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**GETTING CLOSER? EMPIRICAL EVIDENCE ON THE USE
OF MOBILE PHONES IN SUB-SAHARAN AFRICA**

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Abstract

The potential impact of mobile phones on development in Africa has been recognized for some time now. Their use is considered to be a solution to the relative lack of infrastructure in the areas of communication and transport, enabling small-sized farms and businesses to save enormous amounts on transportation costs, as well as allowing isolated parties to access price information in real-time, cutting down dramatically on transaction costs.

In recent years, with the privatization of state companies, there has been a pronounced increase in the number of mobile phone subscriptions. While there is a considerably large body of literature discussing the potential impacts, empirical studies detailing these developments remain scarce. This gap brings up the following question: why do mobile phones have a tremendous impact on development in some regions but almost none in others, where social, political and economical conditions seem to be similar?

Several cell phone projects have been implemented in recent years, and an assessment of their results helps understanding which factors are improving, and which are inhibiting, the use of this tool for development. By comparing the characteristics of such projects in Sub-Saharan Africa, isolating the main catalytic conditions becomes possible, with subsequent insight for development policy. Several such factors are discussed here, namely the urban bias in network coverage and research, the role of government in facilitating or hindering the expansion of mobile phones access, and recent technology and costs developments.

Introduction

Using modern technologies to solve development problems in the world's poorest regions is a dream that many practitioners and thinkers have shared for some time now. When searching through all the knowledge and techniques the western world has acquired in the past decades, one should find enough ideas for lasting solutions to blossom, should it be medicine to curtail the spread of diseases devastating entire regions, the use of the internet to improve education in the deepest corners of the globe, or agricultural research to spur economic growth in rural counties.

Of these potential applications, few have received more attention in recent years than cell phones. Where population density is small, as is the case in most regions of Sub-Saharan Africa, wireless communications represent an easy and cheap way to circumvent the need to build and maintain expensive landlines. Furthermore, in 2001 Africa became the first region where the number of mobile phone subscribers exceeded those using fixed lines, in the midst of an astonishing increase from 2 million subscribers in 1998 to 198 million in 2006 (ITU 2007).

Mobile phones, and information and communication technologies (ICTs) more generally, have come to be seen as a tool "for enhancing knowledge sharing, and promoting economic and social development for women and men" (CIDA 2007). Hence the need to assess the results and progress made in recent years regarding the use of cell phones as a tool for development. This paper proposes a look at recent experiences and studies concerning these matters. A summary of the theoretical aspects is presented, followed by a section discussing some of the main issues of concern coming out of a survey of recent case studies and projects, namely the urban bias in network coverage and research, the role of government in facilitating or hindering the expansion of mobile phone access, and developments regarding equipment costs and technologies.

Theoretical considerations about mobile communications and development

A growing body of literature has already assessed some of the impacts of mobile telecommunications on development. Some economists suggest a positive correlation between the spread of telecommunications and economic growth (Hardy 1980; Norton 1992; Sridhar and Sridhar 2004; Waverman and Roller 2001; Waverman, Meschi, and Fuss 2005). Mody and Yilmaz (1994) also found that a country's exports are significantly influenced by the quality of its transactional infrastructure (proxied by the penetration of telecommunications).

Two main findings emerge from these studies in relation to developing countries. One is that mobile phones seem to be playing the same crucial role that fixed telephony played in developed countries from 1970 to 1990. "Mobile telephony has a positive and significant impact on economic growth, and this impact may be twice as large in developing countries compared to developed countries" (Waverman, Meschi and Fuss 2005, 11). The potential impact is larger in several African regions because other means of communication are inaccessible, unreliable or too expensive (postal systems, fixed-line telephony, and roads) (Ochieng and Davis forthcoming).

The second finding is that rapid mobile telephony growth is achieved with much less investment in countries with under-developed fixed-line networks than the latter would have needed (Waverman, Meschi and Fuss 2005). Moreover, "mobile phone networks (...) are built on less site-specific, re-deployable modules, which make this technology less dependent on institutional characteristics" (Andonova 2006, 29). Some pilot projects have even bypassed the need of electricity infrastructure, such as the Grameen Telecom's Village Phone Programme, which can be established in areas where electricity is unavailable and where the network can be accessed with a booster antenna. These conclusions seem to suggest a positive and significant link between telecommunication penetration and investment and economic growth.

Several causal paths have been hypothesized to explain why such a link would exist. One theory derives from the idea that in developed countries, "markets function efficiently because the prices of goods and services are known or can be accessed cheaply, widely, and readily", which is not the case of smallholders farmers in Africa (Eggleston, Jensen, and Zeckhauser 2002, 4). This results in "farmers producing the wrong mixture of crops and using inefficient technologies, consumers not receiving the goods they want or are willing to pay for, and dispersions of agricultural prices or deviations from the law of one price" (Ochieng and Davis forthcoming, 5). In other words, inefficiency.

The argument is thus that these information imperfections may be resolved by improving the access to mobile telephony, with the potential for very high economic and social returns in rural areas (Coyle 2005). As some experiments have shown, mobile telephony access is enabling farmers to check prices in different markets before selling, and eventually allows for the quick and easy transfer of funds—where the banking system allows it.

Thus from a purely economical view, cell phone access helps users because in many ways, being poor is expensive: lack of access to accurate information, borrowing from local moneylenders at rates of 10% to 15% per

day¹, and other factors mean that “the poor falls prey of intermediaries who profit from their weakness” (Molina 2006, 8). Hence the phones help “cut the middleman”—or at least give increased bargaining power when dealing with him.

Whilst spot-price checking is probably the main argument for rural communities, other upturns arise from the expansion of mobile phone usage. One such improvement is the fact that it helps people save the financial costs and time involved with travelling. This can be illustrated by communicating more easily with distant family members, making it easier to find employment opportunities, as well as having more options during emergency situations. Again, these arguments are based on the relative reliability of cell phone networks when compared with landlines and transport infrastructure. If people in developed countries are saving time and money by using phones to spare them travelling costs in a context of very well-maintained and accessible infrastructure, this is only truer for rural communities virtually isolated by deficient roads.

As for addressing the ‘digital divide’ with developed countries, the opportunities that cell phones provide are not limited to voice services: access to a mobile telecommunication network also brings Internet access to phones, eliminating the computer as a necessary mean for eventually connecting to the World Wide Web. This is no small issue in a continent that is said to be cursed by its digital gap with the developed world. This has concrete applications in public policy, allowing for example farmers to get practical information such as the legal protocol to acquiring tenure to land, planting advice, and weather forecast.

Finally, there is a broader point to be made about the political implications of an expansion of mobile communication networks. “Access to digital networks could improve quality of life more generally, by allowing people to summon help, share experiences with others, form political coalitions across a region or the globe, and add their voices to world affairs” (Hammond 2001, 99). Hence all this suggests that by improving communications between people in relatively low-density areas, distances are shrunk, and others conclude that mobile phones can accelerate the growth of social capital in developing countries in general, and in rural communities in particular. It may be reasonable then to believe that “some of this increased ‘information communication’ is having a positive effect on the much-needed political stability in [Africa]” (Thompson and Garbacz 2007, 212).

¹ “Even the lucky small-scale entrepreneurs who get loans from nonprofit microfinance institutions pay between 40% and 70% interest per year—rates that are illegal in most developed countries” (Prahalad and Hammond 2002, 50).

Issues of concern

As the preceding discussion show, improvements in mobile telecommunication access seem very promising, as the theory suggests. However, several qualifications and shortcomings arise when observing cases in different regions and settings. This section attempts to discuss some of these concerns, in light of evidence found in recent projects and observations in the field, with an emphasis on rural regions in Sub-Saharan Africa. The topics discussed are sometimes overlapping, and include the urban-rural digital divide, the impact of government action (or absence thereof), and the rapid changes in equipment technologies and costs.

As discussed below, the use of mobile phones in developing countries, especially where there is no access to fixed-line networks, can be quite different from what developed countries have experienced in the past. Because of this, impacts can differ substantially from what is predicted by theory, hence the importance of assessing evidence in various countries and settings. Three considerations limited the scope of this review. First, the emphasis is put on the use of mobile phones, as opposed to Internet access more generally, although many parts of the discussion apply to both. Second, the projects and studies surveyed concentrate on Sub-Saharan Africa. Finally, the focus is mainly on issues related to rural regions.

The survey covers various reports and studies published by the International Development Research Centre (IDRC), as well as several case studies. The analyses presented here are not intended as conclusions, the evidence being rather anecdotal, but rather they identify aspects that stand out, and that need further investigation in order to help policy-makers and development practitioners provide the best environment for mobile phones to spur development.

The urban bias

A first caveat of particular interest is that the explosion in mobile phones subscriptions in Sub-Saharan Africa hides the fact that this is mainly an urban movement, and that penetration in rural areas remains weak. This is especially important for two main reasons: on one hand, the bridging of the 'digital divide' between developed and developing countries currently ongoing may be transforming itself into a digital gap between rural and urban areas. On the other hand, most of the advantages of having access to telephony (mobile or not) comes from the networking effect, that is, as more people use it, the "enabling" impact of the technology becomes greater. Given the important proportion of people living in rural regions in Sub-Saharan Africa, if the growth in utilization is limited to urban areas, then full

utilization of the technology is impossible, even for those who do have access; as a result, the economy as a whole sees its growth potential hampered (Overå 2006, 1313).

When reviewing the evidence, we must thus look at the following questions: is there really an urban bias in the blossoming of mobile phone access? If so, can we identify causes for it, and factors amplifying it? What kind of solutions should we focus on?

The answer for the first question is not as straightforward as it seems. When it comes to assessing the impact of mobile phones in developing countries, the data available is inaccurate to give proper measurements, since the numbers focus on the western conception of 'users'. As James and Versteeg (2007) have shown, this does not take into account the phenomenon of 'sharing' that is particularly important in Africa. "In Botswana for instance, household surveys reveal that 62.1% of the phone owners share their phones with their family, 43.8% with their friends and 20% share their phone also with their neighbors. Moreover, only 2.2% of the phone owners actually charge for the use of their mobile phones" (James and Versteeg 2007, 120)². Meso, Musa, and Mbarika (2005) come to similar conclusions, arguing that because of the importance of sharing in rural communities in Sub-Saharan Africa, absolute penetration rates in developing countries may lead to an underestimation of their impact on society.

These factors, along with the fact that data is generally compiled at the national level, make it difficult to measure the extent of such a bias. Nevertheless, case studies tend to show a general tendency for providers to focus on urban regions, and some studies have attempted case-specific measurements that show the urban bias to be verified at least in some countries in Sub-Saharan Africa. Without generalizing for all countries, the important amount of observations confirming this tendency leads to believe that it is one of the main issues to consider³.

Several factors may explain this bias. First, coverage is largely reflected by population density and follows the main roads (Overå 2006, 1305). Despite important investment in coverage that accompanied the surge in subscriptions for the past decade, and despite the costs of such investment being only a fraction of what fixed-line networks would ask for, the poor quality and limited extent of original networks demands considerable investments by providers, and the attention is given primarily

² The data is taken from Sebusang, Masupe and Chumai (2005). As James and Versteeg point out, similar data can be found for Namibia in Stork (2005).

³ Observation of this bias has been found at least for Nigeria, Kenya, South Africa and Uganda (UNCTAD 2008), and Ghana (Overå 2006).

to the areas with the highest (economic) returns. In rural areas where the population density is very small, and where roads are inexistent or of very poor quality, the cost of these investments is highest, resulting in incentives to concentrate on urban regions.

Another factor skewing the investment towards urban areas is that the surge in mobile phone subscriptions has produced a situation where cell phone companies are not able to keep up with the demand, which results in network overloads in high density – that is, urban – regions. This has been the case for instance in Ghana⁴, where it was often impossible to call from one network to the other. This resulted in the need to acquire two or three cell phones to reach through on all networks, illustrating the unreliability of current infrastructure, even in urban regions. Since the bulk of the consumer base is found in these regions, this can be seen as an incentive for providers to invest first and foremost in these regions, which, again, results in a neglect of rural regions.

A third factor influencing this bias is that telecommunication market liberalization has benefited mostly urban consumers. Increased competition has resulted in prices dropping, but this is mainly true in urban areas. In conjunction with the factors mentioned above, this highlights the fact that prices tend naturally to be higher in rural regions. This has somewhat been hampered by the introduction of prepaid services, but it remains a concern (UNCTAD 2008).

This urban bias has two implications, one for policy-making, and one for research. Regarding the former, these observations confirm that connecting rural areas is still a major issue, with the bulk of the rural population in Sub-Saharan Africa lacking basic telecommunications infrastructure. As the Information Economy Report of the United Nations Conference on Trade and Development (UNCTAD) concludes, “this reinforces their economic marginalization and sustains the unattractiveness of rural development as far as market based, private investment-led solutions are concerned. Moreover, this may be a manifestation of market failure which needs to be addressed through government intervention by means of policies that improve incentives for investment, and ultimately by investing public funds to develop a supply capacity” (UNCTAD 2008, 261). Whatever the – albeit notable – successes of private initiatives to circumvent the problem, for instance the Village Phone projects pushed forward by the Grameen Foundation and others, government action may be needed to both loosen regulation to facilitate telecommunication standardization in rural

⁴ See, for example, Overå (2006).

regions and to foster investment in coverage infrastructure from providers in rural regions.

The second implication concerns research on mobile phones and development, which also tends to focus on the impacts and dynamics related to urban users. The very importance of mobility, for instance, may be overemphasized, as economically disadvantaged users in rural regions may not be mobile (UNCTAD 2008). Moreover, as Donner (2008) pointed out, this focus of on urban users may lead researchers to underestimate or misjudge the true development impact of mobile telecommunications, "in places where (a) the mobile is the only phone, (b) shared models of access are important, and (c) issues of economic scarcity are paramount in the decision-making about what and when to communicate" (Donner 2008, 151). Hence the urban bias in all these dimensions is a crucial issue when aiming at realizing the true development potential of mobile phones in rural regions of developing countries.

The role of government

A second topic of interest is the role of governments in helping or hindering the expansion of access to mobile phones for rural inhabitants. The surge in mobile telephony access and use in the past decade is often attributed to the deregulation and privatization of the telecommunications sector. However, some countries, despite relatively similar policies, have performed better than others, which raises questions as to what factors influence this performance.

A first observation is that this deregulation and privatization process has not been completely enacted, with state enterprises remaining important players, and regulation still being a serious impediment to competition. Despite wide privatization since the 1990s, very often this was only partially accomplished, state enterprises remaining important players. As pointed out by Michelsen (2003)⁵, other political, economic, and cultural barriers remain: "cumbersome bureaucratic procedures, individual politicians' interests and the organizational culture in the formerly (and still partly) governmental telecommunications sector, in addition to problems related to the physical environment and lack of infrastructure in rural areas making equipment installation difficult", are all factors hampering the profitability of investments (Overå 2006, 1305).

Once the heavy regulation has been changed to allow for greater competition and participation of the private sector, it may still not be

⁵ From Overå (2006).

adequate for the use of the most beneficial technologies. An especially acute challenge is the need “to influence legislators to amend or introduce regulations that permit innovative, low-cost solutions aimed at social upliftment particularly where vested interests have failed to address the problems” (FMFI 2007, 4). This is a concern for all wireless technologies in rural areas, where regulatory obstacles have been the major barrier to progress. In some countries, the legal framework often prevents telecentres to function as local Internet service providers, and alternative telecommunication means are not allowed in some regions where monopolies over telephony by fixed-line operators prevents it (Macanze 2007). In others, mobile phone prices remain high when compared with fixed-line rates, as a result of incomplete price liberalization, most notably in South Africa (UNCTAD 2008).

The issues are thus complex, and government action is often misguided or hindered by the fact that most models for regulation or innovation policy are based on the experience of developed countries, where, again, the context is different, at least because access to fixed lines is often considered as given. This makes the questions related to the allocation of radio frequency spectrum, to the promotion of competition and innovation in the information and communication technologies service sector, and to the protection and enhancement of consumer welfare ever more difficult to address (Waldick 2003). Nevertheless, as illustrated by the fact that the implementation of appropriate policies to support mobile services development and competition in mobile markets have allowed countries with low per capita income to obtain higher levels of growth in mobile subscriptions than other wealthier countries, it is an area worth paying more attention to (UNCTAD 2008).

Equipment, coverage, and accessibility

The previous two sections have illustrated that special attention needs to be paid to both the reduction of the urban bias in wireless telephony access and the facilitation of the use and expansion of mobile phones by appropriate policies and legal frameworks. In this section, the focus is shifted towards various issues related to the technology itself, especially concerning equipment cost and adaptability.

Two of the main obstacles to the spread of mobile phones are still the price of handsets and the possibility for these to be used in the conditions that prevail in most rural regions of Sub-Saharan Africa, where access to electricity to charge batteries is often a concern. Regarding the former, African mobile operators generally do not subsidize handsets like their counterparts in Europe and the United States. Furthermore, high tariffs

imposed on products and services by many African governments add a tax burden on consumers (Anonymous 2005).

Lower-cost handsets are nevertheless becoming available, and these remain profitable for manufacturing companies. Since the needs for functions other than voice and basic SMS are lessened in rural regions of developing countries, this allows manufacturers to provide handsets at a cheaper cost. Such initiatives include the GSMA Emerging Market Handset Program, which helped Motorola design phones with basic features which cost less than 30\$ (EMHP 2008), proving that these costs could be steeply reduced.

As for the power issues, these same phones are being designed with such limitations in mind, resulting in models with longer lives and battery duration and minimal power and charging needs (Lehr 2007). Moreover, alternative charging equipment is being provided, for instance in the Village Phone kits of Grameen Phone, which allows for the use of an automobile battery or a solar panel (Keogh and Wood 2005). Other innovative projects have led to the building of antennas built from locally available material such as an empty coffee tin or a bicycle spoke (the 'Cantenna'), which cost about a tenth of the price of a regular antenna, can be installed and operated with ease, while at the same time being more robust to suit rural operating conditions (Le Roux 2005). These innovations help bypass the poor infrastructure quality of remote regions (including bad reception), allowing for a better access to wireless networks.

Nevertheless, it is worth noting that these innovations are often not permanent solutions per se, but rather temporary schemes to circumvent accessibility problems in problematic regions. Access to mobile phone for voice and basic text functions may be the most important aspect for regions where the technology has not penetrated – especially when even fixed lines are not available or reliable enough – but if the overarching attempt is to close the digital gap, more elaborate use must be considered, even at these early stages. On this, the provision of phones stripped of any additional function, however cheap they may be, can only be a transitional solution, and must not overshadow other major issues for further development of adapted solutions, most notably network type, data services, privacy and security aspects, and lack of standards for features such as screen resolution and memory (Lehr 2007).

The improvement of coverage is another area where technologies that seem at first glance unnecessarily too advanced for rural regions in developing countries, may in fact provide lower-cost solutions. Infrastructure improvement implies drastic investments by network providers. In

Bangladesh, for instance, Grameen Phone, despite having declared profits only a few years after the launch of their Village Phone programme, had still invested more than US\$ 1 billion after a decade. This is not uncommon for the telecommunications field, but it underlines the long-term involvement necessary for improvements to be achieved, let alone for companies to reap profits (Molina 2006).

The size of the needed investments is yet another strong reason to pay attention to the choice of technology for expansion, especially for eventual basic Internet access. For example, older cellular networks have very little capacity to transmit data, but newer networks such as CDMA2000, even if they are often being deployed simply to cope with increases in voice traffic, can offer much greater capacity for data traffic (Hammond and Paul 2006).

Finally, there are still questions regarding the sustainability of a subsequent information society, especially in regions where the technology is new. First, the training of a mass of local trainers and professionals in networks will be necessary, in order to transfer practical technology skills and to foster regional training mechanisms, as access to wireless telecommunications improves – especially as Internet-based applications are used. Initiatives such as the African Network Operators Group have provided promising attempts in this matter (IDRC 2005).

Second, whether it's through the use of mobile phones or not, the development of local content and its adaptation to local language and culture brings up new challenges that need to be addressed. Many efforts have been made in this direction, but coordination and development costs are still major impediments. In this area, the Open Source movement may help in the development of low-cost solutions to these problems, but coordination initiatives remain important to provide a common localization framework for such projects to be successful (IDRC 2007).

Conclusions

These discussions underline the complexity of the expansion of mobile phone infrastructure in developing countries. From the evidence presented here, it appears that the role of cell phones in accelerating development certainly has great potential, but several additional conditions come into play, some of which have received too little attention, both in the policy-making arena and in academic works. Future research will thus have numerous avenues to explore, especially to determine whether some of the issues aforementioned arise from market failure, government failure, or both, in order to identify rapidly, if possible, the best practices to push for in a given context. It is worth noting that from the wide variety of the results

discussed above, it comes out that contextualized experiences through development projects seem to be a particularly important source of knowledge; and since the results of such projects evolve rapidly, frequent reviews are crucial.

Bibliography

- Andonova, Veneta. 2006. "Mobile Phones, the Internet and the Institutional Environment". *Telecommunications Policy* 30: 29-45.
- Canadian International Development Agency (CIDA). 2007. *CIDA's Strategy on Knowledge for Development through Information and Communication Technologies*. Gatineau, Canada: Canadian International Development Agency.
- Coyle, Diane. 2005. "Introduction". *The Vodafone Policy Paper Series* (March): 3-9.
- Donner, Jonathan. 2008. "Research Approaches to Mobile Use in the Developing World: A Review of the Literature". *The Information Society* 24 (3): 140-59.
- Eggleston, Karen, Robert Jensen, and Richard Zeckhauser. 2002. "Information and Communication Technologies, Markets, and Economic Development" (Working Paper #2002). Medford, Massachusetts: Tufts University, Department of Economics.
- EMHP. 2008. *Emerging Market Handset Programme*. GSM World. Online, <<http://www.gsmworld.com/emh>> (page accessed May 10th, 2008).
- First Mile First Inch (FMFI). 2008. *FMFI in Mozambique and Angola: Meeting Social Needs Through Low-Cost Telecom*. Online, <http://www.fmfi.org.za/wiki/images/4/48/FMFI_Moz_Angola_Brochure_Final.pdf> (page accessed May 8th, 2008).
- Hammond, Allen L. 2001. "Digitally Empowered Development". *Foreign Affairs* 80 (March/April): 96-106.
- Hammond, Al, and John Paul. 2006. *A New Model for Rural Connectivity*. Washington, D.C.: World Resources Institute.
- Hardy, Andrew P. 1980. "The Role of the Telephone in Economic Development." *Telecommunications Policy* 4 (4): 278-86.
- International Development Research Centre (IDRC). 2005. *Training Workshop for the African Network Operators Group*. Online, <http://www.crdi.ca/un_focus/ev-121002-201-1-DO_TOPIC.html> (page accessed May 12th, 2008).
- International Development Research Centre (IDRC). 2007. *WordForge Project*. Online, <http://www.idrc.ca/en/ev-121066-201-1-DO_TOPIC.html> (page accessed May 12th, 2008).
- International Telecommunication Union (ITU). 2007. *World Telecommunication/ICT Indicators*. Online, <<http://www.itu.int/ITU-D/icteye/Indicators/Indicators.aspx#>> (page accessed on November 19th, 2007).
- James, Jeffrey and Mila Versteeg. 2007. "Mobile Phones in Africa: How Much Do We Really Know?" *Social Indicators Research* 84: 117-26.
- Keogh, David and Tim Wood. 2005. *Village Phone Replication Manual*. Grameen Technology Center, Grameen Foundation USA, USA.

- Lehr, David. 2007. *Going Wireless: Dialing for Development. How Mobile Devices are Transforming Economic Development at the Base of the Pyramid* (Working Paper). New York: The Acumen Fund.
- Le Roux, Helene. 2005. "Tin-Can Bridge to Digital Society". *Engineering News*. Online, <http://www.engineeringnews.co.za/print_version.php?a_id=74454> (page accessed May 10th, 2008).
- Meso, Peter, Philip Musa, and Victor Mbarika. 2005. "Towards a Model of Consumer Use of Information and Communication Technology in LDCs: The Case of Sub-Saharan Africa". *Information Systems Journal* 15: 119-46.
- Michelsen, G.G. 2003. *Institutional Legalities at Work in African Telecommunications*. Report 80, Bergen: Department of Administration and Organization Theory, University of Bergen.
- Mody, Ashoka and Kamil Yilmaz. 1994. *Is There Persistence in the Growth of Manufactured Exports?* (World Bank Policy Research Working Paper #1276). New York: The World Bank.
- Molina, Alfonso. 2006. *The Village Phone Constituency in Bangladesh. A Case of a Sustainable e-Inclusion Enterprise*. Paper for SPRU 40th Anniversary Conference, "The Future of Science, Technology and Innovation Policy: Linking Research And Practice," 11th-13th September 2006.
- Norton, Seth W. 1992. "Transaction Costs, Telecommunications, and the Microeconomics of Macroeconomic Growth." *Economic Development and Cultural Change* 41 (1): 175-96.
- Ochieng, Cosmas and Kristin Davis. Forthcoming. *ICTs as Appropriate Technologies for African Development*.
- Overå, Ragnhild. 2006. "Networks, Distance, and Trust: Telecommunications Development and Changing Trading Practices in Ghana". *World Development* 34 (7): 1301-15.
- Prahalad, C.K. and Allen Hammond. 2002. "Serving the World's Poor, Profitably". *Harvard Business Review* 80 (September): 48-57.
- Sebusang, S., S. Masupe and J. Chumai. 2005. "Botswana". In A. Gillwald, Ed., *Inwards on Africa e-Index, Household and Individual ICT Access and Usage Across 10 Countries in Africa*. Johannesburg, South Africa: The Ling Centre, Witwaterstand University.
- Sridhar, Kala Seetharam, and Varadharajan Sridhar. 2004. "Telecommunications Infrastructure and Economic Growth: Evidence from Developing Countries." Working Paper 14. National Institute of Public Finance and Policy, New Delhi.
- Stork, C. 2005. "Namibia". In A. Gillwald, Ed., *Inwards on Africa e-Index, Household and Individual ICT Access and Usage Across 10 Countries in Africa*. Johannesburg, South Africa: The Ling Centre, Witwaterstand University.

- Thompson, Herbert G. Jr. and Christopher Garbacz. 2007. "Mobile, fixed line and Internet service effects on global productive efficiency". *Information Economics and Policy* 19: 189-214.
- UNCTAD. 2008. *Information Economy Report 2007-2008. Science and Technology for Development: The New Paradigm of ICT*. Geneva: The United Nations Conference on Trade and Development.
- Waldick, Lisa. 2003. *The Best Policy: Telecom Research from an African Perspective*. Ottawa: International Development Research Centre (IDRC). Online, <http://www.idrc.ca/en/ev-46209-201-1-DO_TOPIC.html> (page accessed April 30th, 2008).
- Waverman, Leonard, Meloria Meschi and Melvyn Fuss. 2005. "The Impact of Telecoms on Economic Growth in Developing Countries". *The Vodafone Policy Paper Series* (March): 10-23.
- Waverman, Leonard, and Lars-Hendrik Roller. 2001. "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach." *American Economic Review* 91 (4): 909–23.