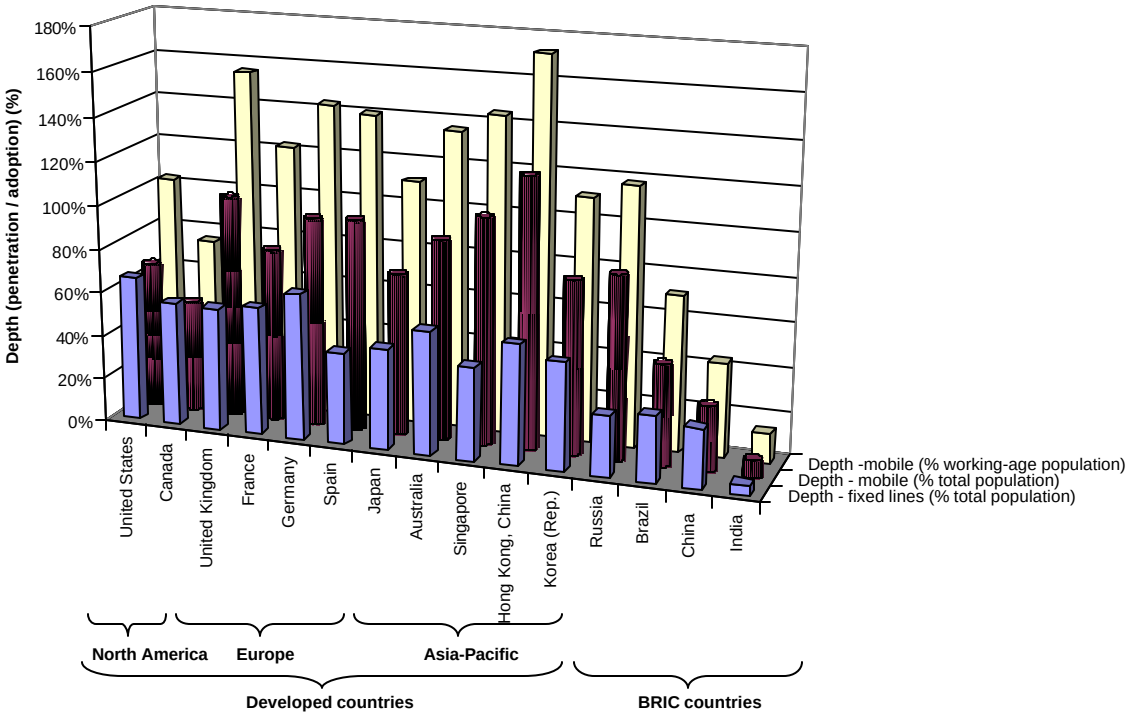

Figure 1.
Mobile and fixed line technology depth in developed and BRIC countries

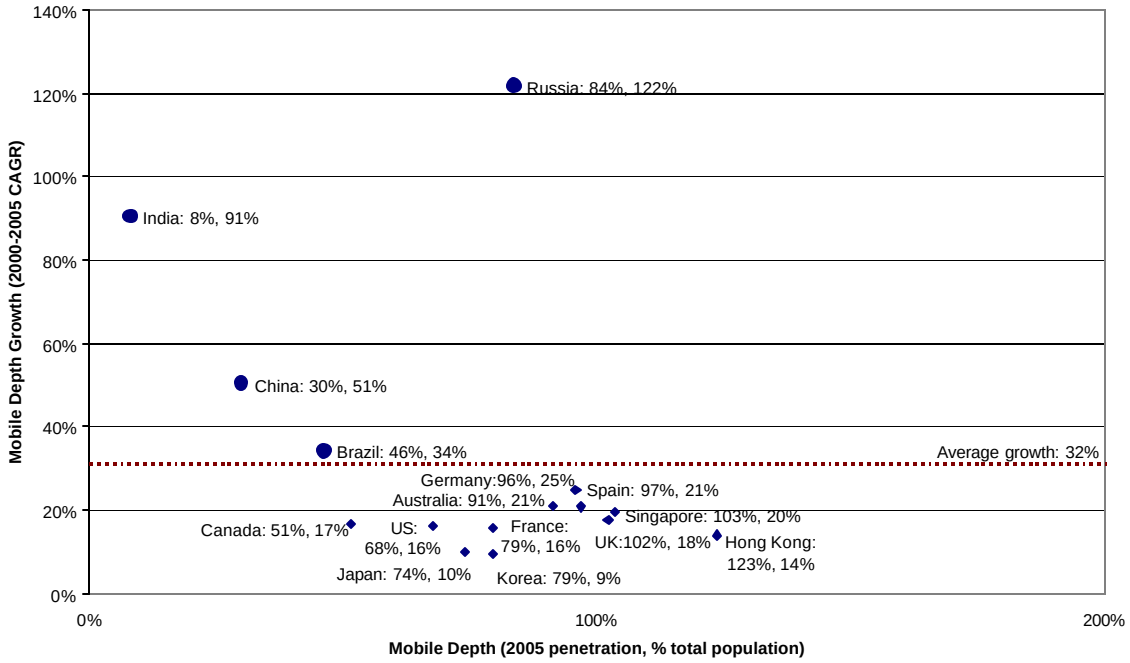

Figure 2.
Mobile technology depth: Current levels and growth rates in developed and BRIC countries(*)
(*) Data points indicate the country name and the percentages for mobile technology depth level and growth

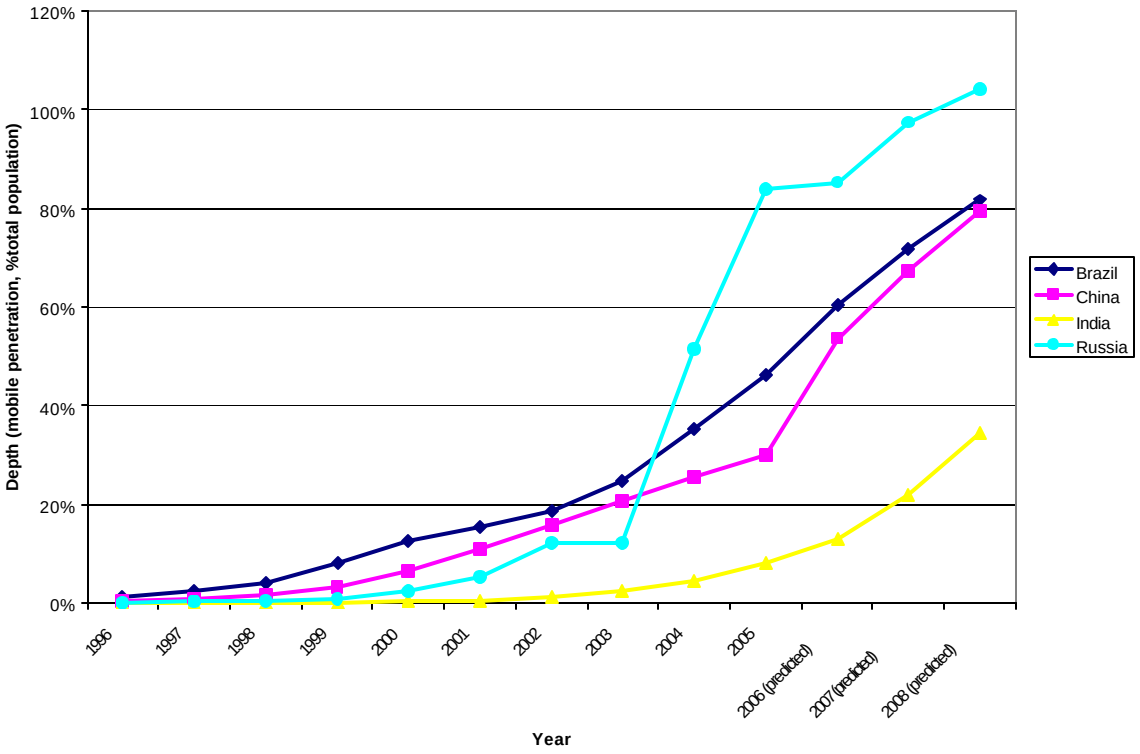

Figure 3.
Mobile technology depth growth in BRIC countries(*)
(*) 2006-2008 figures are estimated as described in Table 3.

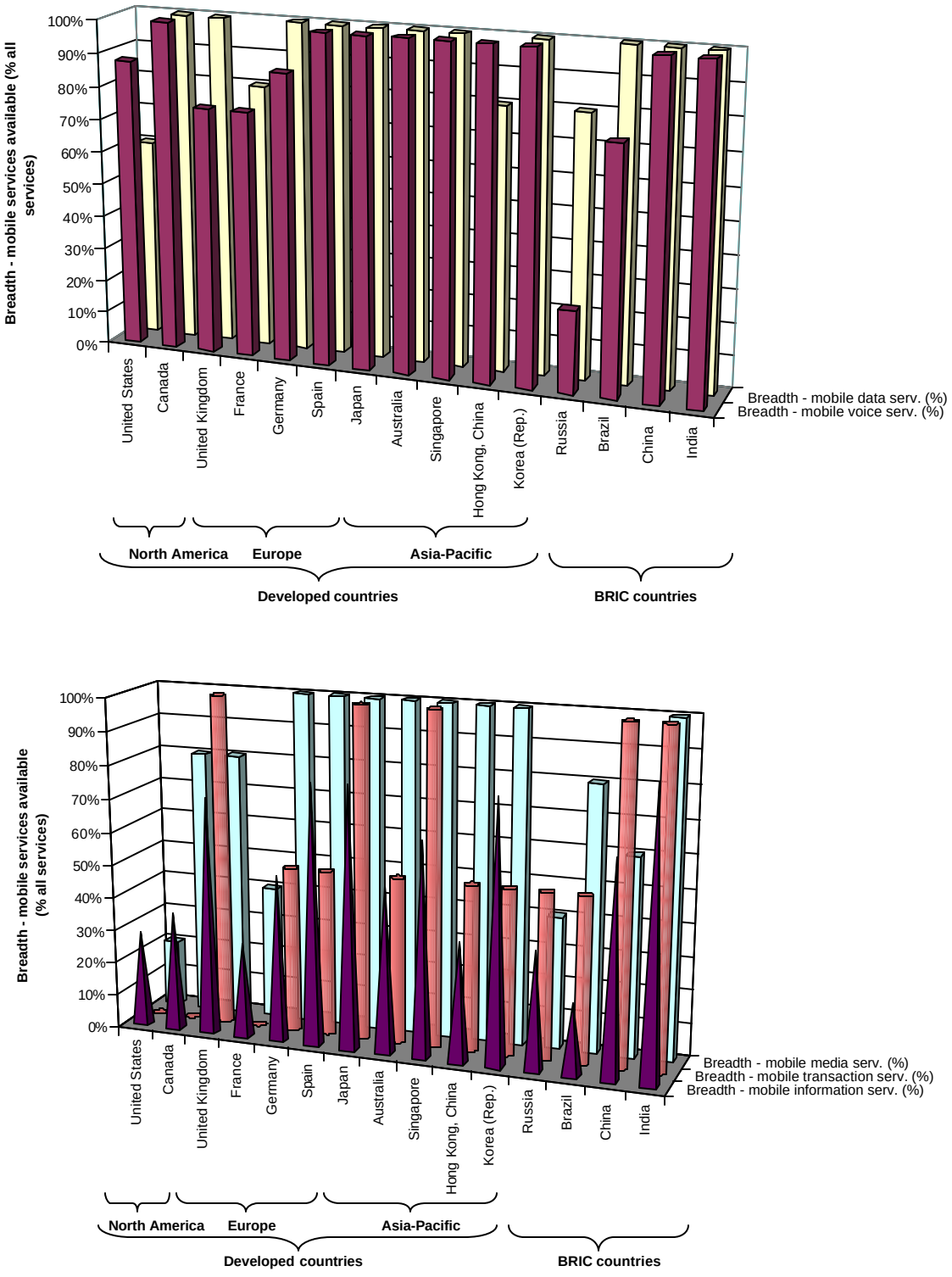

Figure 4.
Mobile technology service breadth in developed and BRIC countries

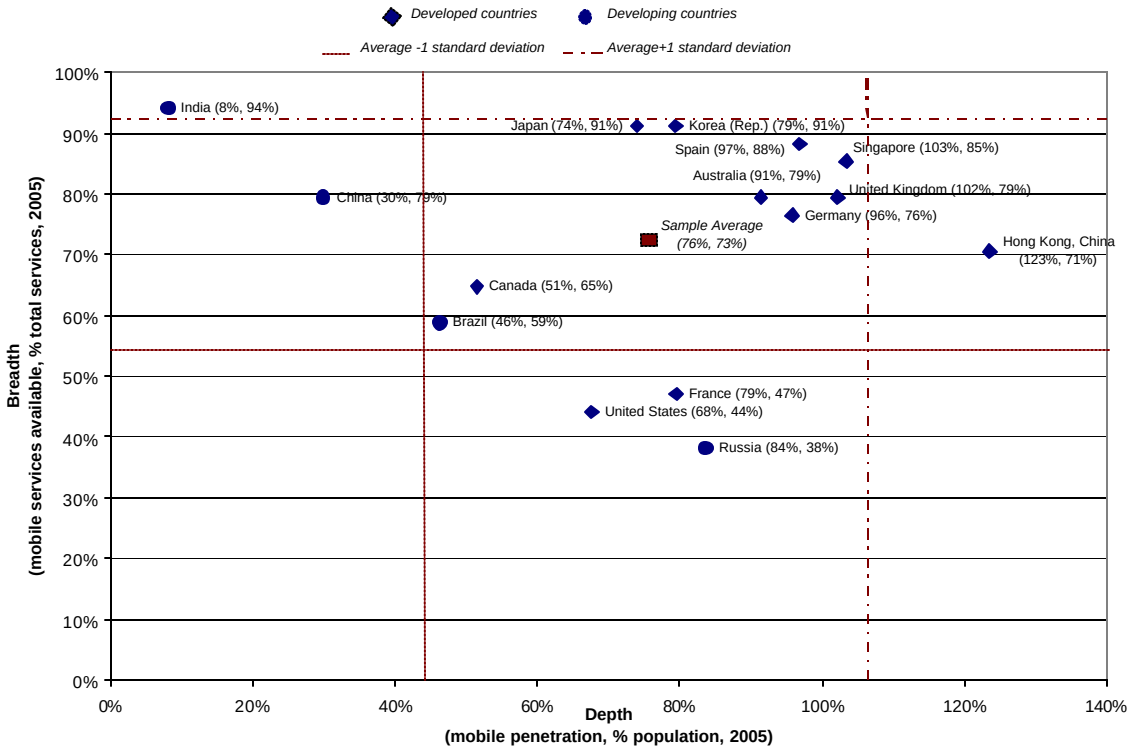

Figure 5.
Understanding digital divide along mobile technology depth and service breadth dimensions(*)

(*) Data point labels indicate the country name and the mobile technology depth and service breadth percentages

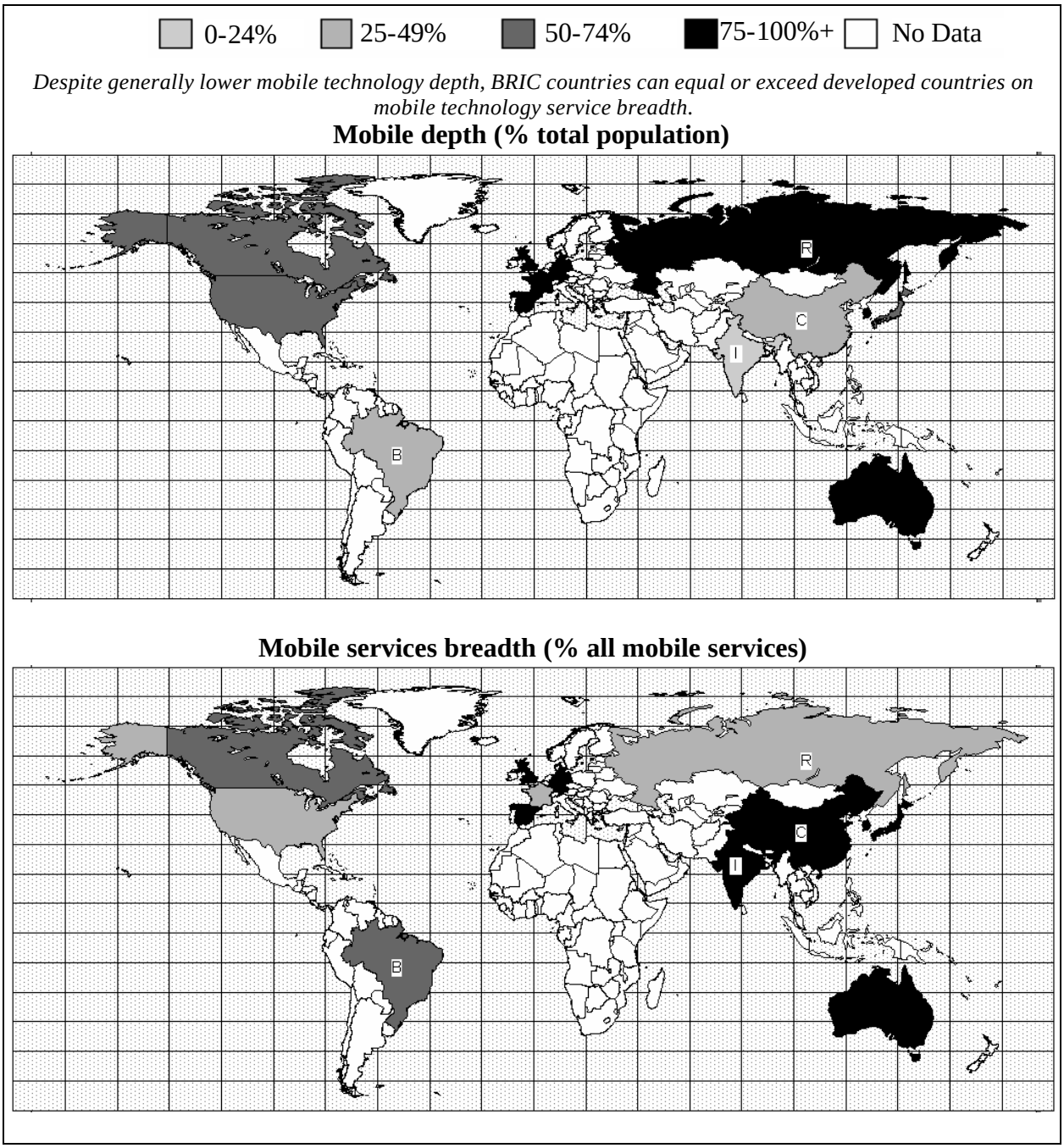

Figure 6.
Geographical distribution of mobile technology depth and service breadth

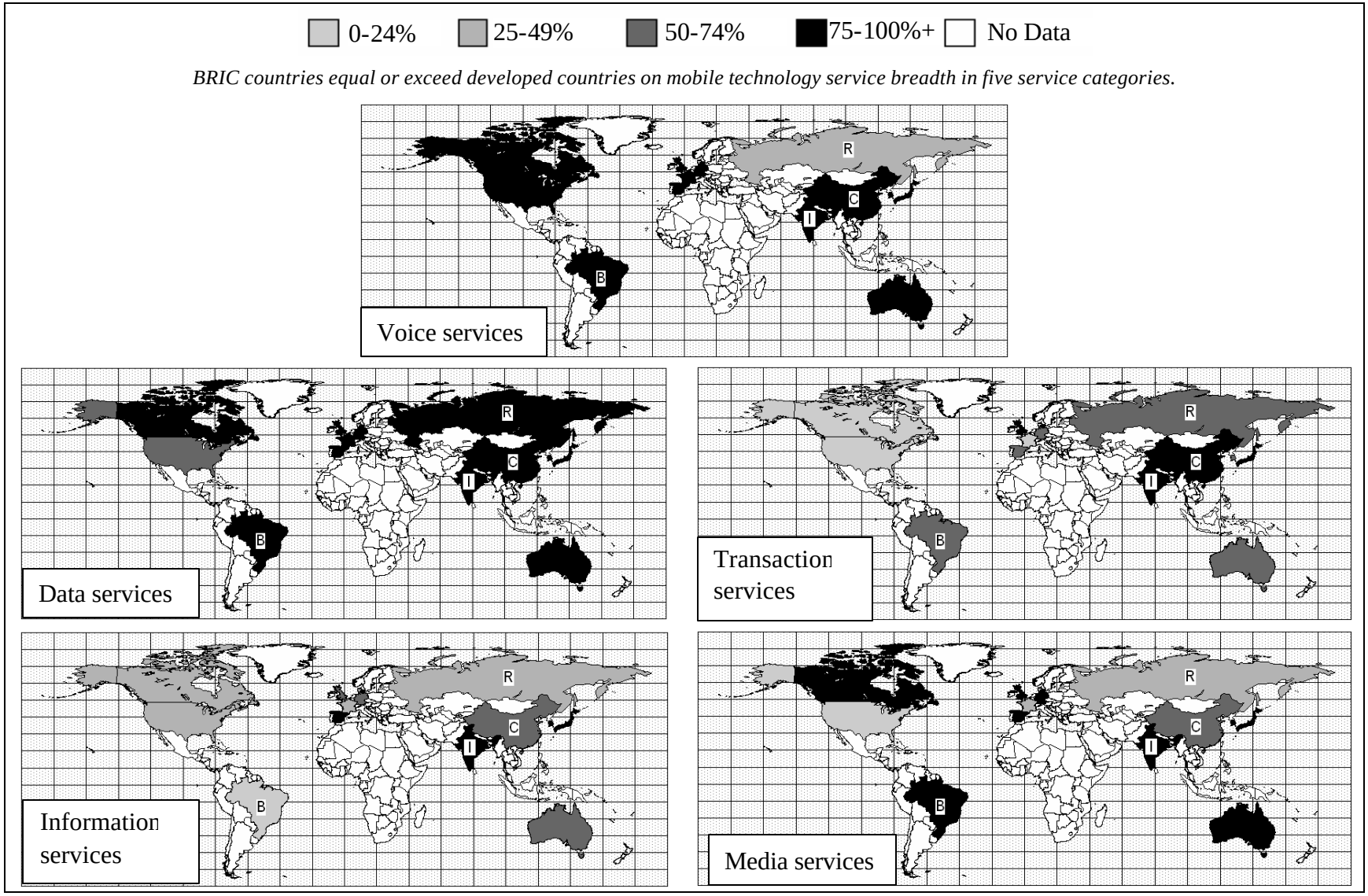

Figure 7.
Geographical distribution of mobile technology service breadth in 5 service categories

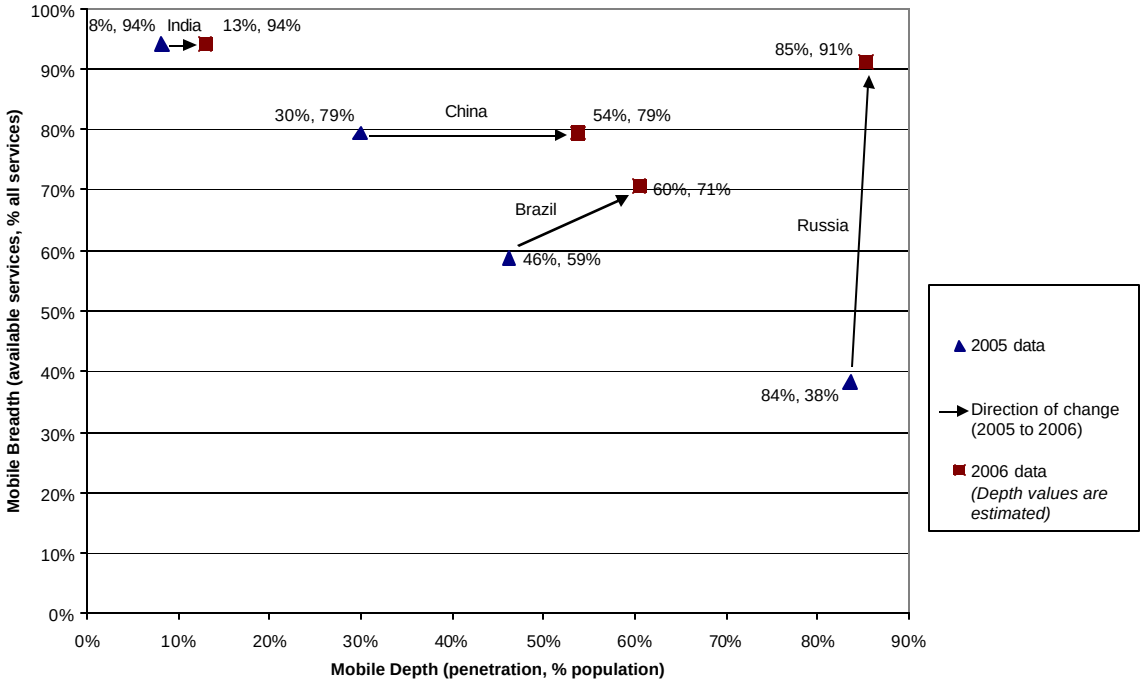

Figure 8.
Narrowing the digital divide: BRIC countries growth patterns along mobile technology depth and service breadth, 2005-2006(*)
(*) 2006-2008 mobile technology service breadth is estimated as described in Table 3

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