KIWANJA.NET
MINDFUL SOCIAL CHANGE

MOBILE DATABASE · REPORT

VODAFONE MOBILE IMPACT

Author / organisation	Vodafone
Year recorded	2005
Region	Africa
Category	Economic
Original source	vodafone.com
Archive page	kiwanja.net/mobile-database/vodafone-mobile-impact/

This document is part of the kiwanja.net Mobile Database, an archive of more than 700 articles, reports and projects on mobile technology for development, collected between 2003 and 2010. It is reproduced here for reference; the original author's rights are retained.

Explore more. Browse the full archive at kiwanja.net/mobile-database.
Looking for support with your own social change work? See kiwanja.net/work-with-me.
Ken Banks offers coaching, mentoring and strategy support.

The Vodafone Policy Paper Series • **Number 2 • March 2005**

Africa: The Impact of Mobile Phones

Moving the debate forward

The Vodafone Policy Paper Series • **Number 2 • March 2005**

Moving the debate forward • The Vodafone Policy Paper Series • Number 2 • March 2005

Africa: The Impact of Mobile Phones

Foreword

I hope you enjoy our second Vodafone Policy Paper. Our aim in these papers is to provide a platform for leading experts to write on issues in public policy that are important to us at Vodafone. These are the people that we listen to, even if we do not always agree with them. These are their views, not ours. We think that they have important things to say that should be of interest to anybody concerned with good public policy.

Arun Sarin, Chief Executive, Vodafone Group

Contents

Page

Foreword 00

– Arun Sarin, Chief Executive, Vodafone Group

Introduction 01

– Neil Gough and Charlotte Grezo, Vodafone Group

Overview 03

– Diane Coyle

The impact of telecoms on economic growth in developing countries 10

– Leonard Waverman, Meloria Meschi, Melvyn Fuss

Mobile networks and Foreign Direct Investment in developing countries 24

– Mark Williams

Introduction to the community and business surveys 41

Mobile communications in South Africa, Tanzania and Egypt:
results from community and business surveys 44

– Jonathan Samuel, Niraj Shah and Wenona Hadingham

Linking mobile phone ownership and use to social capital in rural South Africa and Tanzania 53

– James Goodman

Bibliography 66

To keep the environmental impact of this document to a minimum, we have given careful consideration to the production process. The paper used was manufactured in the UK at mills with ISO14001 accreditation. It is 75% recycled from de-inked post consumer waste. The document was printed in accordance with the ISO14001 environmental management system.
All the steps we have taken demonstrate our commitment to making sustainable choices.

Designed and produced by Barrett Howe Plc

Neil Gough
International Institutions Director

Neil is currently the International Institutions Director for Vodafone Group, coordinating international policy and relationships with global institutions throughout Vodafone Group.

Charlotte Grezo
Director of Corporate Responsibility

Charlotte is Director of Corporate Responsibility for Vodafone and is responsible for coordinating the Group's approach to managing social and environmental issues.

Introduction

About 18 months ago we became interested in studies on the economic and social impacts of mobile telecommunications. However, a thorough review of the existing literature revealed surprisingly little systematic evidence. There were many anecdotes, some interesting sociological research, but few successful studies looking at the economic impacts on individuals, businesses and overall economic activity.

This project has its roots in our dissatisfaction with that situation. It seemed extraordinary that a technology that has clearly taken the world by storm had attracted so little rigorous research. It was equally clear that there was widespread interest in the subject. As we discussed our programme and ideas with people both inside and outside the industry, the appetite for this work became obvious.

We wanted the work to be able to survive the scrutiny of a potentially skeptical audience. Therefore, with advice from the Vodafone Advisory Panel (a group of academics, officials and NGO representatives with interests in this field) we developed a programme of research.

The field was wide open so we could have chosen to focus anywhere but we started with the impact of mobile in the developing world. The reason was simple. We were inspired by a conversation with Alan Knott-Craig, the CEO of our affiliate company in South Africa, in which he talked about the impact mobile was having in Africa. The variety of the examples he mentioned were simply extraordinary.

Vodafone operates around the globe and has a particular interest in developing markets in Africa, not least because of the success of our investment in Vodacom, initially operating in South Africa and now also in Democratic Republic of Congo, Lesotho, Mozambique and Tanzania. Vodafone also operates in Egypt and Kenya.

At the time we began this work, the fact that Africa was to play such a leading part in the G8 agenda for 2005 and the work of the Africa Commission was unknown. We have been fortunate that the issues we have covered resonate with these important international initiatives. We hope that these studies will assist in highlighting the part that mobile telecommunications can play in the developing world.

We have learned a great deal. Most important is the fact that the ways in which mobiles are used, valued and owned in the developing world are very different from the developed countries. More attention should be paid to the characteristics of how people actually do use phones in the developing world in policy debates on increasing access to Information and Communication Technology (ICT). It is wrong to simply extrapolate our developed world models of needs and usage patterns to poorer nations. Understanding the context is vital. In the UK, the ratio of the

number of outgoing voice calls made to the number of SMS messages sent is 0.6:1; in South Africa as a whole, the ratio is 3:1 for pre-pay phones; yet in the rural communities we surveyed, the average ratio was a remarkable 13:1. In Ndebe, a rural community in South Africa, the ratio was 17:1, but when one considers this in the context of a community in which access to education is not universal, the data are more understandable. The combination of illiteracy and indigenous languages clearly has dramatic effects on the use of SMS messaging; the implications of this extend to other types of data usage (e.g. the internet). Our view is that the policy debates on ICT policy are not sufficiently informed by this type of evidence.

The value of communications in the developing world is also different. Imagine you are painter living in a township near Johannesburg and you are some way from your potential clients. You are looking for work but the postal service is poor and there is no fixed-line phone. How does a potential employer contact you? A mobile provides you with a point of contact; it actually enables you to participate in the economic system (see photograph below). Similarly, if you live in a rural community and you need to go to the nearest town to shop for some particular goods, a mobile phone call could save you a relatively expensive return bus fare and the lengthy journey time, if the goods were out of stock. When other forms of communication are poor, whether roads or fixed-line telephones, the value of quality mobile communications is much greater.

We have also learned that people in Africa use mobile phones very differently. Most striking is the accessibility of mobile. While penetration rates are by the standards of the developed countries low, the way in which mobiles are informally shared between people, the formation of private resellers of mobile services and the provision of mobile phones for public use, all increase accessibility, even in rural communities. The impact of mobile extends well beyond what might be suggested by the number of subscriptions alone.

The informal arrangements that extend the reach of telecommunications are very powerful. In the data for the rural communities in South Africa, we noticed that the ratio of inbound texts to outbound texts was about 8:1. This imbalance is attributed to the entrepreneurial activity of some of the more literate individuals with cell phones who, for a marginal fee, receive and relay text messages to those without cell phones or those who cannot read or write. This is apparently a very common practice in most of the rural areas.

The developed world model of personal ownership of a phone is not relevant, or indeed appropriate, to the developing world. With an understanding of this context, one can more easily appreciate why the usage of the technology is growing so quickly and in such distinctive ways in Africa. In the UK, there are now more mobile subscriptions than fixed lines; that cross-over occurred in 2000 (about 15 years after the first mobile call was made); in Tanzania, that cross-over point was also reached in 2000 (but just 5 years after the first mobile was sold). The relative impact of mobile on communications has been much more dramatic in Africa and the growth is now accelerating at a tremendous rate. The number of subscribers in Nigeria, the world's fastest-growing market according to the International Telecommunications Union, increased by 143 per cent in the 12 months to June 2003. In Africa, increasingly telecommunications means mobile telecommunications. Fixed-mobile substitution is not a relevant concept, because the whole developmental stage of widespread fixed line service has been leap-frogged by mobile in many nations.

The mobile telecommunications story in Africa and the developing world is a remarkable one. There have been large infrastructure investments, which have enabled millions of people to communicate better. While there is a lot of focus on low absolute rates of mobile penetration, this underestimates the real impact that mobile is having through the innovative and entrepreneurial ways in which the technology has been extended beyond the model of individual ownership. Thousands of jobs have been created and some very successful indigenous companies have emerged. All of these results were achieved through enterprise rather than aid. A clear success story in commercial terms but one that also had a profound impact on the development of the economy and society.

We have been greatly assisted in this program by the work of Diane Coyle, who has written the introductory piece and edited this pamphlet. It would not have been possible without her efforts and enthusiasm. We would also like to express our thanks to the various contributors for their papers and the stimulating discussion that has accompanied the work. We all have a lot to learn about mobile communications in Africa and the developing world. This is our initial contribution to that process, which we hope will stimulate you to explore these issues further.

A mobile enables tradesmen to participate in the economy. Innovative advertising on the outskirts of Johannesburg.

Diane Coyle
Enlightenment Economics

Overview

Just 20 years after the launch of the world's first commercial mobile services, there were more mobile than fixed-line users globally, and nearly as many people had a mobile as a television.[1] Vodafone's Socio-Economic Impact of Mobile (SIM) programme started from the beginning of 2004 to commission research which would help extend the evidence and develop a better understanding of the effects of this extraordinary phenomenon.

Mobile communications are experiencing faster growth rates in low-income countries – more than twice as fast as in the high-income countries in recent years. Low- and middle-income countries are therefore accounting for a rising share – now more than 20 per cent – of the world mobile market. But there is great variety between countries in mobile phone penetration and use. Surprisingly, given its extensive poverty, Africa has been the fastest-growing mobile market in the world during the past five years. The first cellular call in Africa was made in Zaire in 1987 (the operator was Telecel). Now there are more than 52 million mobile users in the continent (compared to about 25 million fixed lines). In 19 African countries, mobiles account for at least three quarters of all telephones.[2] Africa as a whole lags far behind richer regions of the world. Nevertheless, the rapid spread of mobile in so many of its countries is a remarkable phenomenon, especially in the context of their huge economic and social challenges.

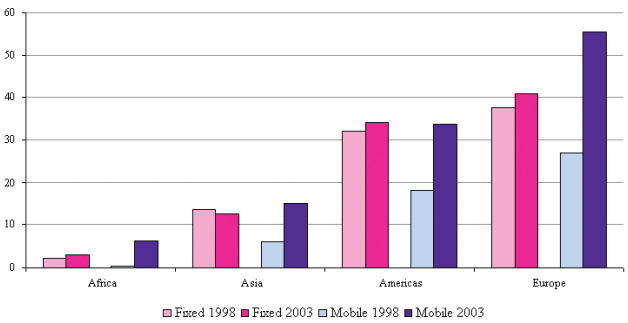
This report describes and summarises the initial research projects commissioned by Vodafone and carried out in the second half of 2004. The results described here confirm the vital social and economic role already played by mobile telephony in Africa less than a decade after its introduction there. The research documents its impact both at the macro-economic level and at the level of particular communities and businesses. It contributes to the evidence base for the development of both regulatory policies and business strategies in Africa. This opening section sets the context with an overview of the data and of the earlier academic literature on mobile, and information and communication technologies more generally, in developing countries.

A Vodacom Community Phone Shop bringing new communication possibilities to Dobsonville, South Africa.

The African context

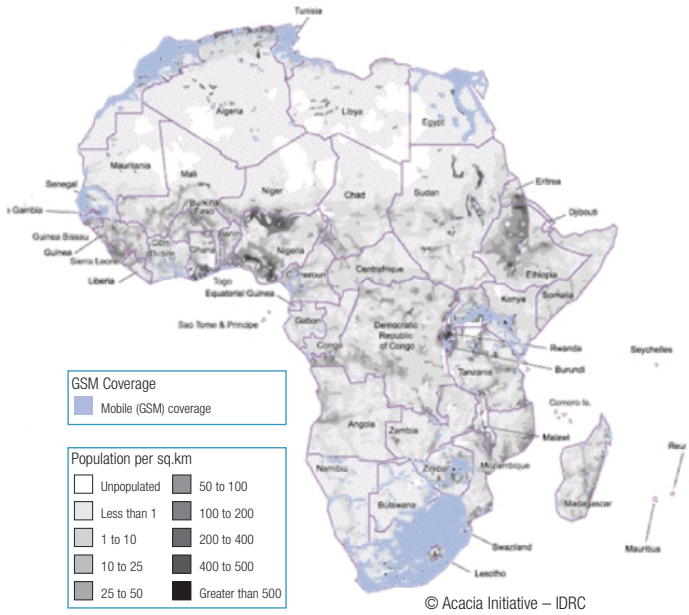
At the end of 2003, there were 6.1 mobile telephone subscribers for every 100 inhabitants in Africa, compared with 3 fixed line subscribers per 100.[3] Mobile penetration is much higher in other regions of the world – 15 per 100 inhabitants in Asia for example, 48.8 in the US and 55 in Europe. Even so, there were 51.8 million mobile subscribers in Africa at the end of 2003, reflecting an increase of more than 1000 per cent in five years. Access to mobile telephony in Africa is also almost certainly far more extensive than the subscriber figures suggests, as each handset and subscription has many users.

Figure 1: Mobiles and fixed lines per 100 people, 1998 and 2003



Investment in total telecommunications in Africa has been about 5-6 per cent of total fixed investment spending on the continent in recent years, although with wide variations between countries. Mobile network coverage is most extensive in the North African countries and South Africa, where coverage has improved dramatically. Continuing to improve telecommunications infrastructure is a priority area of policy for African governments and organisations such as Nepad (New African Partnership for Economic Development) and the international community.[4]

Figure 2: GSM mobile coverage in Africa



© Acacia Initiative – IDRC

As the International Telecommunication Union has pointed out, the phenomenon of the rapid spread of mobile cuts across many of the obvious characteristics distinguishing one country from another, such as GDP per capita, socio-demographic or geographic criteria.[5] Thus Finland and Uganda have a similar proportion of mobile-only users but are obviously not sensibly comparable countries. Within Africa, countries as different in their socio-economic characteristics as Algeria and Lesotho have similar mobile penetration rates. So there is no simple way to summarise the penetration patterns across countries. According to the most recent ITU figures, shown in Table 1, penetration rates ranged from 0.1 per 100 in Guinea-Bissau and 0.14 in Ethiopia to 68.18 per cent in Seychelles and 74.74 per cent in Reunion. In most of the continent's biggest economies, penetration rates lie in the 20-40 per cent range, although with exceptions such as Egypt (8.26 per cent) and Nigeria (2.55 per cent).

However, there can be little doubt that the wildfire spread of mobile was triggered partly by the liberalisation of the telecoms markets in many African countries from the mid-1990s, including the issuing of private mobile licenses, often to international operators. Those countries which made an early start down this path – such as Gabon or Mauritius – have mobile penetration rates which might seem surprisingly high given other social and economic indicators, and their size; and the converse is true for countries where there were no early private licences issued, such as Algeria or Nigeria. Research by the World Bank[6] looking at 41 African countries found that the introduction of a second and subsequent (private sector) competitors accelerates mobile penetration, whereas the presence of a state-owned telecoms incumbent in the market inhibits diffusion. Table 2 demonstrates this pattern for a number of countries.

Understanding the differences will be important for the design of policy by African governments and telecoms regulators, and this is an important area for further research. Formal competition policies are in their infancy in Africa, with only Kenya and South Africa having a clear framework in place at present. Many countries still have dominant state telecoms operators, with sufficient political power to ensure the regulatory framework is designed in their own interest. Given their typical history of inefficiency and corruption, their dominance is counter-productive, inhibiting the rapid spread of mobile communication networks.

Table 1: Mobile penetration rates in Africa

	Population, millions	Mobiles, thousands	Mobiles/100
Algeria	31.8	1447	4.6
Egypt	70.2	5731	8.2
Libya	5.5	100	1.8
Morocco	30.1	7333	24.3
Tunisia	9.9	1844	18.6
North Africa	**147.5**	**16455**	**11.2**
South Africa	**46.4**	**16860**	**36.4**
Angola	14.4	250	1.7
Benin	7.0	236	3.4
Botswana	1.8	493	28.0
Burkina Faso	12.3	227	1.9
Burundi	7.1	64	0.9
Cameroon	16.3	1077	6.6
Cape Verde	0.4	53	12.1
Cen. African Rep.	4.1	13	0.3
Chad	8.1	65	0.8
Comoros	0.8	2	0.3
Congo	3.5	330	9.4
Cote D'Ivoire	16.6	1236	7.4
DR Congo	52.8	1000	1.9
Djibouti	0.7	23	3.4
Eq Guinea	0.5	42	7.6
Ethiopia	69.4	98	0.1
Gabon	1.3	300	22.4
Gambia	1.4	130	9.5
Ghana	22.4	800	3.6
Guinea	7.8	112	1.4

	Population, millions	Mobiles, thousands	Mobiles/100
Guinea-Bissau	1.3	1	0.1
Kenya	31.7	1591	5.0
Lesotho	2.2	165	7.6
Liberia	3.4	2	0.1
Madagascar	16.3	280	1.7
Malawi	10.5	135	1.3
Mali	10.9	250	2.3
Mauritania	2.8	300	10.9
Mauritius	1.2	463	37.9
Mayotte	0.2	36	21.6
Mozambique	18.8	429	2.3
Namibia	1.9	190	9.9
Niger	12.3	24	0.2
Nigeria	123.3	3149	2.6
Reunion	0.8	565	74.7
Rwanda	8.4	134	1.6
S Tome & Principe	0.2	5	3.2
Senegal	10.4	783	7.6
Seychelles	0.1	55	68.4
Sierra Leone	5.0	100	2.0
Somalia	10.3	40	0.4
Sudan	33.3	650	2.0
Swaziland	1.0	88	8.4
Tanzania	35.3	891	2.5
Togo	5.0	200	4.0
Uganda	25.6	776	3.0
Zambia	11.2	150	1.3
Zimbabwe	11.8	363	3.1
Sub-Saharan	647.7	18363	2.8
AFRICA	841.5	51678	6.1

Source: ITU African Telecommunication Indicators (2004)

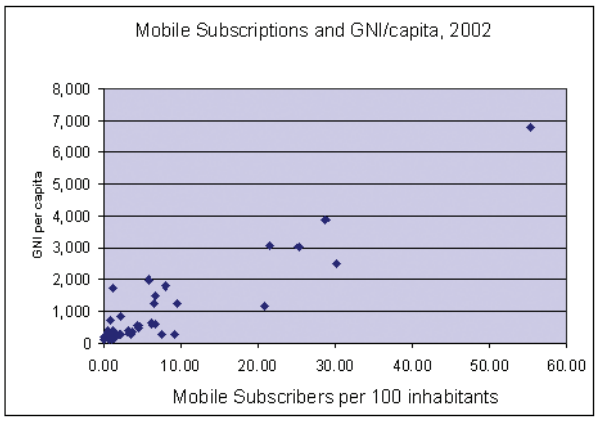
Table 2: Mobile competition in selected African countries

Country	Date of 1st mobile licence	Date of 1st competing private licence	State-owned mobile operator?	Mobiles/100 population
Algeria	1989	2001	Y	4.6
Benin	1995	2000	N	3.4
Egypt	1987	1998	N	8.2
Mauritius	1989	1996	N	37.9
Morocco	1987	1994	Y[7]	24.3
Nigeria	1992	2001	Y	2.6
Senegal	1992	1998	Y	7.6
S Africa	1986	1994	N	36.4
Tunisia	1985	2002	Y	18.6
Uganda	1995	1998	Y	3.0

Source: Based on Gebreab (2002), ITU database.

There are of course many other possible explanatory factors apart from regulatory policy for differences in mobile penetration rates – factors such as incomes and growth, urbanisation, education levels, and other aspects of policy including tariffs. Not surprisingly, as Figure 3 shows, mobile penetration is strongly positively correlated with income per capita. (The simple correlation coefficient is 0.75 for the period 1995-2002.[8]) However, it is not strongly correlated with trade, measured as the ratio of imports plus exports to GDP. The correlation coefficient in this case is just 0.34.

Figure 3



On the other hand, per capita income is clearly not the only important explanatory factor, as many African countries have seen rapid growth in mobile during a period when income growth has been low. This means there is some trend towards convergence in access to mobile telephony across countries.[9] For example, between 1998 and 2003 the number of mobile subscribers per 100 rose from 7.92 to 36.36 in South Africa, which has one of Africa's highest penetration rates; during the same period the figure for Rwanda, which has one of the lowest, increased from 0.12 to 2.52. Mobile seems to be a good example of a technology that permits leapfrogging of an older infrastructure.[10] What's more, in contrast to the diversity of patterns between countries, mobile use within any given country is characterised by greater uniformity than other ICTs across, for example, socio-economic groups or gender. The implication of these two trends – some convergence between countries and smaller differences within countries – is that the digital divide could be smaller in the case of mobile compared with other ICTs. However, there is some evidence that an increase in (fixed line) telephone density in the past has been correlated with faster growth in the incomes of the poor but even faster growth in the incomes of the rich, therefore associated with increasing inequality.[11] It is far from established that mobile is yet affecting income distribution in either direction. The likelihood is that the distributional impact will be complicated, depending on the geographic pattern of rollout between different areas, and especially as between urban and rural areas.

Potential explanations for the rapid spread of mobile

There are, then, many potential explanations for the universally rapid spread of mobile in the developing world. Research has focussed on the following list:

- the shorter payback period on investment compared to fixed line; lower installation costs and faster build than fixed line eg. in India up to six times lower than the estimated $1000 variable cost per additional fixed line;[12] straightforward scalability of mobile compared to other infrastructure investments.[13]

- complementary with lower levels of skills than needed for computers or the internet.[14] Especially important for providing technological access to the poorest people, who are much more likely to be illiterate and speakers of minority languages.[15]

- potentially lower social/income entry barriers than the internet, due to lower up-front expenditure[16], and also compared to fixed lines because of greater ease of sharing mobile handsets.

- business model innovations: pre-pay which helps overcome credit barriers; the Grameen model of micro-entrepreneurship; mobiles as public telephones (model found in Bangladesh, Botswana, India, South Africa, Thailand, Uganda)[17]; telecenter models.[18]

- network effects which generate rapid momentum once critical mass is reached.[19]

- greater ability to overcome geographic hurdles eg mountains, deserts. Bhutan is an extreme example – the mountainous state was unsuitable for the installation of fixed line telephony at all.[20] Also less vulnerable to natural disasters than fixed telecoms. Mobility itself is likely to be valuable for some users, but less so than in developed economies where mobiles are complementing extensive fixed networks rather than substituting for them.

- competition with fixed incumbent, stimulating the growth of the telecommunications market.[21] The poorest developing countries are still substantially less likely to have reformed their telecoms markets.[22] Competition has knock-on effects to related influences such as operators' pricing policies.

- rollout requirements in licences.[23] Specific requirements for rollout in rural and low-income areas are to be found in Ghana, South Africa and Uganda, for example. In a well-known example in another region, Chile ran a reverse auction to subsidise bidders for rolling out services to under-served areas.[24]

Many of these favourable factors for the spread of mobile have been present in many African and other developing countries. At the same time, as noted above, an explanation is needed for the *differences* in penetration rates and usage in different countries. To sum up, the key explanatory factors here are likely to include:

economic fundamentals such as income per capita, or relative prices of handsets and calls (there are high price elasticities of demand, see below). Macroeconomic stability and urbanisation also appear to have a significant impact on teledensity;[25]

policy differences such as regulatory structure and the competition regime; tariff and non-tariff barriers to imports which raise the price of handsets; the structure of universal access obligations; government attitude (are mobiles a dangerous liberty? A frivolous luxury?);[26]

social and cultural factors such as urbanisation, trends in rural-urban or overseas migration,[27] women's security, women's empowerment, cultural attitude to communication;[28]

natural differences such as geography, population density. Although the economics of mobile make this less of a problem than for fixed lines, thin population density rapidly escalates the average cost of extending rollout in rural or remote areas.[29]

Mobiles and economic growth

The spread of telecommunications should improve growth and consumer well-being in poor countries. Earlier research suggests that, as might be expected, telecommunications rollout boosts growth, with a surprisingly strong effect reported in some studies.[30] This kind of evidence contrasts with the difficulty in demonstrating a positive link between ICTs in general and an increase in trend growth in most countries.[31] Successful once-developing countries such as Hong Kong, Korea and Singapore used telecommunications as a key part of their economic development strategies.[32] More recently Malaysia has placed the same emphasis on telecoms investments.[33] Hardy (1980)[34] found that the impact of telecoms investment was greatest in the least developed economies and lower in advanced economies, which is entirely intuitive given the much wider availability of fixed-line telephony and other complementary technologies in the developed economies. Roeller and Waverman (2001)[35] analysed only OECD countries and found that there was a critical mass effect – that the impact of increased telecoms penetration was especially important at near universal service. (Network effects may also favour larger markets – South Africa over Botswana, for example.)[36] Roeller and Waverman also attempted to analyse the experience of the developing economies (in an early 1996 draft, looking at the period 1970-1990), but the data limitations made the results problematic. However, these results suggested low impacts of telecom advancement for developing countries, as they are not near universal service. Nor are developed country approaches to achieving universal service appropriate for countries where so little of the population yet has access to telecommunications, despite the rapid spread of mobile.

The impact of mobiles on growth in developing countries,

however, is not covered the earlier literature.[37] This is the gap filled by the next section of this report, by Leonard Waverman, Meloria Meschi and Melvyn Fuss. They confirm that the growth impact of mobiles is large in both developed and developing countries, but around twice as important in the latter group, where there is also a critical mass effect. The policy implication of their results for developing countries is clear: it will be worth investing large amounts in telecommunications to get close to universal service. As wireless technologies are much lower cost to roll out over large areas than fixed line systems, mobile can potentially play a vital role in economic development.

World Bank research suggests the internal rate of return generated by telecoms investments in developing countries of around 20%. There is also some evidence that telecoms rollout is linked with higher levels of foreign direct investment.[38] This relationship is explored in the section on FDI in this report by Mark Williams, which assesses the separate impacts of fixed line infrastructure and mobiles on FDI.

Other economic and social impacts of mobile

The existing evidence on other impacts of mobile indicates positive correlations between teledensity and quality of life indicators – allowing for GNP per capita – such as longer life expectancy, lower infant mortality and lower illiteracy (although such correlations must be treated with great caution given the existence of simultaneity and omitted variables).[39] One measure of the perceived opportunities and benefits provided by mobile or by telecommunications in general is the amount consumers are willing to spend on services. The available evidence is that telecoms services are very highly valued. In all developing countries, the average spent on telecommunications is 2% of monthly expenditure. In a sample of Indian villages, the average was 3% of household income. In Chile poor people spend more of their incomes on telecommunications than on water, and even the average household spends more on telecoms than on water and electricity combined.[40] However, estimates of the price elasticity of demand are typically quite high, which implies that high call charges could inhibit mobile penetration and usage in some developing countries. Income elasticities are also high: one study in India found a 1% rise in household income almost doubled demand for telecommunications.[41] Waverman et al in this report also confirm that price and income eleasticities of demand are high.

There is every reason to believe that the economic and social returns to mobile will be highest of all in rural areas, which are consistently less well provided with telecommunications services. Serving rural areas is also closely linked to anti-poverty efforts. Half the world's population – 3 billion people – lives in rural areas, and there is a substantial overlap between poverty and rural dwelling. Telephone connectivity appears to be highly correlated with the extent of the non-farm sector, and consequently average incomes, in rural areas. A study of 27 Thai villages found that the only non-agricultural activities took place in the 18 with Public Call Offices (mostly fixed line); the other 9 had no manufacturing businesses. This is consistent with findings from other countries from Botswana to Ecuador showing an improvement in non-farm incomes in rural areas.[42]

To the extent that mobile communications are reaching some rural areas with little or no fixed line availability, rural people are better able to stay in contact with family members. Mobiles are also improving the flow of information available to would-be migrants from urban centres or from overseas. Survey evidence from Bangladesh suggests the main reason for calls made via GrameenPhone mobiles are financial (queries about remittances, finding jobs in the city) or family-related (staying in touch with relatives working elsewhere).[43]

There can be medical or educational benefits from improved access to expertise, for example in access to medical advice for a remote villager. Earlier research documented such impacts of telephony in the remote areas of developed countries, such as Canada and Australia. Likewise, previous studies on telephony looked at the importance of social contact for people living in remote and lightly populated areas – such as the Australian outback. Researchers suggest this is particularly important for women.[44]

There are now several studies documenting the improvement in prices received by farmers as a result of better access to telephony in general and mobile in particular, in developing countries in Asia, Africa and Latin America. One particularly nice example is the case of fishermen in India using mobile phones to get information about prices at different ports before deciding where to land their catch.[45] This specific example was confirmed in a study of fishermen on Mafia Island, off the Tanzanian coast, where the Vodafone Foundation partners the WWF in a marine project.[46]

The improved flow of information evidently reduces monopsony power in agricultural markets – especially non-commodity markets such as perishable fruits, where prices were not already published in newspapers. The impact of an improved information flow thanks to better telecommunications ought to be apparent in the dispersion of prices for the same product in different parts of the same national or regional market. If information flows are poor, the 'law of one price' will not operate: the market will not work well, and middle-men will be able to discriminate between different suppliers or customers (although competition amongst middlemen can limit this). There is evidence from the historical record that the telegraph and telephone reduced the dispersion of agricultural prices, and raised farm incomes, in the United States in the 19th and 20th centuries. Earlier work demonstrated the impact of the development of a long-distance fixed line

network in the creation of a credit market for coffee growers in Ethiopia.[47] The same phenomenon of reduced farm price dispersion has been documented in China recently.[48]

Just as in developed countries, mobiles save time and enable efficiencies in business, especially in terms of coping with unexpected events (taxis responding to customers in the cities, dealing with a blocked road or an accident when making a delivery). There is plentiful anecdotal evidence of this kind, much of it to be found in newspaper coverage. A few studies report similar findings – for example, reduced emergency response times.[49] In a few countries – notably China – mobiles are being used for e-commerce: home shopping or trading in shares.[50] Studies also report law enforcement benefits from the ability to contact police quickly. In Bangladesh for example, law enforcement agencies give GrameenPhone some credit for reduced rural crime rates. There are other examples of mobiles being used to improve security and thus efficiency – for example, maize farmers in the Democratic Republic of Congo have provided phones to security guards, increasing their yields significantly through reducing looting.[51]

The two final sections of this report contribute to this research on social and economic impacts of mobiles using the results of surveys on the use of mobile carried out for Vodafone in rural communities in South Africa and Tanzania, and of small businesses in Egypt and South Africa. The community surveys assess the factors affecting mobile use, and the range of potential impacts, in relatively poor, rural African communities. As Jonathan Samuel, Niraj Shah and Wenona Hadingham report below, the surveys suggest that mobile telephony is frequently accessed by the poorest people, thanks in part to widespread sharing. The surveys suggest that gender, age and education do not present insurmountable barriers to access – nor even the absence of electricity. Individuals surveyed in rural communities highlighted savings in travel time and costs and easier communication with family and friends, in addition to access to business information and easier job search. A majority of small businesses reported increased sales and profits, time savings and greater efficiency. For many black-owned businesses in Cairo, a mobile phone was the only means of communication available. The final section of this report, by James Goodman, looks specifically at the implications of the survey results for social capital, or the strength of social networks and contacts in the rural communities. Mobile phone ownership in the communities surveyed was positively linked to life satisfaction and a willingness to help others. A clear majority of respondents said owning a mobile had improved their relationship with family members living elsewhere.

The studies included here represent the early stages of Vodafone's SIM programme, which will continue to contribute to the growing body of evidence. As more data and more research become available, it will be important for policy makers and anybody interested in social and economic development in Africa to understand the impact of the extraordinary spread of mobile.

All references in this section are to the bibliography at the end of the report.

Notes

1 UNDP HDR database.

2 ITU 2003, ITU 2004, Kirkman and Sachs, World Bank2000, World Economic Forum 2003. (All references are to Mobile Bibliography).

3 Figures in this paragraph from ITU 2004.

4 DFID (2004); see also www.infodev.org.

5 ITU 2003.

6 Gebreab (2002)

7 The Kingdom of Morocco and Vivendi Universal agreed on November 18, 2004, to the acquisition by Vivendi Universal of 16% of the capital of Maroc Telecom. The agreement allows Vivendi Universal to increase its stake from 35% to 51%, thereby perpetuating its control over the company. Payment for this transaction was made in January 2005.

8 See also Eggleston et al (2002), Forestier et al (2002), World Economic Forum (2003).

9 Grace et al (2001). See also ITU World Telecommunications Indicators 2004, Chapter 4 on the Millennium Development Goals.

10 Grace et al (2001).

11 Forestier et al (2002), Navas-Sabater (2002), Rodriguez and Wilson (2000).

12 Kenny (2002)

13 Dholakia and Kshetri (2002)

14 Mansell (2001), Qiang et al

15 Kenny (2002)

16 Forestier et al, Kenny (2002)

17 Bruns et al (1996), ITU (2002), Navas-Sabater et al (2002).

18 Latcham and Walker (2001), Proenza (2001)

19 Grajek (2003); see also Roeller and Waverman (2001).

20 Dorj (2001)

21 Azam et al – Senega (2002); Bruns et al – Thailand (1996); Forrestier et al (2002); Gebreab – Africa (2002); ITU (1999) – Bangladesh; Laffont et al – Cote D'Ivoire (2002); Rossotto et al (2000) – MENA; Rossotto et al (2003); UNDP; Wallsten (1999) – Africa and Latin America,

22 Beardsley et al. (2002)

23 ITU (2003), Navas-Sabater (2002).

24 Kenny (2002), Wellenius (2001)

25 Forestier et al (2002);

26 Lopez (2000).

27 Bruns et al (1996),

28 Dholakia and Kshetri (2002).

29 Dorj (2001), Kenny (2002).

30 See Röller and Waverman for a careful study using OECD data – this refers back to the older literature; Madden and Savage (1998) find a stronger result for Central and Eastern Europe; Nadiri and Nandi (2003) also find a strong link for developing countries.

31 OECD 2003.

32 Saunders et al (2003).

33 Riaz (1997).

34 Hardy (1980).

35 Roeller and Waverman (2001).

36 Qiang et al

37 An exception is Jha, R and S. Majumdar (1999).

38 Mansell (2001), Navas-Sabater (2002).

39 Forestier et al (2002), Kenny, UNDP (2002).

40 Navas-Sabater (2002), Wellenius (2000); Blattman et al (2002); De Melo cited in Forestier (2002).

41 Grajek (2003), ITU (2003); Blattman et al (2002).

42 Bruns et al (1996); Duncombe and Heeks (1999), Forestier et al (2002).

43 Bruns et a (1996); Bayes et al (1999).

44 Bayes et al (1999), Hammond (2001); Hudson (1995)

45 Bruns et al (1996); Forestier et al (2002); Hudson (1995); ITU (1999); Lopez (2000). Dholakia and Kshetri (2002).

46 http://www.wwf.org.uk/annualreview/2003-2004/business.asp

47 Hirschman, referenced in Forestier et al (2002).

48 Hudson (1995); Eggleston et al (2002).

49 Bruns et al (1996), Schwartz (2001.)

50 Dholakia and Kshetri (2002), Laperrouza (2002).

51 Bayes et al (1999); Lopez (2000).

Leonard Waverman

Professor & Chair of Economics, London Business School

Meloria Meschi

Associate Professor of Economics, John Cabot University, Rome and Affiliate, LECG, London

Melvyn Fuss[1]

Professor of Economics, University of Toronto

The Impact of Telecoms on Economic Growth in Developing Countries

Introduction

There is a long tradition of economic research on the impact of infrastructure investments and social overhead capital on economic growth. Studies have successfully measured the *growth dividend* of investment in telecommunications infrastructure in developed economies.[2] But few have assessed the impact of telecommunications rollout in developing countries. Given the importance of telecommunications to participation in the modern world economy, we seek to fill the void in existing research. Investment in telecoms generates a growth dividend because the spread of telecommunications reduces costs of interaction, expands market boundaries, and enormously expands information flows. Modern revolutions in management such as 'just-in-time' production rely completely on efficient ubiquitous communications networks. These networks are recent developments. The work by Roeller and Waverman (2001) suggests that in the OECD, the spread of modern fixed-line telecoms networks alone was responsible for one third of output growth between 1970 and 1990.

Developing countries experience a low telecoms trap – the lack of networks and access in many villages increases costs, and reduces opportunities because information is difficult to gather. In turn, the resulting low incomes restrict the ability to pay for infrastructure rollout.

In the OECD economies, modern fixed-line networks took a long time to develop. Access to homes and firms requires physical lines to be built – a slow and expensive process. France, which had 8 fixed line telephones per 100 population (the 'penetration rate') in

1970, doubled this by 1976, and reached 30 main lines per 100 population in 1980. Mobile phones are lower cost and far quicker to rollout than fixed lines. In 1995, Morocco had 4 fixed lines per 100 inhabitants after many years of slow investment, and zero mobile phones per 100 inhabitants. In 2003, only eight years later, the mobile phone penetration rate in Morocco was 24, while fixed line penetration had stagnated at its 1995 level.

We find that mobile phones in less developed economies are playing the same crucial role that fixed telephony played in the richer economies in the 1970s and 1980s. Mobile phones substitute for fixed lines in poor countries, but complement fixed lines in rich countries, implying that they have a stronger growth impact in poor countries. Many countries with under-developed fixed-line networks have achieved rapid mobile telephony growth with much less investment than fixed-line networks would have needed.

We subjected the impact of telecoms rollout on economic growth in poorer nations to a thorough empirical scrutiny. We employed two different approaches – the Annual Production Function (APF) approach following the work of Roeller and Waverman (2001) and the Endogenous Technical Change (ETC) approach similar to the work of Robert Barro (1991). The latter provided us with the most robust and sensible estimates of the impact of mobile telephony on economic growth. We used data on 92 countries, high income and low income, from 1980 to 2003, and tested whether the introduction and rollout of mobile phone networks added to growth.

We find that 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*. This result concurs with intuition. Developed economies by and large had fully articulated fixed-line networks in 1996. Even so, the addition of mobile networks had significant value-added in the developed world: the value-added of mobility and the inclusion of disenfranchised consumers through pay-as-you-go plans unavailable for fixed lines. In developing countries, we find that the growth dividend is far larger because here mobile phones provide, by and large, the main communications networks; hence they supplant the information-gathering role of fixed-line systems.

The growth dividend of increasing mobile phone penetration in developing countries is therefore substantial. All else equal, the Philippines (a penetration rate of 27 percent in 2003) might enjoy annual average per capita income growth of as much as 1 percent higher than Indonesia (a penetration rate of 8.7 percent in 2003) owing solely to the greater diffusion of mobile telephones, were this gap in mobile penetration to be sustained for some time. A developing country which had an average of 10 more mobile phones per 100 population between 1996 and 2003 would have enjoyed per capita GDP growth that was 0.59 percent higher than an otherwise identical country.
For high-income countries, mobile telephones also provide a significant growth dividend during the same time period. Sweden, for example, had an average mobile penetration rate of 64 per 100 inhabitants during the 1996 to 2003 period, the highest penetration of mobiles observed. In that same period, Canada had a 26 per 100 average mobile penetration rate. All else equal, we estimate that Canada would have enjoyed an average GDP per capita growth rate nearly 1 percent higher than it actually was, had the mobile penetration rate in Canada been more-than-doubled.

Our research also provides new estimates of demand elasticities in developing countries – we find both the own–price and income elasticities of mobile phone demand to be significantly above 1. That is, demand increases much more than in proportion to either increases in income or reductions in price. We also find that mobile phones are substitutes for fixed-line phones.

Economists have long examined the importance of social overhead capital (SOC) to economic growth. SOC is generally considered as expenditures on education, health services, and public infrastructure: roads, ports, and the like. Telecommunication infrastructure, whether publicly or privately funded, is a crucial element of SOC. We in the west tend to forget what everyday life would be like, absent modern telecommunications systems. These networks enable the ubiquitous, speedy spread of information. Alan Greenspan, the Chairman of the US Federal Reserve Board, coined the term “New Economy” to represent how the spread of modern information and communications technology has enabled high growth with low inflation. This “New Economy” is the direct result of the networked computer – the ability of higher bandwidth communications systems to allow computer-to-computer communications.[3] The ”New Economy” enables greater competition and new means of organising production.

In earlier periods, telecommunications networks helped generate economic growth by enabling firms and individuals to decrease transaction costs, and firms to widen their markets; Roeller and Waverman (2001)[4] estimated the impact on GDP of investment in telecoms infrastructure in the OECD between 1970 and 1990. They showed it significantly enhanced economy-wide output, allowing for the fact that the demand for telecoms is itself positively related to GDP. One must remember that in 1970 telecoms penetration was quite low in a number of OECD countries. While the US and Canada had near-universal service in 1970, in the same year France, Portugal and Italy for example, had only 8, 6, and 12 phones per 100 inhabitants respectively. It is then not surprising that the spread of modern telecommunications infrastructure between 1970 and 1990 generated economic growth over and above the investment in the telecoms networks itself.

Roeller and Waverman also demonstrated that the scale of impact of the increased penetration of telecoms networks on growth depended on the initial level of penetration, with the biggest impact occurring near universal service – a phone in every household and firm. The standard government policy of

universal service was, then, not only a question of equity, but was also implicit recognition of the growth-enhancing properties of telephony expansion.

In 1995, just under half of the membership of the International Telecommunications Union (ITU), an international organisation comprising 214 countries, had telecoms penetration rates below 8, the level attained by France in 1970. Much of the world still lacked a major component – the telephone – of a modern, efficient economic system in 1995.

In the 1970 to 1990 period analysed by Roeller and Waverman mobile phones were not important: telecoms networks were fixed-line systems. Today, when we consider telephone networks, the importance of mobiles stands out, especially when we examine the 102 members of the ITU that had low phone penetration in 1995.

Table 1 lists these countries (i.e., with less than 8 phones per 100 population in 1995, when virtually all phones were fixed lines) and the penetration rate in 2003 for both fixed lines and mobiles. The average fixed-line penetration rate of these 102 countries in 1995 was 2.5 phones per 100 population, and this level was achieved after decades of investment. With the subsequent rapid growth of mobile phones in many, but not all, of these countries, the average penetration rate of mobile phones alone rose to 8 per cent in 2003. In 22 of the 102 countries, mobile penetration reached double digits in 2003. And in 7 countries, over one-quarter of the population had mobile phones in 2003 – Albania, Bosnia, Botswana, the Dominican Republic, Paraguay, the Philippines and Thailand.

The story is clear. In developing countries, modern telecoms systems are largely mobile systems and not fixed lines. The reason is the lower cost and faster roll-out of mobile systems as compared to fixed lines. It has been estimated that a mobile network costs 50 percent less per connection than fixed lines and can be rolled out appreciably faster. The cost advantages of mobile phones as a development tool consist not only of the lower costs per subscriber but also the smaller scale economies and greater modularity of mobile systems.

Table 1: The Emergence of Mobile Telephony in 102 Low and Middle-Income Nations

Country	Main lines per 100 population in 1995	Main lines per 100 population in 2003	Mobile Subscribers per 100 population in 1995	Mobile Subscribers per 100 population in 2003
Afghanistan	0	0	0	1
Albania	1	8	0	36
Algeria	4	7	0	5
Angola	0	1	0	..
Bangladesh	0	1	0	1
Benin	1	1	0	3
Bhutan	1	3	0	1
Bolivia	3	7	0	15
Bosnia and Herzegovina	6	24	0	27
Botswana	4	7	0	30
Burkina Faso	0	1	0	2
Burundi	0	0	0	1
Cambodia	0	0	0	4
Cameroon	0	..	0	7
Cape Verde	6	16	0	12
Central African Rep.	0	..	0	1
Chad	0	..	0	1
China	3	21	0	21
Comoros	1	2	0	0
Congo	1	0	0	9
Congo (Democratic Republic of the)	0	..	0	2
Cote d'Ivoire	1	1	0	8
Cuba	3	..	0	..
Dem. People's Rep. of Korea	2	4	0	..
Djibouti	1	2	0	3
Dominican Rep.	7	12	1	27
Ecuador	6	12	0	19
Egypt	5	13	0	8
El Salvador	5	12	0	18
Equatorial Guinea	1	2	0	8
Eritrea	0	1	0	0
Ethiopia	0	1	0	0
Gabon	3	3	0	22
Gambia	2	..	0	..
Ghana	0	1	0	4
Guatemala	3	..	0	..
Guinea	0	0	0	1
Guinea-Bissau	1	1	0	0

Table 1: The Emergence of Mobile Telephony in 102 Low and Middle-Income Nations – continued

Country	Main lines per 100 population in 1995	Main lines per 100 population in 2003	Mobile Subscribers per 100 population in 1995	Mobile Subscribers per 100 population in 2003
Guyana	5	..	0	..
Haiti	1	2	0	4
Honduras	3	..	0	..
India	1	5	0	2
Indonesia	2	4	0	9
Iraq	3	..	0	..
Jordan	7	11	0	24
Kenya	1	1	0	5
Kiribati	3	..	0	1
Kyrgyzstan	8	..	0	..
Lao P.D.R.	0	1	0	2
Lesotho	1	..	0	..
Liberia	0	..	0	..
Libya	6	14	0	2
Madagascar	0	0	0	2
Malawi	0	1	0	1
Maldives	6	..	0	..
Mali	0	..	0	2
Marshall Islands	7	8	1	1
Mauritania	0	1	0	13
Mayotte	4	..	0	22
Micronesia (Fed. States of)	7	10	0	5
Mongolia	4	6	0	13
Morocco	4	4	0	24
Mozambique	0	..	0	2
Myanmar	0	1	0	0
Namibia	5	7	0	12
Nepal	0	2	0	0
Nicaragua	2	4	0	9
Niger	0	..	0	0
Nigeria	0	1	0	3
Oman	8	..	0	..
Pakistan	2	3	0	2
Palestine	3	9	1	13
Papua New Guinea	1	..	0	..
Paraguay	3	5	0	30
Peru	5	7	0	11
Philippines	2	4	1	27
Rwanda	0	..	0	2
Samoa	5	7	0	6
Sao Tome and Principe	2	5	0	3
Senegal	1	2	0	6
Sierra Leone	0	..	0	..
Solomon Islands	2	1	0	0
Somalia	0	..	0	..
Sri Lanka	1	5	0	7
Sudan	0	3	0	2
Swaziland	2	4	0	8
Syria	7	..	0	..
Tajikistan	4	4	0	1
Tanzania	0	0	0	3
Thailand	6	10	2	39
Togo	1	1	0	4
Tonga	7	..	0	..
Tunisia	6	12	0	19
Turkmenistan	7	..	0	..
Tuvalu	5	..	0	0
Uganda	0	0	0	3
Uzbekistan	7	7	0	1
Vanuatu	3	3	0	4
Viet Nam	1	5	0	3
Yemen	1	..	0	3
Zambia	1	1	0	2
Zimbabwe	1	3	0	3

Average Fixed Penetration in 1995: 2 Average Fixed Penetration in 2003: 5 Average Mobile Penetration in 1995: 0 Average Mobile Penetration in 2003: 8

The importance of conveying information

Consider what communicating in France must have been like 35 years ago, in 1970, with only 8 phones per 100 people. The description of Geertz (1978) as applying to developing countries, "information is poor, scarce, maldistributed, inefficiently communicated and intensely valued"[5], must have applied equally to France. Residents of remote villages with no phone connections would have enormous difficulty in discovering prices of commodities. Farmers would not have access to alternative sources of fertilisers or to alternative buyers of their products. As recent studies on the use of mobile phones in South Africa show, the substitute for telecommunicated information would have been physical transport.[6] Instead of a quick phone call, never mind Internet usage, determining selling or buying prices would require costly, time-consuming physical contacts and transport. Thus without telecommunications, the costs of information retrieval and of transacting in general would be high. Besides greater transaction costs, the range of supply would be much smaller, or for transactions across large distances, risks would be higher as prices and conditions of sale would not be known exactly. Modern telecom networks, then, are crucial forms of Social Overhead Capital. But how important are they?

There are two basic ways in which economists determine the extent of the economic growth impact of some factor such as increased education or telecoms infrastructure investment – aggregate production function (APF) estimation and the endogenous technical change (ETC) approach.

In the first approach – the APF – the level of economy-wide Gross Domestic Product (GDP) each year is assumed to be determined by that year's aggregate capital, aggregate labour, and other specific factors such as education or the spread of telecommunications. The growth dividend of telecoms would be measured by its annual contribution to GDP growth. The second approach – the ETC – relates the average rate of growth of GDP over a substantial period (we use the 24-year period 1980 to 2003) to the initial level of GDP, average investment as a share of GDP during that period, the initial stock of labour represented in terms of its educational attainment[7], and the initial or average telephone penetration rate. The contribution of telecoms to growth is here measured by its boost to the long-term growth rate. The ETC approach is not an average over time of the APF approach, as the two models rest on different theoretical underpinnings.

Empirically, the two methods differ as well: the production function approach uses annual data, so errors or missing observations cause significant difficulties. The endogenous technical change approach uses period averages and initial period values instead, and it is thus less prone to data errors. Given the paucity of reliable data in developing countries, the ETC approach should prove more robust and tractable.

Because demand for telecoms services rises with wealth, it is crucial in the APF approach to disentangle two effects – the impact of increased telecoms rollout on economic growth and the impact of rising GDP itself on the demand for telecoms. This is called the two-way causality issue, or 'endogeneity', as the demand for telecoms is itself dependent on the level of GDP. Hence estimating an APF alone would lead to biased and likely exaggerated measures of the growth dividend of telecoms.

This endogeneity problem is handled in Roeller-Waverman by developing a four-equation model: the first equation is the output equation or economy-wide production function; the second equation determines the demand for telecoms; a third equation determines the investment in telecoms infrastructure and a final equation relates investment to increased rollout. In this model, the explicit causality from GDP to demand is recognised in equation two, allowing any estimated effect of telecoms on growth (equation one) to be net of the demand-inducing effects of rising GDP.

The two-way causality problem cannot be dealt with explicitly in the endogenous growth model approach but is unlikely to be a central issue. One cannot, for example, add a demand equation defined as the average demand over the period. Instead one has to use data analysis, instrumental variables and statistical tests to determine whether there is any reverse causality present.[8]

Existing literature

The notion that telecoms infrastructure is an important part of SOC is not new. Various researchers beginning with Hardy[9] in 1980, Norton[10] in 1992 and others[11] have all found that there is an "externality" component in enhanced fixed telecoms penetration – that is, GDP is higher, and growth faster in countries with more advanced telecoms networks. Of course, as noted, one has to worry about reverse causality in richer countries; there, as income rises, demand for luxuries such as a universal telephone service rises as well. Although these studies do not adjust for reverse causality, several facts bear out the existence of the telecoms externality. First, Hardy examined both radio and telephone rollouts, since if the telephone simply provides information, radio broadcasts might be good alternatives. Hardy found no significant impact of radio rollout on economic growth, in contrast to telephones. Secondly, telephones (unlike radios, for example) have strong network effects – the value of a telephone to an individual increases with the number of other telephone subscribers.

Hence, as networks grow, their social value rises. This suggests that the social return – the value to society of an additional person connected or of an additional dollar invested in the network – exceeds the private return to the network provider, if that provider cannot price so as to extract these externality values. The Roeller-Waverman paper shows strong network

effects. In the OECD in from 1970 to 1990, incremental increases in penetration rates below universal service levels generated only small growth dividends. Only at near universal service (30 mainline phones per 100 inhabitants which is near 70 or so mainline phones per 100 households) were there strong growth externalities from telephone rollout.

Several more recent papers extend this analysis to mobile phones – among these are Torero, Choudhary and Bedi[12] (2002) and Sridhar and Sridhar[13] (2004). Several points need to be made on this research. First, for economies without many fixed lines, or where mobiles supplement low fixed-line rollout, there should be no inherent difference in the growth dividend of a phone, whether it is mobile or fixed. In developing countries, an additional phone, whether fixed or mobile, increases the small network size and adds to the economy's growth potential. Secondly, where mobile phones complement fixed lines (in advanced economies), their externality effects will probably be different from those found for fixed lines. As individual lifestyles change and as firms utilise mobiles in productivity-enhancing ways, we should see new economic growth from mobile networks as well. For penetration rates of fixed lines are not 100 percent in developed economies. For example, in the USA in 1995, the penetration rate was 60 phones per 100 people. Mobile phones move the developed economies closer to universal service because pre-pay contracts allow exact monitoring of use, something very difficult to manage with fixed-line phones, making them accessible to other groups of users.

Some of the recent empirical studies specifically examine the impact of mobile phone expansion on growth in developing countries, using the Roeller-Waverman (RW) framework. Three caveats must be mentioned here. First, in many of these countries, growth has been low due to a host of issues – poor governance, lack of capital, low skill levels, and the like. It is difficult to show that mobile telephony increases growth rates where growth is low. Secondly, advances in telecoms penetration rates in developing countries are recent, so there is little real trend as yet. Finally, since mobiles are so new, there has been extremely rapid growth in mobile penetration starting from zero. Thus, if one tries to explain economic growth by changes in capital, labour, education and mobile phones, one could find either that *all* economic growth is due to the explosive growth in mobile phones, or conversely that mobile phones *decrease* growth since their use increases so quickly with little underlying economic growth occurring. Good econometrics requires careful consideration of underlying facts.

Sridhar and Sridhar (2004) apply the RW Framework to data for 28 developing countries over the twelve-year period 1990 to 2001. The average compounded annual growth rate (CAGR) of GDP per capita in this period was *minus* 2.03 per cent, while the CAGR of mainlines was 6.60 and of mobile phones 78.0 percent. In their regression, they find that mobile phones explain all growth – a 1 percent increase in mobile phone penetration increases growth by 6.75 percent. Below, we provide our own analyses of the RW aggregate production function approach. We do find more plausible although still exceedingly high impacts of mobile phones on growth. But the result is not robust to alternative specifications or to changes in countries included in the sample, and we do not rely on these estimates to draw any conclusions. We provide the APF model also to show the demand equation estimates – these are also most interesting, and robust.

The Aggregate Production Function

In order to estimate the impact of mobile phones in developing countries, we gathered information from the World Bank's World Development Indicators (WDI) database for basic variables such as GDP, population, labour force, capital stock and so on for both low-income and lower-middle-income countries. The International Telecommunication Union (ITU) produces a World Telecommunications Indicators database, updated annually, and we used this for data on our major telecoms-related variables – such as revenue, investment, and subscriber numbers. We also relied on the World Bank's Governance Indicators, so that we could incorporate some measures of institutional quality, which most certainly has an impact on growth. We included 38 developing countries for which full data are available for the period we used, which is 1996 to 2003.[14]

The framework employed was a three-equation modification of the Roeller-Waverman approach. **Appendix A** provides further details. We summarise briefly the model that we used:

1. The **Output** equation models the level of output (GDP) as a function of the total physical capital stock net of telecoms capital, the total labour force, a variable that captures the extent of the "rule of law", and the mobile telecoms penetration rate. To account for the fact that output generally increases over time, we included a time trend term. We also included indicator variables capturing the level of external indebtedness of the country (there were three levels – High, Medium and Low). Roeller and Waverman used a dummy variable for each country (a so-called "fixed effects" or "Least Square Dummy Variables" approach). This variable controls for unobservable characteristics or omissions from the equation that are peculiar to each country; our approach here is similar in spirit, since it captures the impact of particular characteristics (such as the indebtedness level) on output.[15]

2. The **Demand** equation models the level of mobile telecoms penetration as a function of income (the level of GDP per capita), mobile price (revenue per mobile subscriber), and the fixed-line price (which is revenue per fixed-line subscriber). The demand equation also allows for a time trend, since demand for a new product such as mobiles could also feature a strong trend.

3. The **Investment** equation simplifies the Roeller-Waverman "supply" and "investment" equations. It assumes that the growth rate of mobile penetration depends on the price of telecoms (the relationship should be positive since higher prices should invite additional supply), the geographic area (the relationship should be negative), and a time trend term.

We estimated the system of equations described above using the Generalised Method of Moments (GMM) method.[16] This approach uses all the exogenous variables in the system of equations (i.e., those that we can reasonably assume are not determined by the other variables in the system, such as the amount of labour and the amount of total capital) as "instruments" for the endogenous variables (output, the level of mobile and fixed penetration, and the mobile and fixed prices).[17]

The results for the output and demand equations from running this GMM regression are summarised in **Tables 2** and **4** respectively (see **Appendix A** for the full set of results):

Table 2: Output equation (dependent variable is log of output)

Variable	Coefficient	T-Statistic
Capital	0.776	13.79
Labour	0.204	3.91
Mobile Penetration[18]	0.075	3.60

The coefficients obtained above are encouraging at first glance. The coefficients on capital and labour sum to close to 1, which is roughly consistent with the standard hypothesis of constant returns-to-scale for the economy as a whole. The coefficient of the log of mobile penetration (which is a transformed version of the original variable) is 0.075. However, the interpretation of this is not straightforward: the impact of penetration on output depends on the level of penetration. **Table 3** shows the average levels of mobile penetration and GDP in those countries that the ITU classifies as "Low Income" and "Lower-Middle-Income" for 1996 and 2002 respectively.[19] For the average country, with a mobile penetration of 7.84 phones per 100 population in 2002, the coefficient of 0.075 on the transformed mobile penetration variable implies that a doubling of mobile penetration would lead to a 10 percent rise in output, *holding all else constant*.

Table 3: Mobile Penetration and GDP for "average" developing country, 1996-2002.

Year	Mobile Penetration	GDP
1996	0.22	$41 billion
2002	7.84	$47 billion

Considering that the average CAGR of GDP in these nations has been roughly 2 percent, this seems to high an estimate of the impact of mobile penetration. A growth rate of GDP of 2 percent over 8 years for the average country would imply total (compounded) growth of 19 percent. Meanwhile, the average CAGR of mobiles has been 64 percent in these same countries: mobile penetration more than doubles every two years in the average country. Given the estimated impact of mobile penetration presented in Table 2, if a developing country were enjoying "typical" growth rates of GDP and mobile telephones, then increased mobile penetration explains all the growth over the sample period.

The problem here is the one of weak output growth in many of the countries, but robust growth in mobile phone penetration. The model does not adequately control for the other factors affecting growth in the economy.[20] We attempted to extend the sample – both by adding more countries and increasing the time period back to 1980,[21] and also to modify the specification somewhat, but the results did not prove robust to either changes in the sample or changes in the model specification.

On the other hand, the demand equation from the aggregate production function model always performed well. **Table 4** shows the results of the GMM estimation for the demand equation:

Table 4: Demand equation (dependent variable is mobile penetration)

Variable	Coefficient	T-Statistic
Mobile Price	-1.50	-6.06
Fixed-line price	0.31	2.79
GDP per Capita	1.95	23.30

Table 4 shows that mobile demand falls when the price of mobiles increases, but increases when the price of fixed lines increases, suggesting that there is substitution between fixed line telephony and mobiles. Mobile demand is also strongly positively correlated with increases in income. The equation is in double-log form so the coefficients can be interpreted as elasticities of demand, at the average penetration rate.

The own-price-elasticity of mobile phones is minus 1.5, which implies that demand is elastic: a 10 percent price increase would reduce demand by roughly 11.6 percent for a country in which mobile penetration is about 8 percent, the average level of mobile penetration for the developing countries.[22] The cross-price elasticity between mobile and fixed lines is positive, indicating that in these countries, mobiles and fixed telephones are substitutes: an increase in the price of fixed-line phones by 10 percent increases the demand for mobiles by 2.4 percent, assuming mobile penetration at the "average" level of 8 percent. Moreover, mobiles are 'luxuries' (in the technical sense) as the income elasticity is significantly above one – for the "average" developing country with 8 percent mobile penetration, a 1 percent increase in per capita GDP is associated with a 1.5 percent increase in the level of mobile penetration. The structure

of the demand equation is much simpler than that of the output equation and since the equation deals with demand for one particular characteristic – mobile penetration – it is relatively easier to capture the factors that affect this demand than it is to capture all the factors which serve to increase or reduce output over time.

Ultimately, though, in light of the problems with the APF approach, especially the significant difficulties of obtaining adequate data across a large group of developing countries, we turn to the endogenous growth model.

The Endogenous Growth model

We follow the work of Barro,[23] who ran growth regressions for a cross-section of countries for the time period 1960 to 1985. The basic questions Barro was addressing were two-fold: was there 'convergence' between rates of growth between poorer and richer countries as economic theory predicts; and how did differences in skill levels affect growth rates? Barro took average growth rates of per capita GDP for a cross-section of 98 countries and regressed these growth rates against regressors which included initial levels of GDP per capita and human capital stock,[24] the average government consumption to GDP ratio for the period 1970-1985, and measures of stability.[25]

Barro found that, conditional on the initial human capital stock, average GDP per capita growth was negatively correlated with initial GDP per capita.[26] Thus, all else equal, poorer countries should close the income gap with richer countries, albeit only over long periods of time. The initial level of human capital stock was positively correlated with GDP per capita growth, so countries that were initially rich might actually grow faster than poorer countries if there were sizeable differences in their initial endowments of human capital. Only by controlling for these differences could he verify that there is indeed economic convergence between richer and poorer nations.

Our approach is similar. We took the average growth rate of per capita GDP from 1980 to 2003 as our dependent variable, and regressed this average growth rate on variables which included the initial level of GDP, the average ratio of investment to GDP, the stock of telecoms in 1980 (measured by the level of fixed-line penetration in 1980), the proportion of the 15-and-above population that had completed *at least* primary schooling in 1980, and the *average level* of mobile penetration for the period 1996 to 2003 (the period in which mobile penetration increased rapidly). Our sample consisted of 92 countries – developing and developed alike. The data came from the same sources – the World Development Indicators and the ITU – that we used for the APF estimation.

We are not primarily examining the issue of 'convergence' in income levels but instead in whether the increase in mobile penetration increases growth rates, and whether it does so equally in rich and poor countries. As mobile growth starts in essentially the same recent period for all countries, rich and poor alike, this is an interesting and important question. Our hypothesis is that increased mobile rollout should have a greater effect in developing countries than in rich countries. The reason is simple: while in developing countries the benefits of mobile are two-fold – the increase in the network effect of telecoms *plus* the advantage of mobility – in developed economies the first effect is much more muted.

In this model, there are no mobile phones in 1980, as there is for other stock variables (e.g., we have proxied the stock of human capital in 1980, and have included the stock of telecom capital in 1980). We can assume that the 1980 levels of human and telecom capital are exogenous – that is, they ought not to be the result of income growth between 1980 and 2003.[27] We cannot, however, assume that there is no reverse causality between income growth in the 1980 to 2003 period and average mobile penetration over a portion of the same period with quite the same safety. Thus, mobile penetration is potentially endogenous, and we must examine whether or not this is so.

We started with an initial specification that did not attempt to capture differential effects of telecoms between developing and developed countries. **Table 5** (also reported in fuller form in **Appendix B**) reports the results of a simple Ordinary Least Squares (OLS) regression:[28]

Table 5: Baseline results from the ETC model (dependent variable is average per capita GDP growth)

Variable	Coefficient	T-Statistic
GDP80	-0.0026	-4.00
K8003	0.0017	4.73
TPEN80	0.0418	1.63
MPEN9603	0.0003	2.76
APC1580	0.0002	2.43
Constant	-0.0289	-3.93

Table 5 shows that the average GDP growth rate between 1980 and 2003 was positively correlated with the average share of investment in GDP (taken over the entire period), with the 1980 level of primary school completion, and with the average level of mobile penetration between 1996 and 2003. It was negatively correlated with the level of initial GDP per capita (GDP80). The results confirm Barro's convergence hypothesis: conditional on other factors such as human capital and physical capital endowments (captured by school completion rates and telecom penetration), poorer countries grow faster than richer ones. Every additional $1,000 of initial per capita GDP reduces average growth by roughly 0.026 percent. Considering that average growth is typically in the 1 to 2 percent range, a

$10,000 difference in initial per capita GDP would imply growth that would be 0.26 percent lower, which is a substantial difference in the light of typical rates of growth.

The initial level of telecoms (i.e., fixed line) penetration was not significant in this model (TPEN80). However, the average level of mobiles penetration (MPEN9603) was significant – a unit increase in mobile penetration increased growth by 0.039 percent, all else being equal. In line with Barro, the coefficient on primary school completion (APC1580) was positive and significant.

As mentioned above, we were concerned about a potential problem of endogeneity of the mobile penetration rate (as a regressor). We performed a Hausman test,[29] which showed that endogeneity was not likely to be an issue.[30] (See Appendix B for fuller details of the IV estimates and the Hausman test).

Having tested for endogeneity, we then divided the sample into four income quartiles according to their level of GDP per capita in 1980. We classified countries as "low income" (or potentially fast-growth) if they were in quartiles 1, 2 or 3, while quartile 4 countries were classified as "high income." Our "low income" sample included a mix of some countries that had (and still have) much catching-up relative to the highest-income nation, and some countries (like Hong Kong) that were on the verge of becoming advanced economies in 1980. We created dummy variables for high and low income countries and then split the effects of penetration by generating new variables that were the product of these dummy variables and initial telecoms penetration, and the dummy variables and average mobile penetration from 1996 onwards. **Table 6** (reported also in Appendix B) illustrates the results:

Table 6: Table 5 regression separating out effect of telecoms variables

Variable	Coefficient	T-Statistic
GDP80	-0.0025	-3.68
K8003	0.0018	4.67
TPENH80	0.0005	1.92
TPENL80	-0.0002	-0.32
MPENL	0.0006	2.46
MPENH	0.0003	1.99
APC1580	0.0002	2.22
Constant	-0.0284	-3.83

Here, we found that the effect of initial telecoms stock in 1980 was not significant for the low-income countries (TPENL80) but was almost significant (at the 5 percent level) for high-income countries.[31] This is to be expected in view of the fact that fixed penetration was extremely low for low-income countries in 1980 (an average of 3.3 main telephone lines per 100 inhabitants).

The coefficient on the average mobile penetration from 1996 to 2003 (MPENL for low-income countries and MPENH for high-income countries) was positive and significant for both cases, but the impact was twice as large for the low-income countries. The results suggest a noticeable growth dividend from the spread of mobile phones in low-income and middle-income countries.

All else equal, in the "low income" sample[32], a country with an average of 10 more mobile phones for every 100 people would have enjoyed a per capita GDP growth higher by 0.59 percent. Indeed, the results suggest that long-run growth in the Philippines could be as much as 1 percent higher than in Indonesia, were the gap in mobile penetration evident in 2003 to be maintained. The Philippines had 27 mobile phones per 100 inhabitants in 2003, compared to 9 per 100 in Indonesia. Another estimate of the importance of mobiles to growth can be seen by comparing Morocco to the "average" developing country. In 2003, Morocco had 24 mobile phones per 100 inhabitants, compared to 8 in the typical developing country. Were this gap in mobile penetration maintained, then Morocco's long-run per capita growth rate would be 0.95 percent higher than the developing country average.[33] Thus, current differences in mobile penetration between developing countries might generate significant long-run growth benefits for the mobile leaders. Finally, while Argentina and South Africa both had disappointing economic performance over the 1980 to 2003 period, both registering negative average growth in per capita incomes, the analysis suggests that South Africa's higher level of mobile telecoms penetration over the period (17 for South Africa versus 11.4 for Argentina) prevented this difference from being even larger – South Africa's negative average per capita growth of 0.5 percent compares with Argentina's negative average per capita growth of 0.3 percent, but this difference would have been 0.3 percent wider had it not been for the greater spread of mobiles in South Africa.

For the high-income countries, mobile telephones still provide a significant growth dividend. Sweden, for example, had an average mobile penetration rate of 64 per 100 inhabitants during the 1996 to 2003 period, whilst Canada had a mere 26 per 100 average penetration rate. All else equal, Canada would have enjoyed an average GDP per capita growth rate 1 percent higher than it actually registered, had it been able to achieve Swedish levels of mobile penetration over the 1996 to 2003 period.

Conclusions

In summary, telecommunications is an important prerequisite for participation in the modern economic universe. There is a long-standing literature attempting to gauge the economic impact of telecommunications, with the findings of Roeller and Waverman (2001) suggesting a substantial growth dividend in OECD nations.

We have modelled the impact of mobile telecommunications in poorer countries, since in these countries mobile phones are fulfilling the same role as fixed lines did previously in the OECD nations. Initially we attempted to use the Roeller-Waverman framework, but data problems and econometric problems made it difficult to get truly sensible estimates of the growth impact of mobile telecommunications that were also robust to changes in the sample and small changes in the specification of the model. We turned to a purely cross-sectional model that looked at long-term averages of growth, and our results were more robust and sensible than under the previous framework.[34] They suggest the following:

- Differences in the penetration and diffusion of mobile telephony certainly appear to explain some of the differences in growth rates between developing countries. If gaps in mobile telecoms penetration between countries persist, then our results suggest that this gap will feed into a significant difference in their growth rates in future.

- As Romer (1986) and Barro (1991) hypothesised for human capital stocks, there are also increasing returns to the endowment of telecoms capital (as measured by the telecoms penetration rate).

- Given the speed with which mobile telecoms have spread in developing nations, it is unlikely that large gaps in penetration will persist for ever. However, differences in the speed of adoption will affect the speed with which poor countries converge to rich countries' level. Relative poverty still poses serious political problems, such as instability and increased demand for emigration. Our analysis suggests the need for regulatory policies that favour competition and encourage the speediest possible rollout of mobile telephony.

Notes

[1] London Business School and LECG; John Cabot University and LECG; University of Toronto and LECG. Funding for this research was provided by Vodafone and the Leverhulme Trust. We thank Kalyan Dasgupta for sterling assistance. We are indebted to Mark Schankerman for suggesting the use of an endogenous growth approach.

[2] These studies include Hardy (1980), Norton (1992), and Roeller and Waverman (2001). Full bibliographical details are given in footnotes 8, 9 and 3 respectively.

[3] The "Networked Computer" is the focus of a major research programme at London Business School funded by the Leverhulme Trust.

[4] Roeller, Lars-Hendrik and Waverman, Leonard. "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach." *American Economic Review*, 2001, 91(4), pp.909-23.

[5] Geertz, Clifford. "The Bazaar Economy: Information and Search in Peasant Marketing." *American Economic Review*, 1978, 68(2), pp.28-32.

[6] See (for example) World Resources Institute. *Digital Dividends Case Study: Vodacom Community Phone Shops in South Africa*, www.digitaldividend.org

[7] In this, we follow the endogenous growth literature, which postulates increasing returns to human capital.

[8] The data requirements of the full 4 equation APF model are much larger than for the one equation endogenous growth model.

[9] Hardy, Andrew. "The Role of the Telephone in Economic Development." *Telecommunications Policy*, 1980, 4(4), pp. 278-86.

[10] Norton, Seth W. "Transaction Costs, Telecommunications, and the Microeconomics of Macroeconomic Growth." *Economic Development and Cultural Change*, 1992, 41(1), pp. 175-96.

[11] Among these others are Leff, Nathaniel H. "Externalities, Information Costs, and Social Benefit-Cost Analysis for Economic Development: An Example from Telecommunications." *Economic Development and Cultural Change*, 1984, 32(2), pp. 255-76. And Greenstein, Shane and Spiller, Pablo T. "Estimating the Welfare Effects of Digital Infrastructure." National Bureau of Economic Research (Cambridge, MA) Working Paper No. 5770, 1996.

[12] Torero, Maximo; Chowdhury, Shyamal and Bedi, Arjun S. "Telecommunications Infrastructure and Economic Growth: A Cross-Country Analysis." Mimeo, 2002.

[13] Sridhar, Kala S. and Sridhar, Varadharajan. "Telecommunications Infrastructure and Economic Growth: Evidence from Developing Countries, National Institute of Public Finance and Policy (New Delhi, India) Working Paper No. 14, 2004

[14] Since the production function approach is so data-intensive, the sample used in this regression consisted of 38 countries and 260 observations. Even from this sample, 95 observations were eliminated in the course of the regression analysis due to missing data. Of these 38 countries, 19 are low income countries (Bangladesh, Benin, Burkina-Faso, Central African Republic, Cote d'Ivoire, Gambia, India, Indonesia, Kenya, Lesotho, Madagascar, Mali, Mozambique, Myanmar, Nepal, Pakistan, Senegal, Tanzania and Vietnam) and 19 are lower middle income countries (Armenia, Bolivia, Brazil, China, Colombia, Egypt, Fiji, Iran, Jordan, Morocco, Namibia, Peru, Philippines, South Africa, Sri Lanka, Swaziland, Thailand, Tunisia, and Turkey).

[15] Because we had very few observations for some of the countries in the sample, a model with full fixed effects collapsed.

[16] GMM estimation offers some advantages in terms of efficient estimation and ability to correct for serial correlation over other methods available for estimating a model comprised of a system of equations.

[17] Instrumenting the endogenous variables essentially involves isolating that component of the given endogenous variable that is explained by the exogenous variables in the system (the "instruments"), and then using this component as a regressor.

[18] Following Roeller-Waverman, we used a transformed and "unbounded" version of the penetration variable, namely (PEN/0.35-PEN) in the regression analysis. We do so to increase the range of the observed penetration rates.

[19] It should be noted that this is a larger set of countries than we were able to include in our actual regression analysis.

[20] Appendix A shows the sign on the time-trend term is negative and statistically significant, implying that there is large-scale technological regression: unlikely and troublesome. This also suggests that the mobile penetration rate variable is explaining too much growth.

[21] Since there were no mobiles in 1980, we ran a model for the effects of total telecoms penetration with the demand equation adjusted so that both fixed lines and mobile demand are estimated when mobile penetration is non-zero.

[22] Since we use a transformed version of mobile penetration, the impact of an increase in GDP per capita or increase in the price level varies according to the level of mobile penetration.

[23] Barro, Robert J. "Economic Growth in a Cross Section of Countries." *The Quarterly Journal of Economics*, 1991, 106(2), pp. 407-43.

[24] Measured by school enrolment rates in 1960.

[25] The average numbers of revolutions per year and assassinations per million population during the sample period.

[26] Standard neoclassical growth theory predicts long-run convergence of income levels between countries as richer, more capital-intensive countries run into the problem that the returns to capital diminish beyond a certain level of capital intensity. In the later growth literature, initiated by Romer (1986), there are increasing returns to particular factors- such as human capital- that also play a significant role in determining the speed of convergence. See Romer, Paul M. "Increasing Returns and Long-Run Growth." *Journal of Political Economy*, 1986, 94(5), pp.1002-37.

[27] However, it is possible that these variables proxy for subsequent flows of income into human and telecom capital, a subtlety that Barro (1991) explored for human capital, and rejected.

[28] All results are corrected for heteroscedasticity.

[29] Loosely speaking, the Hausman test computes the "distance" between an estimator that is potentially inconsistent under the alternative hypothesis of endogeneity bias and one that is always consistent. See Hausman, Jerry. "Specification Tests in Econometrics." *Econometrica*, 1978, 46(2), pp. 1251-71.

[30] In this context, the Hausman test compares the OLS estimates with estimates from an instrumental variables regression (IV). We used average fixed line penetration between 1960 and 1979 as an instrument for average mobiles penetration between 1996 and 2003: the correlation coefficient between the two variables is 0.81.

[31] This is also consistent with Roeller and Waverman (2001) who report an inability to derive consistent results for low-income countries.

[32] Because data for more advanced countries is more widely available, and because we only treated the very advanced nations (top quartile) of 1980 as "high income", our "low income" sample probably underweights the most underperforming developing country. Developing countries and overweights middle-income countries. Clearly, better data availability – particularly of historical data – would enable us to expand our sample and thereby gauge how robust our results really are.

[33] It should be noted that Morocco is not part of the sample from which our results were actually derived.

[34] However, we need to examine whether our sample can be expanded, and while we have tested for the endogeneity of the mobile phones penetration variable, we still need to examine some more subtle issues such as the potential endogeneity of some of the other regressors. We also need to test for the possibility that some third factor (such as institutional quality) that we have not captured influences both growth and the level of mobile penetration, thereby generating a spurious relationship between the two.

Appendix A: The Production Function Approach

1. Overview of Data

Variable	Variable Description
GDP	Real GDP in constant 1995 dollars
PC_GDP	Real GDP per capita in constant 1995 dollars
POP	Population
TLF	Total Labour Force
GA	Geographic Area (square kilometres)
TTI	Total telcommunications investment in constant 1995 dollars
LAW	"Rule of Law"
K1	Physical capital stock (net of telecoms capital) in constant 1995 dollars
MPEN	Penetration rate of mobile telecoms (expressed per 100 inhabitants)
MTELP	"Price" of mobile telecoms measured as revenues per mobile subscriber (converted to constant 1995 dollars)
FPEN	Penetration rate of fixed telecoms (expressed per 100 inhabitants)
FTELP	"Price" of fixed telecoms measured as revenues per telephone subscriber
T	Time (starting with 1996=1)

Sources of Data: World Development Indicators (available from the World Bank website), World Bank Governance Indicators (1996-2002) and International Telecommunication Union (ITU), World Telecommunications Indicators, 2004 CD-ROM.

Table I: Summary Statistics

	N	Mean	St. Dev	Min	Max
GDP	255	90234.8	192231.2	317.4	1095347.2
PC_GDP	255	1.1	1.0	0.1	5.3
POP	255	100879359	256181098	774000	1312709294
TLF	260	49.7	137.2	0.3	769.3
GA	260	1090.1	1963.4	10.0	9327.4
LAW	260	-0.3	0.5	-1.6	1.2
K1	243	221514.7	460234.2	719.7	3066821.0
TTI	237	1103.0	3523.6	0.1	27629.4
MPEN	260	3.3	5.7	0.0	34.8
MTELP	216	359.9	295.6	20.2	1897.7
FPEN	260	5.6	6.1	0.2	28.5
FTELP	231	518.6	314.6	18.8	1626.5

2. The Production Function Model

The three-equation model that we employ is:

$$\log y = a_1.(HIGHDEBT) + a_2.(LOWDEBT) + a_3.(MEDDEBT) + a_4.\log(K1) + a_5.\log(TLF) + + a_6.\log(MPEN) + a_7.(LAW) + a_8.(t) + U$$

$$\log(MPEN) = b_0 + b_1.\log(GDP_PC) + b_2.\log(TELP) + b_3.\log(FTELP) + b_4.(t) + U$$

$$\log(MPEN_t) - \log(MPEN_{t-1}) = c_0 + c_1.\log(GA) + c_2.\log(TELP) + c_3.(t) + U$$

The results from this regression are reported in Table II (variable names starting with "A" correspond to first equation, "B" to second equation, and "C" to third equation):

Table II: Summary of Regression Results

Variable	Coefficient	Standard Error	T-Statistic
AHIGHDEBT	1.544122	0.5984	2.58
AMEDDEBT	1.536928	0.5746	2.67
ALOWDEBT	1.705664	0.5771	2.96
AK1	0.776639	0.0563	13.79
ATLF	0.204081	0.0522	3.91
APEN	0.075426	0.0210	3.60
ALAW	0.060486	0.0656	0.92
AT	-0.08871	0.0239	-3.71
B0	1.60262	1.7523	0.91
BGDP	1.951197	0.0837	23.30
BTELP	-1.49887	0.2475	-6.06
BFTELP	0.312194	0.1121	2.79
BT	0.492504	0.0765	6.44
C0	-1.50804	0.5285	-2.85
CTELP	0.358958	0.0820	4.38
CGA	-0.03535	0.0149	-2.37
CT	0.096033	0.0220	4.37

Appendix B: The Endogenous Growth Model

1. Overview of Data

Variable	Variable Description
GDP8003	Average growth rate of real GDP per capita (in constant 1995 International Dollars at Purchasing Power Parity) over the 1980-2003 period.
GDP80	Level of real GDP per capita in 1980 (in 000s of Dollars)
K8003	Average share of investment in GDP for the 1980-2003 period
TPEN80	Level of telecoms (i.e., fixed) penetration in 1980 expressed in terms of telephones per 100 inhabitants
MPEN9603	Level of mobile penetration averaged over the 1996-2003 period expressed in terms of subscribers per 100 inhabitants
APC1580	Proportion of 15 and over population who had completed at least Primary School in 1980
TPEN80H	Variable obtained by multiplying high income dummy with TPEN1980
TPEN80L	Variable obtained by multiplying low income dummy with TPEN1980
MPENH	Variable obtained by multiplying high income dummy with MPEN9603
MPENL	Variable obtained by multiplying low income dummy with MPEN9603
FPEN6079	Average level of fixed telecoms penetration during the 1960-79 period, used to instrument MPEN9603

Sources of data: GDP and Investment Share from the World Development Indicators; telecoms data from the International Telecommunication Union (ITU). World Telecommunications Indicators (2004), and data on education from the Barro-Lee dataset (updated to 2000) available from various websites, including www.nber.org.

Table I: Summary statistics for main variables

	N	Mean	St. Dev	Min	Max
GDP8003	92	0.01	0.02	-0.05	0.08
GDP80	92	6.97	6.25	0.56	23.26
K8003	92	20.86	5.48	9.32	45.88
TPEN80	92	10.22	14.11	0.06	58.00
TPEN80L	69	3.32	5.07	0.06	25.37
TPEN80H	22	31.84	11.10	11.42	58.00
MPEN9603	92	19.23	20.95	0.05	67.32
MPENL	69	10.27	14.40	0.05	67.32
MPENH	23	46.10	12.96	16.99	64.99
APC1580	92	45.13	25.97	4.00	97.00
FPEN6079	90	7.52	10.66	0.05	47.67

2. The Endogenous Technical Change Model

The basic specification for our Endogenous Technical Change model is:

$$GDP_{8003}=a_0+a_1.(GDP_{80})+a_2.(I/Y_{8003})+a_3.(TPEN_{80})+a_4.(MPEN_{9603})+a_5.(APC_{1980})+u$$

Table II: Basic specification, OLS regression

Variable	Coefficient	Standard Error	T-Statistic
GDP80	-0.0026386	0.0006591	-4.00
K8003	0.0017272	0.000365	4.73
TPEN80	0.0418567	0.0256544	1.63
MPEN9603	0.0003851	0.0001397	2.76
APC1580	0.0002249	0.0000927	2.43
Constant	-0.0289961	0.0073738	-3.93

R-Squared=0.545, n=91.

Table III: Basic specification, IV regression (Instrument for MPEN9603 is FPEN6079).

Variable	Coefficient	Standard Error	T-Statistic
GDP80	-0.0026519	0.0007095	-3.74
K8003	0.0017125	0.0003349	5.11
TPEN80	0.0004352	0.0003466	1.26
MPEN9603	0.0003699	0.0003801	0.97
APC1580	0.000232	0.000103	2.25
Constant	-0.0288258	0.0071842	-4.01

R-squared=0.5450, n=89.

Hausman test: H0: OLS is consistent and efficient under the null hypothesis, IV is consistent
H1: OLS is inconsistent, IV is consistent under the alternative.

Result: $(\hat{B}_{OLS}-\hat{B}_{IV})'(V)^{-1}(\hat{B}_{OLS}-\hat{B}_{IV})=0.34$, P-value=0.9967. Fails to reject H0.

The second specification that we employ is as follows:

$$GDP_{8003}=a_0+a_1.(GDP_{80})+a_2.(I/Y_{8003})+a_3.(TPEN_{80}).(LOW)+a_4.(TPEN_{80}).(1-LOW)+a_5.(MPEN_{9603}).(LOW)+$$
$$+a_6.(MPEN_{9603}).(1-LOW)+a_7(APC_{1980})+u$$

Table IV: Regression with penetration effects split according to income group

Variable	Coefficient	Standard Error	T-Statistic
GDP80	-0.0025463	0.000692	-3.68
K8003	0.0016998	0.0003642	4.67
TPENH80	0.0005329	0.0002769	1.92
TPENL80	-0.0002023	0.000625	-0.32
MPENL	0.0005942	0.0002414	2.46
MPENH	0.0002924	0.0001466	1.99
APC1580	0.0002127	0.0000959	2.22
Constant	-0.0284366	0.0074336	-3.83

R-squared=0.5501, n=91.

Note: Countries that were ranked in quartiles 1, 2 and 3 according to GDP per capita in 1980 were "low" income, quartile 4 countries were "high" income.

Countries in the endogenous growth regression sample

Algeria, Argentina, Australia, Austria, Bahrain, Bangladesh, Barbados, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Cameroon, Canada, Central African Republic, Chile, China, Colombia, Costa Rica, Cyprus, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Finland, France, The Gambia, Germany, Ghana, Greece, Guatemala, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kuwait, Lesotho, Malawi, Malaysia, Mali, Mauritius, Mexico, Mozambique, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sudan, Swaziland, Sweden, Switzerland, Syria, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela, Zaire/Congo (DR), Zambia, Zimbabwe.

Mark Williams
Frontier Economics

Thanks to Reamonn Lydon and George Houpis who also worked on this project.

Mobile networks and Foreign Direct Investment in developing countries

Introduction

Higher investment is central to achieving long-term sustainable economic growth and poverty reduction in developing countries. Foreign investors are often seen as an important source of capital finance and some types of foreign investment may also bring spill-over benefits to the recipient country in the form of transfer of skills, tax revenues and formal employment. Understanding the determinants of the level of foreign investment therefore has potentially important policy implications.

In this study, we investigated the relationship between one type of foreign investment – Foreign Direct Investment (FDI) – and the characteristics of the recipient countries. We have focused, in particular, on the relationship between FDI flows into developing countries and the penetration of mobile telecommunications networks in the recipient country. We found that both fixed and mobile communications networks, in addition to other characteristics including openness of the economy, GDP and infrastructure, are positively linked with inward FDI; and the impact of mobile has grown more significant in recent years.

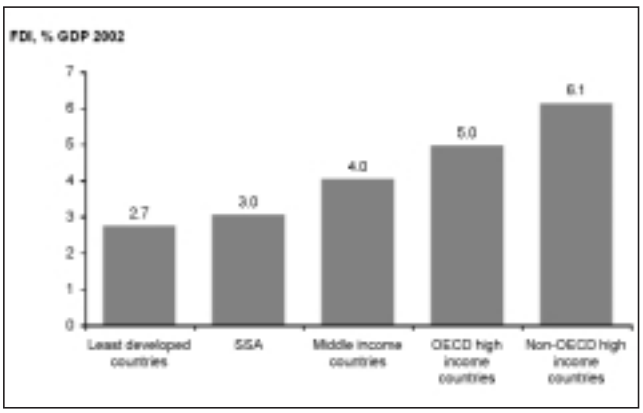
The determinants of FDI

Capital flows from abroad fall into two categories: official finance and private finance. The private flows in turn can be divided into three categories: loans from banks or other private sector lenders; portfolio capital flows for the purchase of securities such as bonds and equities; and foreign direct investment, overseas capital invested as equity in businesses in the recipient country.

FDI involves a long-term relationship between the investor and the entity in which the investment is made and often includes some management control.[1] In practice, FDI includes a range of different activities and transactions. The privatisation of state-owned firms in developing countries is often included, as are programmes of investment in branches or subsidiaries of transnational corporations (TNCs). Another major type of FDI particularly important in Africa is related to concessions for exploring and developing natural resources such as oil, gas or mineral reserves.

The volume of FDI varies significantly between countries and regions, as shown in **Figure 1**, with poorer regions generally attracting the least inward investment.

Figure 1: Foreign direct investment, net inflows (% GDP, 2002)

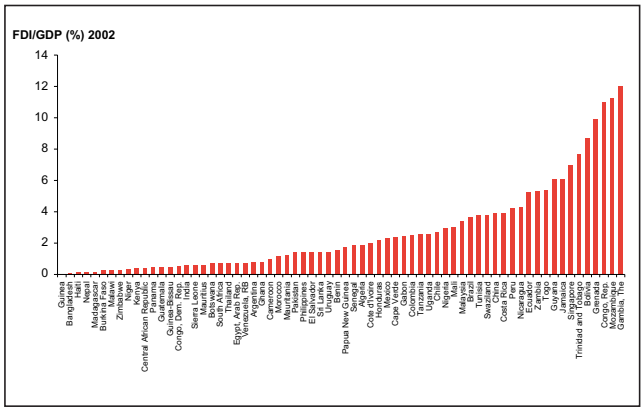


Source: WDI (2004), Frontier Economics[2]

The country groupings in the figure are based on the following definitions: Least developed countries, UN definition; Middle Income Countries, World Bank definition – GNI per capita (2003) between $765 and $9,385;(Non-) OECD high income countries, World Bank definition – GNI per capita (2003) greater than or equal to $9,386.

Even within these country groups there is substantial variation in the amount of FDI between countries. **Figure 2** shows the FDI inflows for each of the countries included in this study. The sample includes 32 of the 48 countries in Sub-Saharan Africa, and 39 other less developed countries.[3]

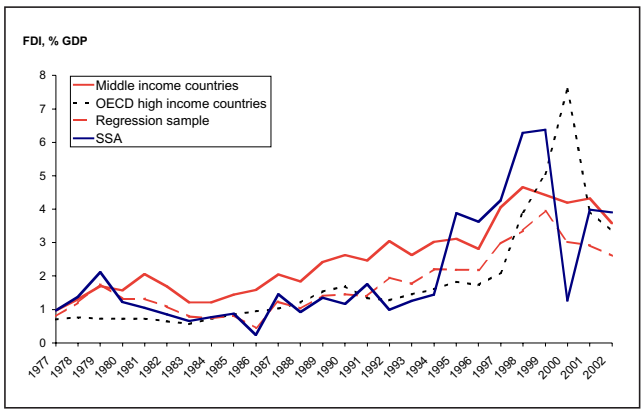
Figure 2: Foreign direct investment by country, net inflows (% GDP 2002)



Source: WDI (2004), Frontier Economics

FDI flows also vary dramatically over time. This is shown in **Figure 3,** which demonstrates clearly the relationship between FDI flows and the global economic upturn of the late 1990s, and the subsequent decline in FDI.

Figure 3: Foreign direct investment, inflows over time by country grouping 1977 – 2002



Source: WDI (2004), Frontier Economics

The evidence on the impact of FDI in developing countries is mixed. Its developmental impact depends on the form of the investment, the sector of the economy concerned, and the policy environment in the host country. Even so, it is generally accepted that FDI can have a number of positive effects on the economies of developing countries. It can increase formal sector employment in countries where it is often scarce. Research indicates that access to employment in the formal sector is the most important factor in shifting poor people out of poverty[4]. FDI usually involves the transfer of skilled personnel to the destination country. Companies also employ and train significant numbers of local staff. FDI is therefore often associated with the transfer of new technologies and skills to nationals of the destination country, which helps to raise productivity and incomes. It also involves medium to long-term commitments by foreign investors. Their investments are tied up with physical capital (plant and machinery, fixed assets etc.). It is therefore harder for the investor to withdraw than in the case of portfolio investments. This reduces the volatility of foreign exchange movements and helps to limit exchange rate fluctuations.

In many developing countries, capital is scarce because there is very little domestic saving and access to international financial markets is either limited or non-existent. FDI in such cases can provide a vital source of capital. There is also some evidence to suggest that FDI stimulates domestic investment in developing countries[5]. Lastly, foreign-owned enterprises in developing countries are often significant sources of tax revenue in countries where public finance is often severely constrained.

These potential benefits mean governments in many developing countries have gone to considerable efforts to attract FDI. However, some countries have been more successful in this than others. Understanding the causes of this variation and the factors that influence the levels of FDI is therefore an important issue for developing countries. Recent research on this question has been based on statistical (regression) analysis, using data from a large number of countries over a number of years, to assess the empirical importance a range of potential determinants of FDI flows. Each of the potential determinants is included as an explanatory variable in the regression analysis.

The majority of the empirical studies focus on average net FDI flows, specified as FDI/GDP in order to take account the impact of the scale of the host country. Furthermore, as FDI tends to vary significantly from year to year, studies using historical data have generally analysed average FDI over a number of years. Morisset's study (2000) also takes account of the natural resource endowment of the country. [6]

Most studies consider explanatory variables including: measures of economic openness (the importance of trade); the extent and quality of infrastructure; GDP; GDP growth; indicators of political stability; and measures of macroeconomic stability.

Several studies have also investigated the relationship between additional specific variables and the level of FDI flows. For example, Asiedu (2002) includes a measure of the return on capital and Morisset looks at the impact of illiteracy and the degree of urbanisation. Of special interest here, Reynolds et al. (2004) look at the impact of telecommunications. They note that telecommunications infrastructure is closely linked to GDP and therefore look at the impact of unusually high levels of telephone infrastructure on FDI flows.

Despite similar analytical frameworks, in general the results of the analysis are mixed and vary significantly between studies depending on the periods chosen and the specification of the regression equations. **Table 1** summarises the results of previous studies on the determinants of FDI.

Table 1: Determinants of FDI

Determinant of FDI/GDP	Positive	Negative	Insignificant
Openness	Edwards (1990) Gastanaga et al (1998) Hausmann and Fernadez-Arias (2000)		
Infrastructure quality	Wheeler and Mody (1992) Kumar (1994) Loree and Guisinger (1995)		Tsai (1994) Loree and Guisinger (1995) Lipsey (1999)
Real GDP per capita	Schneider and Frey (1985) Tsai (1994) Lipsey (1999)	Edwards (1990) Jaspersen, Aylward, and Knox (2000)	Lore and Guisinger (1995) Wei (2000) Hausmann and Fernandez-Arias (2000)
Labour cost	Wheeler and Mody (1992)	Schneider and Frey (1985)	Tsai (1994) Loree and Guisinger (1995) Lipsey (1999)
Taxes and tariffs		Loree and Guisinger (1995) Gastanaga et al (1998) Wei (2000)	Wheeler and Mody (1992) Lipsey (1999)
Political instability		Schneider and Frey (1985) Edwards (1990)	Lore and Guisinger (1995) Jaspersen, Aylward, and Knox (2000) Fernandez-Arias (2000)

Source: Asiedu (2002)

Morrisset finds that GDP growth and trade openness have both been correlated with FDI, over and above the impact of GDP and natural resources. Political stability, illiteracy and infrastructure (as proxied by the number of telephone lines) are not significant in all specifications. Asiedu also finds that openness to trade is positively associated with FDI and finds a positive relationship between FDI and infrastructure in non-Sub Saharan Africa (SSA). She finds that FDI is generally lower in SSA than in other regions and also finds that the effect of most of the other explanatory variables is lower in SSA than in non-SSA regions. Reynolds et al (2003) focus their analysis on the impact of telephone lines on FDI flows and find that having more mainlines than would be expected, given the size of the economy, is linked to a higher level of FDI.

The variables which emerge as unambiguously positively related to FDI flows are economic openness and infrastructure (although infrastructure is statistically insignificant in some studies). In all the cited studies, the quality and extent of infrastructure is proxied by the number of main telephone lines per 1000 population. No research that we are aware of has attempted to disaggregate between the impact of the different types of infrastructure (e.g. transport, energy, communications). By studying the impact of mobile networks on FDI into developing countries, our work is therefore a natural extension of the body of existing research.

Mobile networks and FDI in developing countries

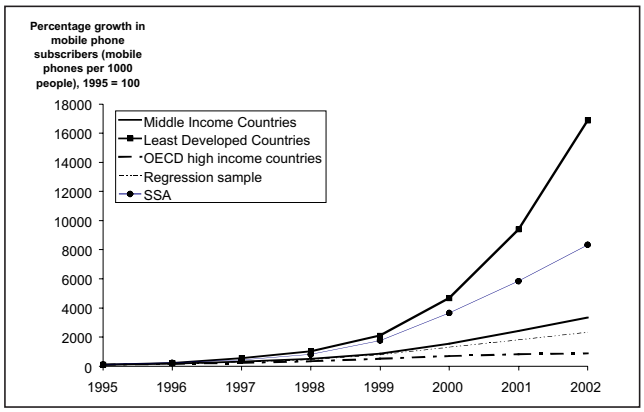
Mobile penetration in developing countries has increased dramatically during the past 10 years, partly as a result of the liberalisation of telecommunications markets. This is shown in **Table 2** and **Figure 4.**

Table 2: Growth in Mobile penetration by country grouping, 1995-2000

	Mobile phones per 1,000 population 1995	Mobile phones per 1,000 population 2002	Average annual growth rate (%) 1995 - 2002
Least Developed Countries	0.13	21.88	109%
SSA	0.74	61.68	90%
Middle Income Countries	5.73	191.29	66%
OECD high income countries	87.33	765.01	37%
Regression sample	5.28	122.83	58%

Source: WDI (2004), Frontier Economics

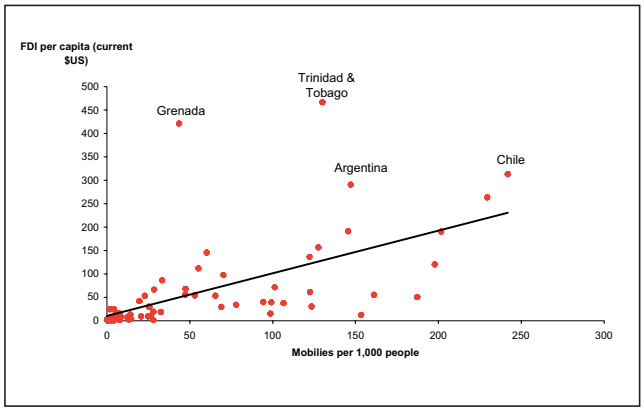
Figure 4: Growth in overall mobile penetration, indexed (1995 = 100)



Source: WDI (2004), Frontier Economics

Our interest is in the possible links between the penetration of mobile networks and FDI flows into developing countries. This relationship is illustrated in a simple way in **Figure 5,** which plots average FDI per capita between 1998 and 2002 against mobile penetration rates in a number of developing countries.

Figure 5: FDI inflows per capita 1998-2002 average



Source: WDI (2004), Frontier Economics

The figure indicates that there is a positive link between mobile penetration and FDI, but in order to probe further, we tested the following relationship:

$$\frac{NetFDI}{GDP} = f(Variables)$$

Where:

Net FDI = net inflow of FDI;
GDP = Gross Domestic Product; and
Variables = a range of possible explanatory variables, including mobile penetration[8].

We included a wide range of possible explanatory variables, in a number of different combinations, in the regression, using data on the value of net FDI and the other variables for the period 1993 to 2002.

We also ran the regressions for different time periods within this span to explore the impact of the period chosen on the parameter values, as growth in mobile networks accelerated in most developing countries towards the end of the 1990s.

There were several other methodological issues. FDI values typically vary significantly from year to year, particularly in developing countries. The data can be dominated by flows relating to specific large projects. For this reason, most studies are based on data averaged over several years, although this has the disadvantage of reducing the number of data points in the analysis. We explored the effect on the results of using different periods for averaging, in addition to using data for 2002 only. A further difficulty is that some of the explanatory variables are correlated with each other. For example, there is a close statistical relationship between the penetration rate of fixed lines and indicators of the quality and extent of the road network. A similar relationship may also exist between fixed-line penetration and other general indicators of the quality of a country's infrastructure. This can cause difficulties in both estimating and interpreting the value of regression coefficients, as it is difficult to separate the effects of closely related variables.

Our analysis is based on a data for developing countries[9], and we identified separately the countries that are in Sub-Saharan Africa (SSA). Some researchers[10] also control for the level of natural resources in these countries by including a measure of natural resources in the regression. We also repeated all of the regressions in this section for measures of FDI, normalised to account for the impact of natural resource endowments on FDI flows[11]. In general we found that the main results are robust to these alternative specifications. The complete list of countries included in the regression is given in **Annexe 1.**

Results

As noted above, many of the existing studies find that the openness of an economy[12] is positively related to net FDI inflows. This result is not surprising. Foreign companies may be investing in developing countries with the intention of exporting the products. Countries with open economies are therefore likely to attract more foreign investment for this type of production. An alternative explanation is that the openness of an economy is related to the quality of general economic management, and well-managed economies attract FDI. We confirmed that there is a stable, statistically significant and positive relationship between economic openness and net FDI inflows. This effect is present in most regression specifications and the value of the coefficient remains stable. This robustness is a good indication that economic openness is indeed significantly related to FDI. It is also consistent with the results of the other studies.[13]

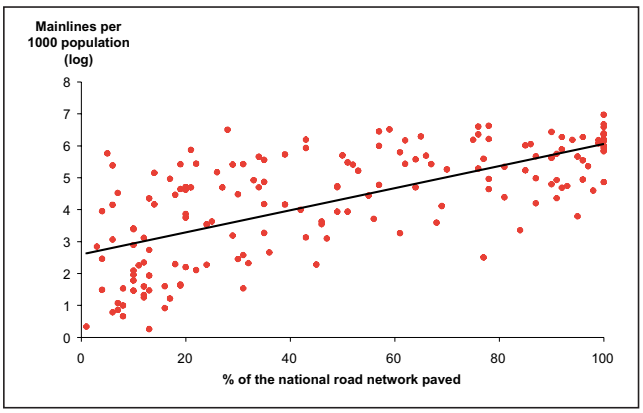
We next looked at the significance of fixed line penetration as an explanatory variable for FDI flows, both on its own and together with measures of mobile penetration. We found that there is a significant relationship between fixed-line penetration rates and FDI inflows in many different specifications. In the specifications which averaged flows across periods (i.e. 1993-2002 and 2000-2002), we found that the statistical relationship between fixed lines and FDI was significant and positive. In regressions that included fixed penetration as the only indicator of telecommunications coverage (with mobile penetration excluded), we found that a 1 per cent increase in fixed line penetration was associated with 1-1.3 per cent higher rates of average FDI. This parameter was statistically significant and relatively consistent across model specifications[14].

We then looked at the relationship between mobile penetration and net FDI inflows. When we included mobile penetration rates but excluded fixed line penetration rates, we found a statistically significant relationship between mobile networks and FDI flows in the later period of the sample (i.e. 2000-2002 and 2002 alone)[15]. This indicated that a 1 per cent increase in mobile penetration rates is associated with 0.5-0.6 per cent higher rates of FDI/GDP. However, we did not find a similar relationship when we included data from the earlier period (1993-1999). This is as we would expect since mobile networks did not develop significantly during this period.

When we included both fixed and mobile penetration rates separately in the regression, we found that mobiles are not statistically significant.

In general, the coefficient on fixed penetration rates in our analysis was higher than for mobile rates. This result may reflect the fact that the fixed penetration rate variable is capturing some of the effect of other (non-telecommunications) infrastructure. For example, **Figure 6** shows the clear relationship between fixed line penetration rates and the quality of the road infrastructure in the countries under consideration.

Figure 6: Relationship between telephone mainlines and road quality



Source: WDI (2004), Frontier Economics. The sample of 169 countries includes both developing and developed countries. The data refers to mainline penetration and road infrastructure in 1999, the latest year for which data is available in the WDI (2004).

This relationship is even stronger for countries in Sub-Saharan Africa. It is therefore very likely that the coefficient on fixed line penetration is reflecting in part the effect of these other forms of infrastructure. However, it is not possible to separate these factors in the analysis because of the lack of data. When the sum of the two penetration rates, fixed and mobile, is included this does a better job than either fixed penetration alone, or mobile penetration alone in explaining FDI. However, direct comparisons of the significance of fixed and mobile networks on FDI flows into developing countries should be treated with caution. At present, given the data available, it is not possible to use regression analysis to separate the effects of all the different types of infrastructure on FDI.

We extended our basic analysis by exploring four alternatives estimating the relationship in differences; looking at Sub-Saharan Africa only; investigating the impact of natural resources on FDI; and controlling for endogeneity (that is, the possibility that higher ratio of FDI to GDP itself leads to greater mobile penetration) in the regression analysis. The analysis of differences[16] (that is, looking at the changes in the variables rather than their levels) found a significant relationship between FDI inflows and mobile penetration. This analysis also indicated that the effect of fixed lines was statistically insignificant. It is likely that this is because mainline penetration typically did not change significantly in many developing countries during the

period. However, it should be noted that this analysis is sensitive to the period over which it is carried out.

The results of carrying out the analysis for the Sub-Saharan African countries alone are shown in **Annexe 3**. The sample consists of only 32 countries so the results need to be interpreted cautiously. However, compared with the full sample of around 70 countries, the effect of fixed line penetration on FDI flows is significantly smaller. Whereas in the full sample we observe significant coefficients in the range of 1.0-1.3, the coefficients for the SSA sample, while also significant, are in the range of 0.6-0.9. Secondly, the size of the positive relationship between mobile penetration and FDI flows is greater when we look at the sub-sample of SSA countries in some periods. This is particularly the case for 2002, where the coefficient doubles from 0.5 to 1.0[17]. Overall, the tentative conclusion from the analysis of the SSA sample is that telecoms infrastructure is positively correlated with FDI flows. However, relative to other developing countries, fixed line penetration is less important, and mobile penetration is more important. This is consistent with the observed weaknesses of fixed line networks in many Sub-Saharan African countries.

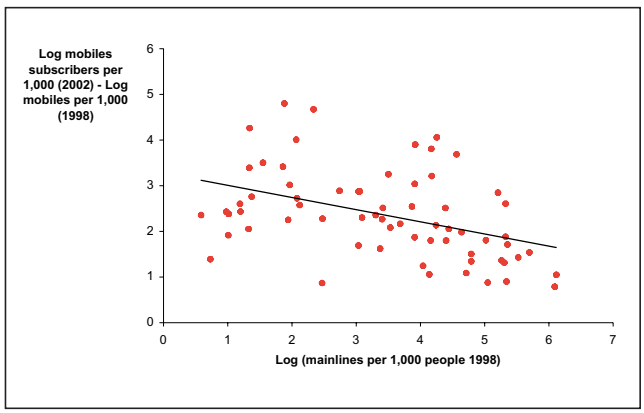
We estimated the regression analysis using 'normalised FDI'[18] as a means of controlling for the impact of natural resource endowments such as oil in the recipient country. The results from this analysis are shown in **Annexe 4**[19]. This analysis does not significantly change the conclusions from our basic analysis. Telecoms infrastructure remains positively correlated with FDI flows. In this case, the statistical significance of mobile penetration is reduced[20]. In contrast to the basic regression results, we find here that natural resources have a significant and positive impact on FDI flows into SSA. This is a different result from that found by Asiedu (2002), who finds that the 'fixed effect' for SSA is negative. Our results imply that an important difference between developing countries in Africa and outside Africa, in terms of attracting FDI, is in the relationship between FDI flows and the value of natural resources. However, we find that, even taking account of this effect, the positive relationship between mobile telecoms and FDI remains significant.

Finally, we considered the impact of endogeneity, which will arise if FDI inflows in turn affect any of the variables we are using to try to explain FDI. If the regression contains some endogenous variables, then the coefficients on these variables will be biased. It might be the case that FDI could be affected by mobile penetration rates and mobile penetration rates simultaneously affected by GDP, which is in turn a function of FDI. We have addressed this problem by using a technique known as Instrumental Variable (IV) estimation, which substitutes the variable of interest (mobile penetration) with a predicted value, based on factors known not to be correlated with FDI/GDP.

This means we need to find an 'instrument' that affects mobile phone penetration but which has no impact on FDI flows. If we use this instrument to 'predict' mobile phone penetration, and subsequently use this predicted value in the FDI/GDP regression, then the estimated effect of mobile penetration on FDI flows, as measured by the regression coefficient, is unbiased.

We analysed the effect of growth in mobile penetration on growth in FDI over the 1998 – 2002 period using fixed line penetration in 1998 as an instrument for the growth in mobile penetration between 1998 and 2002. The relationship between growth in mobile penetration and the number of mainlines per 1,000 population in 1998 is shown in **Figure 7**[22]. As we would expect, in those countries where the 1998 level of fixed line penetration is low, growth in mobile penetration is significantly higher, suggesting this is a valid instrument to use in the FDI regression.

Figure 7: The relationship between growth in mobile penetration (1998-2002) and mainlines (1998)



Source: WDI 2004, Frontier Economics

The full results are shown in **Annexe 5**. The first column shows that the negative relationship between growth in mobile penetration and the number of mainlines in 1998 is significant and negative (coefficient –0.299, t-statistic 3.87). The predicted value for mobile growth from this first stage regression is included as an explanatory variable in the second regression, shown in the second column in the table. This shows that mobile penetration is significantly positively correlated with FDI. Furthermore, this approach indicates a stronger positive relationship than the basic results, set out in the third column of the table. Comparing the results shows that the coefficient remains statistically significant and has increased from 1.014 to 2.131[23]. In other words, the problem of a simultaneous impact of FDI on mobile penetration means the initial results were biased downwards in estimating the impact of mobiles on FDI.

Conclusions

The flow of Foreign Direct Investment into developing countries depends on a number of variables, including the country's GDP, the openness of the economy, and its infrastructure. In the case of Sub-Saharan Africa, natural resources are an additional explanatory factor. We have extended earlier findings to show that mobile telecommunications networks are also positively correlated with FDI flows.

This relationship appears to be stable across different model specifications and the impact of mobile on FDI is more significant in recent years, as mobile penetration in developing countries has increased dramatically. Taking account of the fact that mobile penetration may itself be boosted by higher GDP increases the estimated impact of mobile on FDI. One natural extension of the analysis would be to explore whether the growth of mobile networks is related to investment in particular sectors but sectoral FDI data are unavailable.

References

Asiedu, E. 'On the Determinants of Foreign Direct Investment to Developing Countries: Is Africa Different?', World Development, Vol. 30, No.1 pp 107-119, 2002

Bosworth, B.P. and Collins, S.M. (1999), 'Capital flows to developing economies: implications for saving and investment' Brookings Papers on Economic Activity: 1, Brookings Institution pp 143-169

Jenkins, C. & Thomas, L. 'Foreign Direct Investment in Southern Africa: Determinants, Characteristics and Implications for Economic Growth and Poverty Alleviation', 2002

Morisset, J. 'Foreign Direct Investment in Africa Policies Also Matter', Transnational Corporations Volume 9, Number 2, 2000

Reynolds, R., Kenny C., Liu J., Zhen-Wei Qiang, C. 'Networking for foreign direct investment: the telecommunications industry and its effect on investment', Information Economics and Policy Vol 16, 159-164, 2004

Notes

1 The precise definitions of FDI vary between countries, usually according to the degree of share-ownership that is involved.

2 All the data used in this study comes from the World Development Indicators online database, published annually by the World Bank.

3 In constructing a sample of developing countries for the analysis that follows, we are constrained by data availability. The full list of countries included in the analysis is shown in Annexe 1. The average income per capita for the countries included in the sample is $4,370 in 2002.

4 Jenkins and Thomas (2002)

5 Bosworth and Collins (1999)

6 Morisset does this by calculating a variable referred to as the Foreign Direct Investment Climate. This is defined as FDI/(GDP*Natural Resource). This is formally equivalent to assuming that both GDP and the natural resource endowment are determinants of FDI with an elasticity of one.

7 Since financial markets are either thin or non-existent in most developing countries, it is difficult to directly measure the returns to capital. Asiedu uses $\frac{1}{GDP/capita}$ as a proxy for a measure of the returns to capital. The rationale for this is that GDP/capita is a proxy for economic output per worker. High GDP/capita is an indication that there are high levels of capital per worker in the country. This indicates that the returns to capital are relatively low. In countries with a low GDP/capita, capital is relatively scarce which indicates that the returns to investment in capital are relatively high. $\frac{1}{GDP/capita}$ is therefore a proxy for a measure of the returns to capital.

8 Mobile penetration is measured as number of mobiles per 1000 people. A full description of each of the variables used in the analysis, along with a detailed list of sources can be found in Annexe 6.

9 Our full sample of countries includes Low Income, Highly Indebted and Poor and Least developed countries as defined by the World Bank.

10 See, for example, Morisset (2000).

11 We follow Morisset (2000), in normalising FDI flows by the value of natural resources in the country in a given year. The value of natural resources is defined as the sum of output in the primary (agriculture) and secondary (industry) sectors minus output in the manufacturing sector. Details of the industries included in the primary, secondary and manufacturing sectors are given in Annexe 6. We have included the normalised measure of FDI flows as a dependent variable in some of the statistical analysis that follows.

12 Economic openness is defined as (Imports + Exports)/GDP.

13 The regression results presented in Annexe 4, which include a normalised measure of FDI as the dependent variable in order to control for the impact of natural resources, do not include either measures of openness or the return on investments (1/GDP) as explanatory variables. This is because the effects of these variables on FDI flows are already implicitly included through the normalisation calculation.

14 This includes using residual values. These are residuals from a regression of fixed line penetration on GDP/capita. This has the effect of removing the effect of collinearity between GDP and fixed line penetration. It can also be interpreted as being a measure of countries with 'unexpectedly' high rates of fixed-line penetration. This is the approach taken by Reynolds et al (2004).

15 The coefficient on mobile penetration and the mobile penetration residual were significant at the 10% level for the 2000 – 02 averages. However, for 2002, only the mobile penetration residual was significant at the 10% level.

16 This means that we investigated the relationship between the difference in FDI inflows between 1998 and 2002 and the difference in the values of the explanatory variables over the same period.

17 Not statistically significant in earlier periods in some specifications.

18 Normalised for the value of natural resources in a country – see footnote 11.

19 Note that because the dependent variable in this case is a measure of FDI flows normalised by the product of GDP and the value of natural resources, the magnitude of the coefficients in Annexe 4 should not be directly compared with those in Annexe 2 and 3. Furthermore, because natural resources, which account for a significant proportion of trade, and GDP are implicitly included on the left-hand side of the regression, we drop these variables from the right-hand side of the regression.

20 Mobile penetration is not statistically significant when included in the regression analysis on its own or together with fixed penetration. However, the coefficients on the residual values of mobile penetration are significant and positive.

21 Page 108, italics in the original

22 The changes shown in the figure are changes in log variables. If the changes in mobile phone penetration over this period were small, then the log changes could be interpreted as percentage changes. However, growth in mobile phone penetration was significant during this period, therefore the numbers on the Y-axis should not be interpreted as percentage changes.

23 The implication of this is that the endogeneity was contributing to a negative bias in the estimate of the effect of mobile penetration on FDI.

Annexe 1: A description of the countries included in the dataset

Country	Sub-Saharan Africa ?	Country	Sub-Saharan Africa ?	Country	Sub-Saharan Africa ?
Panama	✘	Egypt, Arab Rep.	✘	Mauritius	✓
Uruguay	✘	Venezuela, RB	✘	Central African Republic	✓
Paraguay	✘	Malaysia	✘	Mauritania	✓
Argentina	✘	El Salvador	✘	Cameroon	✓
Costa Rica	✘	Grenada	✘	Congo, Rep.	✓
Sri Lanka	✘	Nicaragua	✘	Cote d'Ivoire	✓
Ecuador	✘	Jamaica	✘	Burkina Faso	✓
Peru	✘	Pakistan	✘	South Africa	✓
Bolivia	✘	China	✘	Swaziland	✓
Nepal	✘	Philippines	✘	Tanzania	✓
Papua New Guinea	✘	Algeria	✘	Mali	✓
Colombia	✘	Haiti	✘	Kenya	✓
Thailand	✘	Morocco	✘	Nigeria	✓
Mexico	✘	Indonesia	✘	Gabon	✓
India	✘	Congo, Dem. Rep.	✓	Botswana	✓
Chile	✘	Niger	✓	Uganda	✓
Tunisia	✘	Malawi	✓	Cape Verde	✓
Brazil	✘	Senegal	✓	Zimbabwe	✓
Bangladesh	✘	Guinea	✓	Madagascar	✓
Honduras	✘	Mozambique	✓	Guinea-Bissau	✓
Guyana	✘	Togo	✓	Zambia	✓
Guatemala	✘	Sierra Leone	✓	Gambia, The	✓
Trinidad & Tobago	✘	Benin	✓	Ghana	✓

Source: Frontier economics

Notes: The primary data sources for information on investment flows, as well as data on the characteristics of each country's economy, is the World Bank's World Development Indicators (2004) and the United Nations Conference on Trade and Development (UNCTAD, 2004).

Annexe 2: Regression results for all countries

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Open=((imports +exports)/GDP)	0.026 (3.72)**	0.018 (2.19)*	0.020 (2.52)*	0.026 (3.99)**	0.019 (2.39)*	0.022 (2.49)*	0.027 (3.80)**	0.020 (2.51)*
Log (fixed + mobile subscribers)	1.507 (3.68)**	1.477 (2.81)**	1.395 (2.43)*					
Log (fixed lines per 1000 people)				1.293 (3.36)**	1.035 (2.29)*	0.906 (1.61)		
Log (fixed lines per 1000 People), residual***							1.233 (3.49)**	1.131 (2.91)**
Log (Mobile subscribers)								
Log (mobile subscribers, residual)								
Log (1/GDP per capita)	1.622 (2.83)**	1.373 (2.03)*	1.562 (2.03)*	1.340 (2.53)*	0.840 (1.47)	0.986 (1.40)	-0.108 (0.38)	-0.223 (0.89)
Dummy variable for SSA	-0.512 (0.88)	0.158 (0.25)	0.248 (0.35)	-0.459 (0.78)	0.401 (0.53)	0.433 (0.52)	-0.737 (1.32)	-0.054 (0.09)
Constant	6.886 (2.37)*	4.551 (1.59)	5.762 (1.76)+	6.048 (2.14)*	3.397 (1.23)	4.420 (1.33)	0.322 (0.16)	-0.230 (0.13)
Period	Average 1993-2002	Average 2000-2002	Average 2002	Average 1993-2002	Average 2000-2002	Average 2002	Average 1993-2002	Average 2000-2002
Observations	69	68	68	69	68	68	69	68
R-squared	0.42	0.26	0.19	0.42	0.24	0.16	0.42	0.26

Robust t statistics in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	0.021 (2.90)**	0.026 (3.86)**	0.019 (2.37)*	0.022 (2.50)*	0.031 (3.95)**	0.023 (2.47)*	0.025 (2.74)**	0.031 (3.86)**	0.023 (2.58)*	0.025 (2.85)**
		1.366 (3.11)**	1.019 (2.18)*	0.890 (1.56)						
	1.322 (2.81)**									
		-0.013 (0.05)	0.370 (1.12)	0.356 (1.07)	0.234 (0.89)	0.577 (1.75)+	0.512 (1.49)			
								0.253 (1.03)	0.514 (1.88)+	0.570 (1.82)+
	0.042 (0.16)	1.426 (2.51)*	1.348 (2.12)*	1.478 (1.93)+	0.285 (0.56)	0.548 (0.99)	0.739 (1.22)	0.028 (0.09)	-0.077 (0.28)	0.203 (0.68)
	0.127 (0.21)	-0.382 (0.61)	0.374 (0.49)	0.398 (0.47)	-1.451 (2.23)*	-0.532 (0.91)	-0.397 (0.63)	-1.460 (2.25)*	-0.548 (0.94)	-0.431 (0.71)
	1.223 (0.62)	6.426 (1.98)+	5.719 (1.80)+	6.666 (1.79)+	2.665 (0.77)	3.157 (1.03)	4.243 (1.27)	1.319 (0.55)	0.813 (0.40)	2.368 (1.07)
	Average 2002	Average 1993-2002	Average 2000-2002	Average 2002	Average 1993-2002	Average 2000-2002	Average 2002	Average 1993-2002	Average 2000-2002	Average 2002
	68	68	67	67	68	67	67	68	67	67
	0.22	0.42	0.27	0.19	0.33	0.21	0.16	0.33	0.22	0.18

Annexe 3: Regression results for SSA countries only

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Open=((imports +exports)/GDP)	0.034 (3.47)**	0.027 (2.30)*	0.034 (2.02)+	0.035 (3.36)**	0.030 (2.26)*	0.041 (1.93)+	0.033 (3.39)**	0.029 (2.23)*
Log (fixed + mobile subscribers)	1.024 (2.21)*	1.231 (1.87)+	1.535 (2.00)+					
Log (fixed lines per 1000 people)				0.783 (1.87)+	0.482 (0.97)	0.161 (0.22)		
Log (fixed lines per 1000 people), residual***							0.883 (2.96)**	0.582 (1.82)+
Log (Mobile subscribers)								
Log (mobile subscribers, residual)								
Log (1/GDP per capita)	1.901 (3.00)**	1.808 (1.88)+	2.539 (2.17)*	1.618 (2.72)*	0.939 (1.14)	0.991 (0.92)	0.699 (1.84)+	0.388 (0.94)
Constant	8.674 (2.81)**	7.487 (1.91)+	10.531 (2.08)*	7.760 (2.55)*	4.850 (1.22)	5.145 (0.94)	4.124 (2.05)+	2.814 (1.25)
Country fixed effects	No	No	No	No	No	No	No	No
Year dummy variables	No	No	No	No	No	No	No	No
Period	Average 1993-2002	Average 2000-2002	2002	Average 1993-2002	Average 2000-2002	2002	Average 1993-2002	Average 2000-2002
Observations	32	32	32	32	32	32	32	32
R-squared	0.45	0.29	0.26	0.44	0.23	0.19	0.47	0.25

Robust t statistics in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	0.037 (1.94)+	0.036 (3.32)**	0.036 (2.80)**	0.045 (2.29)*	0.041 (3.74)**	0.038 (2.84)**	0.044 (2.41)*	0.039 (3.78)**	0.038 (2.72)*	0.042 (2.45)*
		0.974 (2.09)*	0.465 (0.96)	-0.042 (0.06)						
	0.661 (1.81)+									
		-0.151 (0.47)	0.509 (1.48)	1.026 (1.80)+	0.058 (0.17)	0.694 (1.83)+	1.013 (1.93)+			
								0.145 (0.43)	0.578 (2.25)*	1.086 (2.24)*
	0.762 (1.50)	1.732 (2.74)*	1.789 (1.98)+	2.255 (1.93)+	0.941 (1.51)	1.517 (2.01)+	2.286 (2.38)*	0.873 (1.96)+	0.767 (1.69)	1.229 (2.41)*
	4.621 (1.55)	8.167 (2.38)*	8.531 (1.96)+	10.487 (1.82)+	4.765 (1.34)	7.204 (2.00)+	10.631 (2.26)*	4.499 (1.88)+	4.439 (1.86)+	7.014 (2.35)*
	No				No	No	No	No	No	No
	No				No	No	No	No	No	No
	2002				Average 1993-2002	Average 2000-2002	2002	Average 1993-2002	Average 2000-2002	2002
	32	32	32	32	32	32	32	32	32	32
	0.22	0.47	0.35	0.32	0.37	0.33	0.32	0.38	0.33	0.35

Annexe 4: Regression results, normalising FDI flows to control for natural resource endowments

Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (fixed + mobile subscribers)	0.332 (1.38)	0.315 (1.64)	0.307 (1.35)					
Log (fixed lines per 1000 people)				0.388 (1.63)	0.390 (2.03)*	0.344 (1.54)		
Log (fixed lines per 1000 people), residual***							2.057 (4.39)**	2.038 (4.23)**
Log (Mobile subscribers)								
Log (mobile subscribers, residual)								
Sub-Saharan Africa	1.928 (2.49)*	1.953 (3.12)**	1.844 (2.71)**	2.074 (2.66)**	2.233 (3.40)**	2.059 (2.77)**	1.566 (4.83)**	1.040 (3.65)**
Constant	-28.058 (24.97)**	-28.290 (27.35)**	-28.457 (23.86)**	-28.194 (27.27)**	-28.419 (32.03)**	-28.428 (27.67)**	-26.954 (77.21)**	-26.962 (76.54)**
Period	Average 1993-2002	Average 2000-2002	2002	Average 1993-2002	Average 2000-2002	2002	Average 1993-2002	Average 2000-2002
Observations	67	68	65	67	68	65	67	68
R-squared	0.11	0.13	0.10	0.12	0.15	0.11	0.29	0.23
Robust t statistics in parentheses + significant at 10%; * significant at 5%; ** significant at 1%								

The dependent variable in each of these regression is equal to log (FDI/(GDP* Natural Resources)), where each of the components are in current $US. The value of natural resources is equal to the value of national output in the primary (agriculture) and secondary sectors (manufacturing and other industry) minus the value of output in manufacturing. This method for normalising FDI inflows is described in detail in Morisset (2000).

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
		0.646 (1.70)+	0.500 (1.50)	0.342 (1.01)						
	1.911 (3.25)**									
		-0.239 (0.84)	-0.107 (0.42)	0.006 (0.03)	0.153 (0.90)	0.214 (1.49)	0.222 (1.37)			
								1.103 (2.19)*	1.340 (2.74)**	1.168 (2.05)*
	0.997 (3.04)**	2.214 (2.78)**	2.283 (3.37)**	2.007 (2.52)*	1.376 (2.24)*	1.647 (2.95)**	1.534 (2.52)*	0.464 (2.33)*	0.443 (2.22)*	0.491 (2.43)*
	-27.172 (71.92)**	-28.701 (25.30)**	-28.462 (32.20)**	-28.446 (27.44)**	-26.931 (46.57)**	-27.563 (38.35)**	-27.803 (36.44)**	-26.533 (67.54)**	-26.665 (70.11)**	-26.834 (66.59)**
	2002				Average 1993-2002	Average 2000-2002	2002	Average 1993-2002	Average 2000-2002	2002
	65	66	67	64	66	67	64	66	67	64
	0.17	0.12	0.15	0.10	0.08	0.12	0.09	0.11	0.14	0.12

Annexe 5: Regression results from IV-estimation

Instrumental variable estimates of the effect of mobiles penetration (growth) on FDI flows(growth)

Dependent variable/ regression	Equation to predict change in mobile phone subscribers 1998 – 2002 Stage 1	IV-regression Change in FDI/GDP (1998 – 2002) Stage 2	Non-IV regression – Change in FDI/GDP (1998 – 2002)
Log of mainlines per 1000 people 1998	-0.299 (3.87)**		
Change in log of GDP per capita (1998 – 2002)	1.678 (1.49)		
Change in openness (1998 – 2002)	0.004 (0.39)	0.039 (1.20)	0.054 (1.89)+
Log of area of country (Km2, 1998)	0.072 (0.67)		
Log of total road network (1998)	-0.200 (1.56)		
Change in log of mobile subscriptions (1998 – 2002)			1.014 (2.44)*
Change in log of mainlines per 1000 people (1998 -2002)		-0.194 (0.11)	0.326 (0.21)
Change in log(1/GDP per capita)		1.852 (0.42)	-1.202 (0.31)
Predicted change in log of mobile subscriptions		2.131 (2.88)**	
Constant	4.470 (5.14)**	-5.780 (3.14)**	-3.385 (2.95)**
Observations	59	58	64
R-squared	0.32	0.15	0.15

Source: Frontier Economics. Absolute value of t statistics in parentheses, + significant at 10%; * significant at 5%; ** significant at 1%

Annexe 6: Variable definitions and sources (WDI 2004)

In this section we present formal definitions of the variables used in the analysis. The data are all taken from the World Bank's World Development Indicators (2004).

Open=((imports+exports)/GDP)

Exports of goods and services (% of GDP): Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude labor and property income (formerly called factor services) as well as transfer payments.

Source: World Bank national accounts data, and OECD National Accounts data files.

Imports of goods and services (% of GDP): Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude labor and property income (formerly called factor services) as well as transfer payments.

Source: World Bank national accounts data, and OECD National Accounts data files.

Log(fixed + mobile subscribers)

Fixed line and mobile phone subscribers (per 1,000 people): Fixed lines are telephone mainlines connecting a customer's equipment to the public switched telephone network. Mobile phone subscribers refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology that provides access to the public switched telephone network.

Source: International Telecommunication Union, World Telecommunication Development Report and database.

Log (fixed lines per 1,000 people)

Telephone mainlines (per 1,000 people): Telephone mainlines are telephone lines connecting a customer's equipment to the public switched telephone network. Data are presented per 1,000 people for the entire country.

Source: International Telecommunication Union, World Telecommunication Development Report and database.

Log (mobile subscribers)

Mobile phones (per 1,000 people): Mobile phones refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology that provides access to the public switched telephone network, per 1,000 people.

Source: International Telecommunication Union, World Telecommunication Development Report and database.

Log (1/GDP per capita)

GDP per capita (constant 1995 US$): GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant U.S. dollars.

Source: World Bank national accounts data, and OECD National Accounts data files.

Foreign direct investment, net inflows (BoP, current US$)

Foreign direct investment is net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows in the reporting economy. Data are in current U.S. dollars.

Source: International Monetary Fund, International Financial Statistics and Balance of Payments databases, and World Bank, Global Development Finance.

Agriculture, value added (% of GDP)

Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.

Source: World Bank national accounts data, and OECD National Accounts data files.

GDP (current US$)

GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

Source: World Bank national accounts data, and OECD National Accounts data files.

Industry, value added (% of GDP)

Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.

Source: World Bank national accounts data, and OECD National Accounts data files.

Manufacturing, value added (% of GDP)

Manufacturing refers to industries belonging to ISIC divisions 15-37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.

Source: World Bank national accounts data, and OECD National Accounts data files.

Services, etc., value added (% of GDP)

Services correspond to ISIC divisions 50-99 and they include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The industrial origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.

Source: World Bank national accounts data, and OECD National Accounts data files.

Introduction to the community and business surveys

The remaining two papers in this report draw on surveys of poor, rural communities in South Africa and Tanzania, and small businesses, mainly in Egypt and South Africa. The first paper looks at patterns and impacts of mobile use, and the second specifically at the links between mobile use and social capital in rural communities. The surveys were commissioned by Vodafone from Environmental Resource Management and Forum for the Future and were conducted in mid-2004.

In South Africa 10 communities were surveyed, with 252 interviews completed in total. In addition, 140 small businesses were surveyed. In Tanzania 11 communities were surveyed, with 223 completed in total. Nine small businesses in Tanzania were also interviewed. In Egypt 150 small businesses were surveyed. In each case, the mobile services being used were 'traditional', namely voice or SMS text messaging, and no instances of using more advanced data services were observed during the research.

The table below presents some summary statistics on the three countries. The maps show the locations of the communities in relation to major urban centres. In each community a mobile phone mast had been erected in the past five years; prior to this the communities had little or no access to fixed-line telephones. Typical incomes in the rural communities selected will be below the national average. In Tanzania, employment in the communities is mainly agricultural, and often informal. In the case of the South African communities a higher proportion of inhabitants will have formal and non-agricultural employment, but unemployment rates will be higher than the national average in most cases.

In Tanzania, the typical community surveyed was small, with only a few hundred inhabitants. In most cases, the roads to the villages were sealed, although roads within them were not. Most of the dwellings were self-built shacks, and local services were very limited. For example, few of the communities had formal shops, clinics, or official public transport, and in none was running water or electricity to the house commonplace.

The South African communities were generally more developed, with facilities such as formal shops being common, and some had benefited from government housing, electrification and water and sanitation projects. However, self-built shacks were also common, with much of the population living in informal settlements or squatter camps.

Mpumalanga, South Africa, Keuny Maziya on his cell phone.

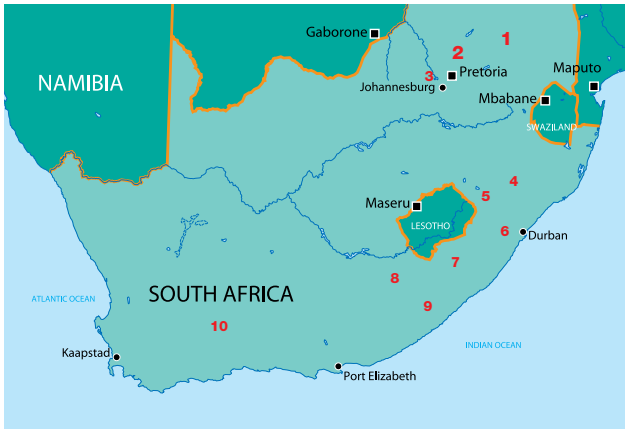
Egypt, South Africa Tanzania – basic information

Country	Population	Percent Urban	Per Capita GDP (US$, PPP)*	Fixed Lines Per 1000 People	Mobile Lines Per 1000 People
Egypt	70.5	42.1	3,810	110	67
South Africa	44.8	56.5	10,070	107	304
Tanzania	36.3	34.4	580	5	22
All Developing Countries	4,936.9	41.4	4,054	96	101
High Income Countries	941.2	77.8	28,741	584	653
World	6225.0	47.8	7,804	175	184

Source: UNDP, Human Development Report 2004. All data are for 2002.

Note: PPP (purchasing power parity) GDP figures are adjusted to reflect the cost of living, so $1000 of PPP income would yield the same standard of living everywhere.

Figure 1. Map showing the location of the communities surveyed in South Africa



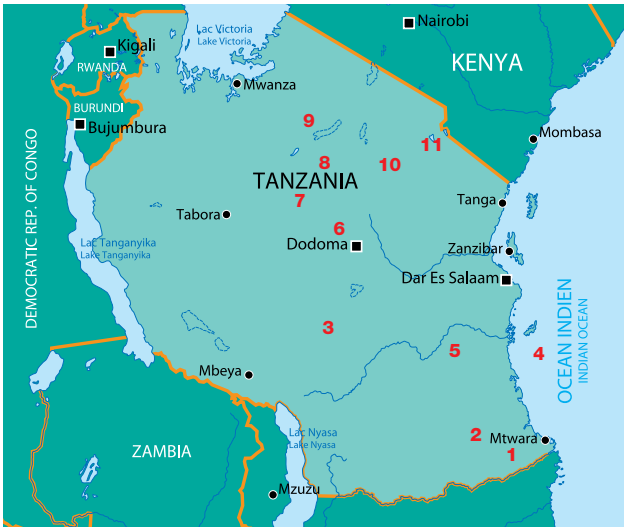
1. Kga Kgapane
2. New Pietersburg
3. Phake
4. Emondlo
5. Oppermans Kraal
6. Msinga
7. Mvenyane
8. Rhodes
9. Butterworth
10. Van Wyksdorp

The aim of the fieldwork was to interview a broad cross-section of the community that included a mix between gender, employment status, age (all respondents were over 16) and mobile phone ownership, use and non-use.

The surveys identified three distinct sets of people:

- people with their own personal mobile phone ("mobile owners");
- people who don't have their own mobile, but do use other people's mobiles ("non-owning users"); and
- people who don't own a mobile phone and never use other people's mobiles ("non-users").

Figure 2. Map showing the location of the communities surveyed in Tanzania

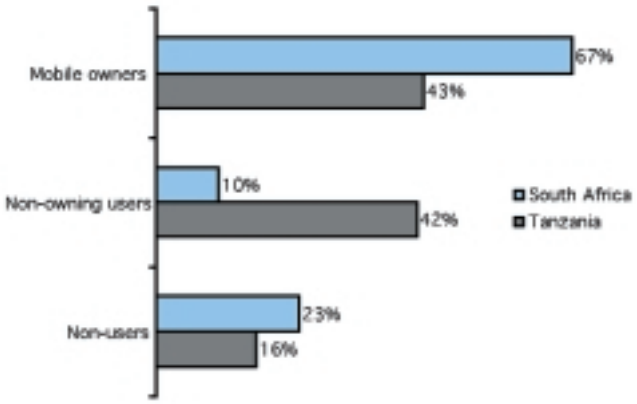


1. Masasi
2. Nachingwea
3. Tanangozi
4. Mafia
5. Dimon
6. Issuna
7. Ndago
8. Manyara Ranch
9. Ngorogoro
10. Mirerani
11. Mango

However, due to the focus of the research, the samples for each community were not randomly selected and exhibit a bias towards individuals owning a mobile phone. Fieldwork concentrated on collecting a large proportion of mobile phone owners and users, and so the profile of respondents in this research is in no way representative of South Africa and Tanzania as a whole or even the rural communities where fieldwork was conducted. Therefore the levels of ownership for both South Africa and Tanzania are not representative of mobile ownership in rural communities in these countries. In addition, there is a higher proportion of females in the sample for each community in South Africa and Tanzania, as the surveys took place during the day, when men were more likely to be out working. The survey samples are also slightly biased towards the younger age groups.

In South Africa, the majority of the sample interviewed had their own phone. Mobile penetration in South Africa was 31 per cent in December 2002 and in rural communities such as those included in this survey, penetration is much lower than this. In the surveys, just under a quarter of those interviewed were "non-users" and 10 per cent had no phone but used other people's phones from time to time – usually borrowing the phone of a friend or relative, for no charge.

In Tanzania, just over 40 per cent of those interviewed in the fieldwork owned their own phones. Again, because the survey actively sought out mobile phone users, this is a much higher proportion than in Tanzania as a whole, where mobile penetration was two per cent at the end of 2002. Non-users made up 16 per cent of the sample, and non-owners who used other people's phones made up another 42 per cent. The majority of these people were using cheap phone cards, which meant that they could borrow other people's handsets at no cost to the owner.



Profile of mobile ownership and use, South Africa (250 respondents) and Tanzania (222 respondents)

The surveys of small businesses were undertaken primarily in Egypt and South Africa, but also in two communities in Tanzania. A total of 150 people were interviewed in Egypt, 140 in South Africa and 9 in Tanzania.

Small businesses were defined as having fewer than 50 employees. Only a small portion of those in the sample did not have a mobile (although this was not a deliberate part of the survey design), reflecting the high rates of mobile phone penetration amongst small businesses in South Africa and Egypt. Businesses surveyed included professional firms, street traders, tradesmen, a range of service firms, manufacturers, retail traders and mobile phone related business operators.

The surveys covered both the formal and informal sectors of business. The people surveyed in Egypt were all located in Cairo, whereas in South Africa, we interviewed small businesses in urban areas (most in Cape Town but some in Durban and Johannesburg) as well as in the same 10 rural communities described earlier. The surveys involved face-to -face interviews supplemented by a mailing of questionnaires to the formal sector businesses in Cape Town, Durban and Johannesburg. Business surveys were also conducted in two communities in Tanzania: Ngorongoro and Mafia Island.

Jonathan Samuel

Partner, ERM

Niraj Shah

Consultant, ERM

Wenona Hadingham

Consultant, ERM

Mobile Communications in South Africa, Tanzania and Egypt: Results from Community and Business Surveys

Many developing country governments and development agencies are focusing on extending telecommunications services into rural areas, as they seek to encourage growth, alleviate poverty and overcome a perceived 'digital divide'. Mobile technologies are playing a major role in this effort. However, relatively little is known about how rural communities and small businesses use mobile technologies, and what impacts they are having.

Mobile communication services in Africa have expanded rapidly in recent years. Most of this growth has been in urban areas, but there are growing rural networks in many countries. The affluent urban markets have naturally been targeted first, but in addition there has been a perception that the rural poor are not able or willing to pay for mobile telecommunications services. Yet in fact, in many instances, rural demand has greatly exceeded initial expectations.

Perhaps equally important, the introduction of mobile services has brought about a change in the business and operating climate of the African telecommunication sector: competing mobile operators have helped create an environment that fosters innovation and competition

This paper presents the results of research into socio-economic impacts of mobile communications on households, rural communities and small businesses in Africa. Some of the questions the research sought to address include:

- Who uses mobile communications services?
- What are the factors that influence ownership, use and non-use of mobile phones?

- What are mobile phones used for – as a consumer good, for business or employment purposes, or both?
- What role do mobiles play in the operation of small businesses in urban and rural areas?
- What social and economic impact are mobile phones having on communities and small businesses in Africa?

Answers to these questions have important implications for both governments and the mobile operators as they seek to expand their networks to cover rural areas. There is very little empirical information on the impacts of mobile phone use in rural communities or by small businesses in Africa. The results of this study are based on data collected in face-to-face interviews, carried out in South Africa, Tanzania and Egypt.

Profile of mobile users and non-users in the communities

a) Who uses mobile phones?

In the surveys, 67 percent of the sample of 252 people in South Africa owned a mobile phone, while a further 8 percent used mobiles, but did not own one, and 25 percent of respondents did not own or use a mobile phone at all. In Tanzania, the figure for ownership was lower, at 43 percent of the 223 respondents interviewed, with users at 42 percent and nonusers at 16 percent. The higher proportion of users as opposed to owners in Tanzania suggests a greater degree of 'sharing' of mobiles than in South Africa. This may reflect a lack of alternative communication facilities for non-owners in most of the communities in Tanzania and the smaller numbers who can afford to purchase a phone. Those respondents who used someone else's phone usually bought airtime vouchers to do so.

When we looked at access to mobile phones (regardless of whether or not the respondent used them), 97 percent in Tanzania stated that they could access a mobile phone if they wished to, whereas only 28 percent could access a landline somewhere in the community. This indicates a very high awareness of the potential to use mobile phones for communication, and very high perceived accessibility, even in these very poor rural communities.

The survey found that the perception of ownership of mobile phones in Tanzania is different to that in South Africa. When the respondents stated that they owned a mobile phone, they often considered it as a household asset rather than a personal or individual one. This was particularly the case for female respondents. However cultural norms in rural Tanzania dictate that ownership of such items lies with male members or heads of the households. We found that a broadly similar proportion of males and females were owners and users of mobiles. Whilst this result is surprising, particularly in the case of Tanzania, it may be explained by the fact that the sample is skewed towards females and those with mobile phones. The figures in Table 1 do show some differences in men's and women's use of mobiles, especially in Tanzania.

We can make no claims for the sample being fully representative of the rural population in these communities. However in the sample of owners and users of mobile phones we found a broad representation of individuals by age, income groups, education levels and gender. We looked at the breakdown of owner, user, and non-user status by gender, age, education and income to see where use or non-use varied with the by these parameters.

Table 1: Mobile status of the interview sample by gender

Gender		Male	Female
South Africa	Owners	39.1	56.8
	Users	40.0	60.0
	Non-users	51.7	46.6
	Census data for communities	47.2	52.8
Tanzania	Owners	50.5	48.4
	Users	47.3	52.7
	Non-users	20.0	80.0

We found that nearly 57 percent of the respondents who owned a mobile phone in South Africa were female. Similarly, 60 percent of respondents who were users but not owners were also female.

Perhaps not surprisingly, almost half of the respondents who were users in the South African communities came from the 25-45 age groups. The respondents in this age group are economically active and therefore may be more likely to own a phone. However, respondents in age groups of 46-55 and over 55 were still well represented in the group of owners and users.

In Tanzania, the patterns of age distribution in the group of owners and users was similar but was more concentrated in the age group of 26-45 as shown below in Table 2.

Table 2: Mobile status by age in South Africa and Tanzania

South Africa	<25	26-45	46-55	>55
Owner	30.2	49.7	10.1	7.7
User	40.0	36.0	20.0	4.0
Non-user	29.3	37.9	6.9	17.2
Tanzania	**<25**	**26-45**	**46-55**	**>55**
Owner	14.7	63.2	13.7	7.4
User	25.8	52.7	10.8	10.8
Non-User	28.6	60.0	5.7	2.9

We also looked at mobile phone status according to the respondents' level of education. In South Africa, we found that broadly speaking the pattern of mobile phone ownership in the rural communities surveyed was skewed towards those with higher levels of education. Table 3 indicates these proportions according to the census data. However, the survey data also reveals that there is a large number of owners and users of mobile phones, who have no or just primary education. This is also evident in the case of the Tanzanian communities, although there is a marked difference between ownership and usage patterns.

Table 3: Mobile status in South Africa and Tanzania by education level

South Africa	No education	Primary	Secondary	Technical College	University
Owner	7.7	14.8	56.2	12.4	4.1
User	16.0	20.0	56.0	8.0	0.0
non-user	15.5	44.8	34.5	1.7	0.0
Population (from census)	22	26	45	6	2

Tanzania	No education	Primary	Secondary	Technical College	University
Owner	5.3	28.4	33.7	20.0	4.2
User	8.6	62.4	18.3	8.6	0.0
non-user	14.3	71.4	11.4	0.0	0.0

Finally we looked at the breakdown of respondents' mobile phone status by income brackets and compared it with the overall breakdown of incomes from the census data. We found that over 50 percent of the respondents who were mobile phone users were within the lowest R501-1000 (monthly) income bracket (approximately $85-170 per month). The data also confirm that at higher income levels, people are more likely to own their own phone. The non-users were unsurprisingly concentrated in the lowest income group. Overall, we conclude that income is not a significant barrier to access to mobile telecommunications.

Table 4: Mobile status in South Africa by income level

South Africa	<500	501-1000	1001-4000	>4001
Owners	51.8	27.7	10.9	9.5
Users	53.4	41.9	2.3	2.3
Non-user	63.1	21.1	10.5	5.3

	<R400	R401-R1 600	R1 601-R6 400	R204 801 or more
Census data %	22.6	49.6	23.4	4.4

South African census bureau income brackets differ slightly from those conventionally used for market research purposes and in these surveys. R=South African Rand. £1=R11.30, US$1=R6.

b) What explains mobile phone use?

The extent to which mobile phones are used, and the ease with which new users can access them, is crucial in terms of their economic and social effects. The reason is that there are strong network effects accruing from phone subscription. A network effect (or externality) occurs because each existing subscriber benefits when the total number of subscribers increases. As the total number of subscribers increases, so does the value of having a phone, because each individual can contact more people.

The network effect is well understood in developed markets where personal ownership of a phone is the common model. However, the operation of network effects will be different where mobile phones are not personally owned, but shared among individuals, or used in a communal facility (such as a Community Service Telephone centre in South Africa). Ownership facilitates two-way communication because an individual is uniquely identified with a number. In a model of shared use two-way communication is more difficult; a non-owning user can make calls out but cannot receive spontaneous inbound calls.

Whether this difference is significant depends upon the type of communication required. Communications which are initiated by an individual to acquire data or information from a central source (such as finding out the availability of goods in a shop) are largely unaffected by the inability for the individual initiating the call to be reached in turn. According to the field observations, mobile phones were essential for searching for work, not only for getting information and making an application, but also as a means of being contacted by a prospective employer – that is, inbound communication was important. On the other hand, family interactions may not be adversely affected by shared usage if the mobile is shared within a co-located family unit.

The distinction between models of access that facilitate essentially one-way communication and individual ownership which permits two-way communications is important from a policy perspective. Understanding how people want to use mobiles can inform policies that are seeking to increase access to ICT services. The survey results shed some light on the nature of communication individuals in the rural communities require and the implications of those needs for the models of ICT access – in particular the difference between one-way and two-way communications.

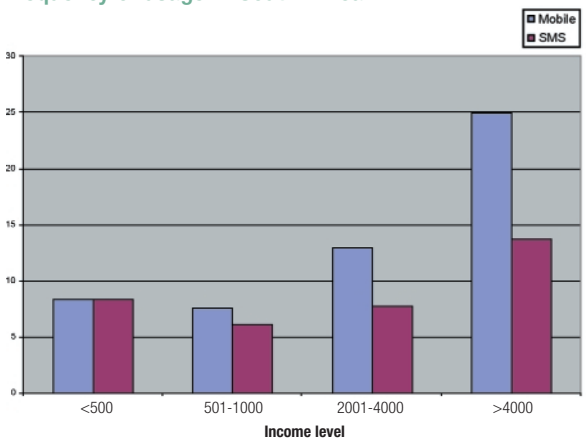
The surveys therefore included a number of questions designed to ascertain the most important influences on the use of mobiles. One obvious candidate was income, but we did not consider this relevant in the Tanzanian communities surveyed. Most of them are dependent on subsistence farming and people earn very little cash income. In addition, the income they earned was seasonal, and dependent on the harvests. A more detailed survey would have been required to get an appropriate estimate of how much the respondents could earn in a typical month.

Our analysis of income for South Africa generally shows a positive relationship between mobile phone usage and income.

Not surprisingly, the number of calls made and text messages sent increases with income, as shown in Figure 1. However, respondents in the lowest income bracket also appeared to be reasonably frequent users of mobile phones. This suggests that making calls is also important for those on very low incomes.

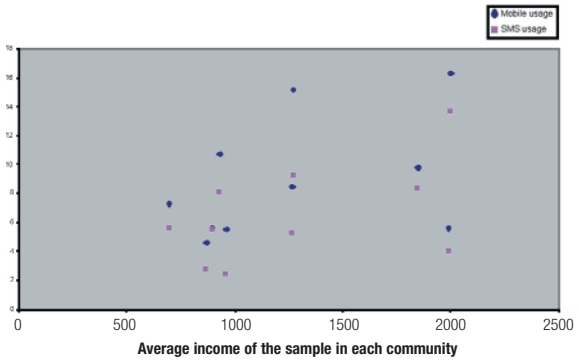
Low income users have also found clever ways to minimise their own call costs. One example is 'beeping', where a caller dials but hangs up before the call is connected, thus avoiding a call charge. The recipient will then call back at their expense. More sophisticated versions include giving meanings to specific numbers of rings. For example, three rings might mean 'I am leaving now' or 'pick me up now'.

Figure 1: Income levels of survey respondents and frequency of usage in South Africa



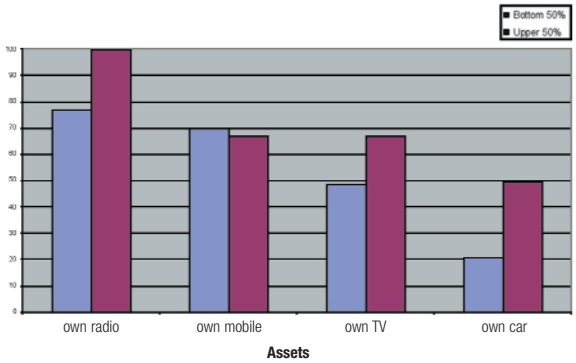
Reviewing this same relationship at the community level in South Africa gives a similar outcome. In those communities where average incomes are higher, people also tend to make more calls on average. This relationship also seems to hold when looking at the cross-sectional data between the communities.

Figure 2: Mobile and SMS usage ranked by average community in South Africa



We also contrasted ownership of mobile phones with ownership of other consumer durables. Mobile phones are one of several consumer durables that households in the survey typically owned.

Figure 3: Top 50% and bottom 50% of individuals by income and the percentage of ownership of assets

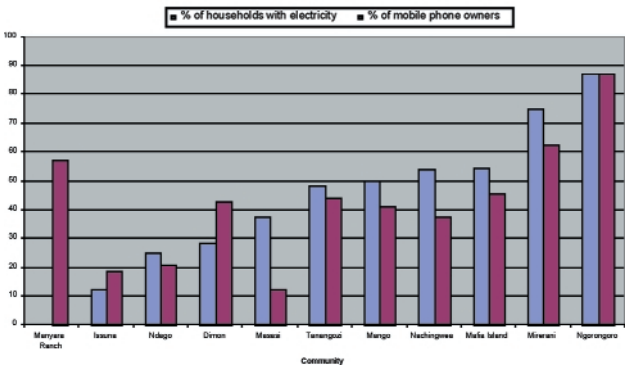


Overall, whilst income is obviously an important influence on ownership and use of mobiles, the survey evidence clearly suggests that mobile phone ownership is less skewed towards the better-off sections of the population than other consumer durables. This is significant, as the survey sample was deliberately targeted at communities, which could be expected to be amongst the poorest in their countries. The results therefore suggest that, on the whole, mobile is very far from a luxury good affordable by only the rich.

Expenditure on mobile phones as a proportion of total expenditure can give some broad information on their importance and impact on household budgets. In South Africa, 134 mobile phone owners were happy to provide information on their income and their mobile phone expenditure. These respondents spent on average between 10 and 15 percent of their income (or 89 to 108 Rand) on mobile phones (estimation was made using mid-points of income and expenditure brackets). However, as only one respondent identified mobile phones in their top three expenditure items, so these figures should be treated with caution. National data suggest the biggest items of expenditure for the poorest black South Africans (urban and rural) are food (about 50 per cent of the household budget), fuel and energy, and housing (each 7 to 8 per cent). Transport and communications follow after these categories, however, in the national statistics[1]. The level of spending indicated by the survey is surprisingly high (as a proportion of income), but it is interesting to explore the extent to which spending on mobiles may be substituting for other categories of expenditure, such as transport. We return to this below.

Another potential barrier the surveys explored was lack of access to electricity, which can inhibit take-up of other technologies in developing countries. Clearly some form of energy is needed to recharge mobile batteries and so a lack of electricity could form a barrier to mobile phone ownership. In Tanzania many communities had limited or no access to electric power. Figure 4 shows the relationship between mobile phone ownership and use and a community's access to electricity in Tanzania. The horizontal axis shows the percentage of households within a community with access to electricity, from lowest to highest. Whether a respondent was an owner of a mobile is positively related to whether he or she has access to electricity.

Figure 4: Access to electricity and mobile phone ownership



Respondents with electricity are more likely to own a mobile phone. Those without electricity are more likely to borrow someone else's.

The communities overcame the constraint of not having an electricity connection in a variety of ways. For example, at Issuna Mission in Tanzania, every week someone collected all seven mobiles in the community and took them to the nearest town that had electricity, to be charged. In a small community, it is likely to be easier to charge a small number of phones and share these rather than each person owning a handset. Communities without electricity managed to achieve a similar level of mobile phone usage to those communities with electricity (in terms of traffic volume), albeit with lower levels of ownership.

In South Africa, communities with and without electricity were equally likely to own and use mobile phones. This might reflect greater possibilities for recharging phones using motor vehicles (motor vehicles were much more prevalent in the communities visited in South Africa than in Tanzania). In Kwa Phake, South Africa, a community without access to electricity, a local hairdresser had a phone charging service using a car battery.

We also looked at whether or not mobile phone ownership and use might depend on whether or not a community has access to a post office, as a proxy for access to an alternative means of communication. However, no relationship of this kind was found in either South Africa or Tanzania.

c) Impacts of mobiles

Respondents to the surveys identified a large number of impacts from using mobile phones. Some of these were social in nature, while others concerned employment or business. The social impacts were very important in both South Africa and Tanzania. Greater contact and improved relationships with family and friends was one of the most significant benefits identified by the surveys. But reduced travel costs and help in job search were also highlighted. A limited number of respondents also made money from renting out their phone.

Table 5: Impacts of using a mobile phone

Impact	South Africa (%)	Tanzania (%)
Prompted responses*		
Improved relationships	78.7	85.3
Call rather than travel to family and friends	77.4	91.1
Un-prompted responses		
Easier communication with family and friends	72.2	84.6
Useful in emergencies	25.8	27.1
Assists in job search	15.5	2.7
Avoids problems with public fixed-line phones**	8.8	n.a.
Easier to organise meetings	8.2	9.0
Faster or improved communication	7.7	53.2
Access to business information/business purposes	7.2	34.0
Saves money	5.7	1.6
Easier to contact school/university	4.6	5.9
Contact employer/clients on road	3.6	3.7
Can send cheap messages using SMS	2.6	0.5
Status symbol	2.1	–
Improved access to telecommunications	1.5	1.1
Place an order for groceries or other items	1.0	6.9
Feel safe	1.0	2.7
Make money from lending out phone	1.0	0.0
Health concerns	0.5	0.5
Expensive/costs money	–	9.7

* These impacts were identified through specific questions, while the rest of the impacts identified were offered by the respondents without a specific question being asked.
** In Tanzania, in the communities surveyed there was generally no public fixed line phone.

We were surprised by the very small number of negative comments made. Only 0.5 percent of respondents in each country mentioned health concerns, and only in Tanzania were concerns about costs raised.

The main unprompted impact identified by the surveys related to easier contact with family and friends. In both Tanzania and South Africa, many people move away from their home to find work, and mobile phones are now an important means of keeping in touch with families. In the survey sample, 91 percent of respondents in Tanzania called friends and relatives rather than travelling to see them. In South Africa, 77 percent of mobile users called rather than visited. (These response rates were to prompted questions.) Indeed, for many families surveyed the costs of travelling to see relatives would be prohibitive, especially in the poorest rural communities, and mobile therefore represented the only option of maintaining contact.

Respondents thought that this generally had a large impact on travelling time and costs saved. There will also be environmental and safety benefits associated with avoided travel. Table 6 illustrates the travel time and cost savings identified by respondents. The impacts were slightly larger for Tanzania, where roads are worse and public transport less extensive. The potential importance of mobile as a substitute for travel is easy to underestimate. Of the communities surveyed in South Africa, only 4 out of 10 had a regular bus service to the nearest town and the typical round-trip cost was 15 Rand. In contrast, a typical pre-paid voice call costs R5 (Average monthly income in the South African communities was R1271). It is not surprising that so many respondents identify mobiles as a source of saving both time and travel costs.

Table 6: Estimates of travel time and cost savings

Saving	South Africa	Tanzania
Large saving in travel time	52.2%	67.3%
Large saving in travel cost	58.2%	65.4%

Interestingly, the vast majority of those who did travel to see relatives (85 percent for Tanzania and 79 percent for South Africa) thought these relationships had improved anyway because of mobile phones. Only a very small number recorded a deterioration in the relationship with friends and relatives who are now phoned rather than visited. A detailed analysis of trips saved compared with call costs incurred would be an interesting area of further work.

As an example, one respondent in Mafia Island, Tanzania, said he was now able to keep in daily contact with his immediate family, who all lived in Dar es Salaam. Using his mobile phone, he is able to get information about his children's progress at school and what they are doing in their free time, thereby maintaining a strong relationship with them despite the distance. He felt that mobile phones had saved him a lot of money as the cost of going to Dar es Salaam, certainly in relation to calling with a mobile phone, is high.

A number of respondents also used mobile phones to contact schools and universities. For example, mobile phones are used by the students in Kwa Phake, to correspond with various tertiary institutions such as UNISA (University of South Africa). Instead of having to travel to these institutions they can easily access information they need using a mobile phone. Monthly calls for educational purposes in this particular community were made by 31 per cent of respondents.

There were also examples of parents using phones to contact children boarding with relatives and attending school in neighbouring towns. Mobile phones enabled parents living in towns without fixed-line services to contact their children during term time. For example, in Rhodes, South Africa, one mother had a daughter attending school in Barkly East (about 60km away on difficult roads) who boarded there with a relative. The very poor public phones in the community and limited public transport facilities meant that mobile phones were the only way she could regularly keep in contact with her daughter.

In Tanzania, a strikingly high proportion of respondents (57 percent) felt that a major impact from mobile phones was faster and improved communication. The proportion in South Africa mentioning this as an impact was substantially lower at 8 percent. This probably reflects a greater presence and reliability of fixed-line phones in South Africa prior to the introduction of mobile phone services.

Nevertheless, poor public phone services (using fixed-line phones) were cited by a number of respondents in South Africa as a key reason for relying on mobile phones. 17 percent of respondents in South Africa who do not own but use someone else's mobile phone noted that problems with the public fixed line phones mean they now rely on a borrowed mobile if they need to make a call. Mobile phones also provided peace of mind to geographically isolated communities with poor fixed line facilities, with about a quarter of both the South African and Tanzanian respondents stating that mobiles were useful in emergencies.

Mobiles can also help to improve services in rural areas. For example, shared taxi drivers operating in Mango Parish, Tanzania, used their mobiles to request additional taxis to come to the taxi stand when there were lots of people waiting for transport, thus reducing their customers' waiting time and increasing their own income.

The responses revealed mobile phones to be important for job search in South Africa. Altogether, 16 percent of respondents volunteered this as an impact and 24 percent of owners or users also said they had made or received a call about an

employment, business or training opportunity. Mobile phones enabled job seekers to ring for information about employment, and enabled them to be contacted by potential employers. This was particularly important in South Africa, where fears about crime would stop many employers visiting potential employees at their homes.

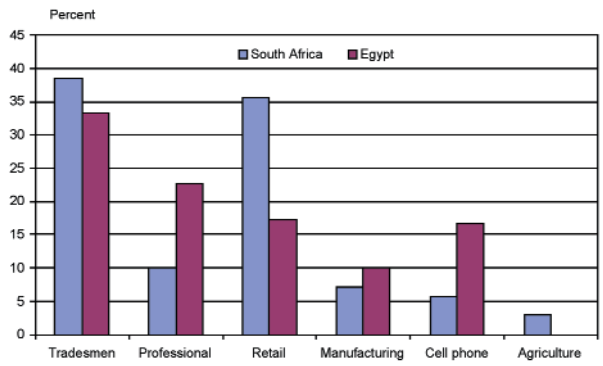
In Tanzania, 34 percent used mobile phones to access business information and for business reasons. This could reflect the importance of agriculture in the economy, with phones being used to get accurate market price data and order supplies. For example in Mafia Island one person running a small fuel supplies operation used his mobile to place an order for more stocks of fuel when his reserves were running low, and to get a specific date for shipments from the mainland. He said he was also now able to source fuel from more suppliers than before.

Business and employment opportunities are an area where network effects play an important role. Two-way communication is important in instances where potential employers or clients would like to contact a prospective employee or supplier. According to the field observations, mobile phones were essential for job search, not only for getting information and making an application, but also as a means of being contacted by potential employers.

Mobile use by small businesses

In addition to the community surveys, we also explored mobile phone use by small businesses, surveying businesses in South Africa (urban and rural businesses) and Egypt (Cairo only). The breakdown of small business respondents in Egypt and South Africa by industry is summarised in Figure 5 below.

Figure 5: Respondents by Type of Business



The differences between the samples in the two countries largely reflect the rural/urban split of respondents. Thus around 42 percent of small business respondents in South Africa were from the 10 rural communities. These were concentrated in the retail sector, so there is a greater representation of retail businesses in the South African sample. There were also very few professional firms in these communities, and this has resulted in a lower representation of professional firms in the South African sample compared with Egypt.

Table 7 presents the impacts identified from the surveys in Egypt and South Africa.

Table 7: Impacts of Mobile Phones on Small Businesses

	Egypt (%)	South Africa (%)
Prompted responses		
Increased call costs	67.3	47.1
Increased turnover	66.0	56.6
Increased customer numbers	65.3	56.2
Increased profits	58.7	61.8
Unprompted responses		
Faster/improved communication	57.3	25.7
Increased efficiency	56.0	21.4
Save time	24.7	10.0
Available to clients all the time	23.3	47.1
Save costs	22.0	15.7
Larger client database	16.7	4.3
Place orders on the job	15.3	21.4
Bad network	11.3	4.3
Assist in breakdowns/emergencies	10.0	20.7
Reduced travelling	8.7	50.0
Contact with the office	8.0	25.0
Less free time/ no privacy	7.3	7.1

Nearly 85 percent of the businesses surveyed in Egypt and 89 percent of businesses in South Africa in the sample used a mobile. Five years ago just 11 percent of the businesses surveyed in Egypt, and 34 percent in South Africa, said they used mobile phones for business purposes.

The number of small business with access to fixed-line telephones stood at 45 percent in Egypt and 52 percent in South Africa five years ago. Whilst this number has increased to 80 percent in Egypt and just over 60 percent in South Africa, mobiles have now overtaken fixed-line phones as the most important communication tool for businesses in the survey. Prior to acquiring a mobile, 27 percent of business respondents in Egypt and 15 percent in South Africa had no telephone access at all. For comparison, the use of fax machines by the small businesses surveyed had also increased substantially over the past 5 years, with 23 percent of small businesses in Egypt and 47 percent in South Africa, now using one (up from 5 per cent and 31 per cent respectively five years ago).

Nevertheless, the rate of increase in the use of mobile phones has exceeded the increase in use of other communication tools. Over the past five years, the number of businesses using mobile phones increased by over 547 percent in Egypt and nearly 125 percent in South Africa. This compared with an

increase of 325 percent and 53 percent in Egypt and South Africa respectively for facsimile machines and 71 percent and 15 percent for fixed-line telephones.

However, where small businesses can use fixed-line telephones and facsimile machines in conjunction with mobile phones, the survey evidence showed that they often choose to do so. One of the reasons for this is the higher price for calls from mobile phones compared with fixed line phones.

In South Africa, mobile phones were the only source of communication for a large number of small businesses run by black individuals. Over 85 percent of small businesses run by black individuals rely solely on a mobile phone for telecommunications. In addition, for many small businesses in rural areas mobile phones are the only source of communication (and most small businesses interviewed in rural areas in South Africa were run by black people). For these small businesses, mobile phones are literally essential to their businesses.

In the cities, there were also some examples of mobiles helping overcome disadvantages. For example, in South Africa, a manufacturer of children's dolls based in Cape Town employed deaf people. Text messaging via mobile enabled the owner and employees to communicate with each other. The owner felt that without the technology it would be much more difficult to interact with his workers and it would not have been practicable to employ them at all.

In Egypt, the informal sector was more reliant on mobile phones for running their business than the formal sector (the informal sector encompasses a wide range of small retail, small manufacturing, transport and service activities). Almost 90 percent of businesses in the informal sector used a mobile phone.

The surveys also revealed that mobile phones played a part in small business start-ups. In South Africa, 29 percent of respondents from non-mobile phone related firms were influenced to some extent by the availability of mobile phones in starting up their business, while 26 percent in Egypt were influenced by mobile phones. This was particularly true for small businesses operating in the service sector. In some cases, access to mobile phones has increased the range of services that can be offered. Mobile phones also mean that small businesses can operate a 24-hour call-out service, which is important for tradesmen and non-professional service firms. For some rural communities in South Africa which previously were without fixed line telephones, mobiles have simply made running a small business feasible. For instance in South Africa and Tanzania, operators of spaza shops (informal general stores) and kiosks are now able to order supplies using a mobile phone without having to travel to place an order.

Figure 6: A spaza shop operating in Nachingwea, Tanzania

Survey respondents in both Egypt and South Africa said mobiles had increased their profits: 59 percent in Egypt, with 31 percent noting a large impact. In South Africa, the figure was 62 percent, with 27 percent noting a large impact. The reported increase in profit levels was in spite of respondents generally also saying that mobile phones had increased their call costs.

Interestingly, none of the businesses in these surveys, including retailers in the rural communities, suggested that higher spending on mobile calls by their customers had dented their profitability. This might suggest that customer spending on mobiles has at least created additional business opportunities (such as selling pre-pay vouchers) which compensate for any lost sales of other products.
Overall, the respondents said increases in profits attributed to the use of mobile phones were due to a combination of reduced travelling time and costs, increased customer numbers and higher turnover.

Reduced travelling was a much more important impact in South Africa than in Egypt, with 56 percent of businesses in South Africa identifying this as a beneficial impact, compared with just 10 percent for Egypt. This might reflect the predominance of rural firms in the South African sample, with 75 percent of small businesses in rural South Africa indicating that mobile phones saved them travelling time. Nevertheless, 46 percent of small businesses based in South African cities also identified reduced travelling as an important impact.

An increase in efficiency was another widely cited impact. Some specific examples included being able to run errands without closing the store, placing orders from the premises without having to visit supplier (important for shops and those in the building trade), and keeping in contact with staff and the office while travelling. Professional firms also noted that mobiles enabled them to keep in contact with clients while travelling.

Conclusions

The results of the surveys suggest that mobiles have brought considerable benefits to communities and small businesses. People at all income levels are able to access mobile services, either through owning or sharing a phone; and gender, age and education do not seem to constitute barriers to access. While income certainly explains the level of usage, lack of income does not prevent mobile use. Even the absence of electricity does not present an insurmountable barrier, thanks to the sharing of mobiles and recharging batteries in the nearest town, or recharging locally by a generator or car battery. For the residents of the rural communities, mobile phones have typically had positive economic and social impacts. Mobiles have reduced travel needs, assisted job hunting and provided better access to business information. Greater ease of contact with family and friends has improved relationships. These benefits were reported even though the communities surveyed were amongst the poorest in their countries.

Mobile phones have also become an essential tool for small businesses. A substantial proportion of small businesses have no alternative method of communication. The proportion is highest for black-owned businesses in South Africa and informal sector businesses in Egypt, suggesting that mobiles have become an important tool for disadvantaged groups. A large majority of small businesses said mobiles have brought higher profits, turnover and increased efficiency, although they are also paying higher call charges.

Notes

[1] Income and Expenditure of Households 2000, Statistics South Africa, release P0111, 2002.

James Goodman

Linking mobile phone ownership and use to social capital in rural South Africa and Tanzania

Introduction: what is social capital?

Human activity uses a variety of resources to achieve different ends. For example, financial capital is one of those resources, accumulated over time for drawing on when needed. Environmentalists use the concept of natural capital to mean the resources of the natural world such as clean air or trees, which we can invest in, use, and deplete. The idea of social capital refers to those social resources that likewise we invest in, accumulate, draw down and sometimes deplete. Social capital represents the intangible value of the social group, on whatever scale, above and beyond the value of its individual members alone. It can be thought of generally as the social resources available for human activity.

The term was first used in 1916, when Lyda Judson Hanifan, a West Virgina school superintendent, published a discussion of the role of schools as community centres. He noted that high levels of participation among local people in school affairs not only led to improved support for the school, but also to general improvements in the school's wider community: there was an unintended social spillover. He coined the term social capital to describe this, and later defined it as a combination of "goodwill, fellowship, sympathy, and social intercourse among the individuals and families who make up a social unit".

In the past decade social capital has become one of the most salient concepts in the social sciences. The American sociologist Robert Putnam has done most to promote the revival of the idea of social capital. He looked at a wide range of indicators in the USA such as membership of voluntary associations, participation in community affairs, trust of strangers and so on, and in his well-known book, "Bowling Alone: The collapse and revival of American Community," used these to argue there had been a decline in social capital in America. He identified a number of causes for this decline – chief among them too much television watching – and proposed means by which the decline might be arrested. For Putnam, the key to a healthy society is participation in social groups, and he has advised national governments around the world (including the UK) on how to promote community participation.

The concept of social capital appeals to sociologists, economists and political scientists alike; one of its strengths is to bring these disciplines together. A weakness, however, is the lack of a precise definition. Putnam defines it as "features of social life – networks, norms and trust – that enable participants to act together more effectively to pursue shared objectives."[1] Francis Fukuyama calls it "an instantiated informal norm that promotes cooperation between two or more individuals"[2]. Michael Woolcock, a sociologist working for the World Bank, refers to "the information, trust, and norms of reciprocity inhering in one's social networks"[3]. Economists are interested in social capital for its contribution to productivity, and define it as the spillover from the individual to the group, a sort of social externality or network effect.[4]

Most definitions include a structural element supporting a cognitive element. A parallel might be with the road network and traffic flowing on it, as the structural element, and the laws and unwritten rules of the road as the cognitive element. The structural element of social capital is made up of social networks and relationships: friendship networks, families, neighbourhoods or communities, companies, social groups, political groups, and so on. These are all forms of association, organised in order to achieve certain ends: to provide support, to distribute products or disseminate an idea, for example. The cognitive element comprises a range of social attitudes, relating to a willingness to trust other people and shared values and norms. Successful participation in a social network creates trust, which can then be invested back into the social network to grow the capital, strengthening and growing the network.

These definitions make it clear that social capital might be a useful way of understanding the social role of mobile phones. Mobile phones are used to mediate contact between different people, and so are likely to have an effect on the size, number and nature of social networks that people participate in. This in

turn may affect levels of trust. Social capital may also provide an indicator of where take-up of mobile telephony could be higher.

What's the use of social capital?

The literature generally agrees that high levels of social capital can result in desirable socio-economic outcomes. According to a 2001 review by the UK Office for National Statistics, "Social capital has a well-established relationship with the outcomes policy makers are concerned with e.g. economic growth, social exclusion, better health and wellbeing."[5] The 2002 Policy and Innovation Unit (PIU, now the Strategy Unit) report on social capital for the UK government identified six general benefits, supported to a varying degree by empirical research:

1. It may facilitate better economic performance, for example through reducing transaction costs, enabling the mobilisation of resources and facilitating the rapid movement of information.
2. It may facilitate the more efficient functioning of job markets, for example by reducing search costs.
3. It may facilitate educational attainment;
4. It may contribute to lower levels of crime;
5. It may lead to better health;
6. It may improve the effectiveness of institutions of government.

Research in rural Tanzania has suggested that increased levels of community participation lead to higher household incomes.[6]

There appear to be strong correlations between national levels of social capital, measured in terms of trust, and socio-economic development. The World Values Survey includes the question, "Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?". The top-scoring countries on the trust measure also tend to be countries with high GDP. In 1996, the top scoring country was Norway, with 65 per cent of people answering that most people could be trusted. Next came Sweden, Denmark, Netherlands and Canada, all with scores of over 50 per cent. Ireland scored 47 per cent, Australia 40 per cent, the USA 36 per cent and the UK 31 per cent. In contrast, less developed countries scored much lower. In Turkey, trust was recorded at six per cent and in Brazil at just three per cent.[7]

Consequently, development organisations and governments have become intensely interested in social capital. The World Bank, for example, has sponsored a great deal of research on the relationship between social capital and macro-level outcomes. It has an extensive area of its website dedicated to social capital, featuring the results of this research as well as guidance on the literature, and tools to help with the measurement of social capital. The Bank aims to promote the use of social capital analysis to aid social and economic development in developing countries, and to counteract poverty. The World Bank and other organisations, such as the OECD, have been followed by a number of national governments keen to understand how understanding social capital can aid successful policy-making. These include the Australian and Irish governments, for example.[8]

In the UK, the PIU report identified many areas where an understanding of social capital could inform public policy. Suggestions included encouraging mentoring schemes to build links across communities; promoting schools as community centres; and reforming the criminal justice system so that convicted criminals can maintain support networks, and discouraging the development of "criminal social capital".

The report also included one proposal involving mobile phones: "Mobile telephones could have emergency help keys or codes that would activate the nearest five phones to indicate that the holder is in danger and needs assistance. Receivers of the distress signal would be expected to respond, at least to establish what the problem is or call the police. The scheme would break down the "diffusion of responsibility" that inhibits strangers helping each other in times of personal emergencies – using technology to strengthen social norms of reciprocity and trust within the wider community."[9]

Social capital may be an even more important concept for developing countries than developed, as in many cases people in the former have less access to formalised structures of support such as the legal system or the financial system, and may rely on informal networks instead.

Social capital and mobile phones

Mobile phones are a communications technology, and as such they facilitate social networks, so there is likely to be a link with social capital. However, research on the social role of information and communication technologies has so far has been heavily biased towards the internet.

Optimistic assumptions that the development of virtual communities online would create whole new forms of social capital have so far been a red herring. However, there is fruitful research on how internet use affects social behaviour, and how social tools on the internet – "social software" – can be used to build social capital.

The US research project, Syntopia, conducted by James Katz and Ronald Rice from Rutgers University,[10] analysed the social behaviour of users and non-users of the internet between 1995 and 2000. The research identified a clear trend: long-term use of the internet was associated with more, not less, frequent socializing; and the same or a higher level of political and civil society involvement. Internet users were more likely to go out

and see friends, although the study found that they also spent more time away from their local community and generally knew fewer of their neighbours.[10] Syntopia's findings are supported by research carried out by the Pew Institute's Internet and American Life Project, which concluded that the use of email enhanced users' contact with family and friends and that email users generally had a richer social life.

Keith Hampton of the Massachusetts Institute of Technology (MIT) led a study specifically into the use of ICT in a community context. He spent two years living in a suburb of Toronto wired with wide-band internet access, observing the activity of other residents to try and find out whether online activity can supplement offline contact and help revive communities. The research found that: "The local computer network was used by residents as a means to exchange introductions, organize barbecues and parties, search for missing pets [etc]… Rather than isolating people in their homes, CMC [computer mediated communication] encourages visiting, surveillance, neighbour recognition and the maintenance of local social ties."[11]

There has been less attention paid to the mobile phone, which may be explained by the fact that widespread mobile penetration occurred later and also because mobile is not as prevalent in the US – where much of the social capital literature originates – as in many other countries. However, there is a rich literature on the social impacts of the fixed-line telephone. It describes, for example, the role of the telephone in empowering middle class women,[12] expanding activities in the local community and beyond, reducing loneliness and anxiety and strengthening social ties.[13]

One European Commission funded study has collected data on social capital and use of different ICTs in several European countries. It suggested that access to social capital is becoming more individualised, with people less dependent on formal groupings and more involved in loose, spur of the moment association. "Mobile communication plays into this approach, since it allows a more flexible form of communication," writes the study's author Richard Ling of Norwegian mobile operator Telenor. He continues, "It allows one to fit sociation into the nooks and crannies of everyday life and possibly obviates the need for social contact in the context of other, more formal institutions."[14] A later report based on the same data showed a positive relationship between communication with friends and quality of life, but a direct link to mobile was not established: "In no country did acquiring a mobile phone, internet access or broadband internet have any positive effect on overall quality of life".[15]

It is possible that mobile telephones are having a more pronounced impact in countries where communications infrastructure has hitherto been less extensive. Most of western Europe has had a dense fixed-line network for some decades, but large numbers of telephones are a very recent phenomenon in countries such as Tanzania. The introduction of mobile telephony might therefore be expected to have important consequences. Many studies have already suggested this, for example Sadie Plant's investigation of the mobile phone undertaken for handset manufacturer Motorola.[16]

Mobiles and social capital in South Africa and Tanzania

We aimed to use the concept of social capital as a framework for understanding the social impacts of mobile phones, theoretically connecting the localised social impacts with wider socio-economic changes. The results shed light on the social impact of mobile, and also suggest the concept of social capital might offer guidance for companies and governments wishing to understand the indirect impacts of mobile products and services.

Questions pertaining to different aspects of social capital, specifically social networks, group participation and social attitudes including generalised trust, were included in the community questionnaires, used in surveys in South Africa and Tanzania.

One of the objectives of the research was to assess the importance of mobile phones relative to other communication means. To this end, we asked a number of questions about general communicaton habits, including the amount of face-to-face contact respondents thought they had with various different types of people.

The responses in South Africa and Tanzania were broadly similar: there was very frequent face-to-face communication with family, close friends and others living within the community. Face-to-face contact with others outside the community was less regular, as was contact with tradesmen and figures of authority.

Face to face communication with…	South Africa (% communicating "frequently" or "very frequently" face to face)	Tanzania (% communicating "somewhat" or "very often" face to face)[17]
Family	81%	87%
Close friends	77%	89%
Others in the community	81%	96%
Others outside of the community	25%	22%
Businessmen or tradesmen	19%	21%
Government services (inc doctors, teachers)	28%	8%
Police or security	16%	5%

Table 1 Percentage of respondents communicating frequently or very frequently face-to-face in South Africa (252) and Tanzania (223).

In the Tanzania survey, the amount of face-to-face contact with "family" and "close friends" was lower than with "others in the community". This may reflect the fact that in Tanzania, people often leave their communities to seek employment or education in larger cities.

We asked respondents whether they had easy access to a number of different means of communication. Fixed-line phones were prevalent in the South African communities surveyed and in Tanzania three quarters of people said they had easy access to a post office. But in both surveys, the mobile phone was the communications tool that most people had easy access to .

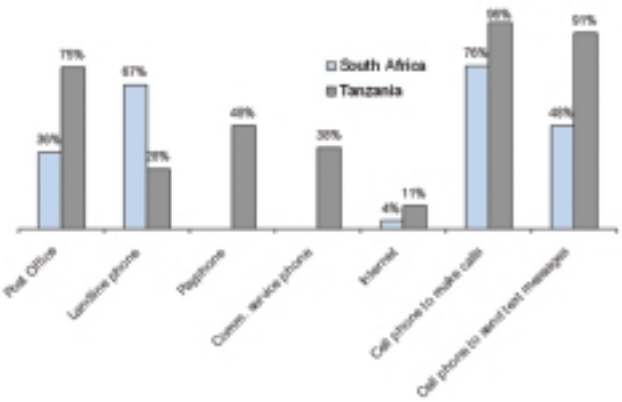


Figure 1. percentage of respondents with access to different communications infrastructure in South Africa (252) and Tanzania (223)

For those who had access to each means of communications, frequency of use varied. The figures in Table 2 below show the average number of times in one week people who had access to each communications medium used it. Mobile phones were by far the most frequently used communications means for the people interviewed, primarily for calls but also, significantly, for texts. The data suggest that in the communities surveyed, despite the relatively recent introduction of the technology, mobile phones are at the very heart of communication.

	South Africa		Tanzania	
	Mean no. of times used/week	Base size	Mean no. of times used/week	Base size
Post Office	1.6	80	1.7	82
Landline phone	3.9	162	2.2	32
Payphone	-		1.7	29
Vodacom phone	-		2.4	35
Internet	4.9	10	1.8	11
Cell phone to make calls	9.7	188	6.5	182
Cell phone to send text messages	7.8	118	5.6	143

Table 2. Mean weekly usage of different communications tools, for those with access.

Group participation is often used as an indicator of social capital. It was one of the main areas of investigation for Putnam in his study of declining social capital in the USA, and features prominently in most social capital questionnaires. We asked respondents to tell us which community groups they were members of, how often they met formally and how often they communicated outside of formal meetings. Overwhelmingly the most popular association was with religious groups – 76 per cent of respondents in South Africa and 95 per cent in Tanzania said they were members of religious groups.

Top group membership – South Africa	Top group membership – Tanzania
Religious group 76%	Religious group 95%
Sports group 19%	Sports group 7%
Community/charity group 10%	Finance/savings group 7%
Finance/savings group 12%	Political party 7%
Political party 15%	
Funeral society 31%	

Table 3. Membership of community groups South Africa (252) and Tanzania (223)

Membership of associations other than religious groups was very low in our Tanzania survey, but quite high in the South Africa survey, indicating a higher degree of formalised socialisation. On average, over half of our respondents in South Africa were members of two or more different social or community groups, double the proportion in Tanzania. However, in the Tanzania survey, due mostly to the importance of affiliation with religious groups, there were fewer people who were members of no group.

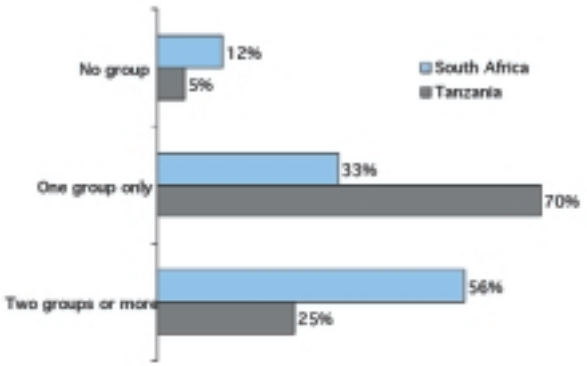


Figure 2. Number of groups respondents are a member of, South Africa (252) and Tanzania (223)

In our South African survey, mobile owners were the most likely to be members of multiple groups, followed by non-owning users, with non-users least likely (figure 3).

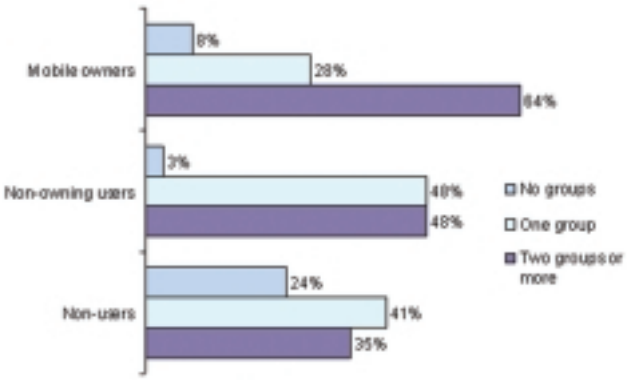


Figure 3. Membership of groups in South Africa, by mobile ownership and use

Likewise in the Tanzania sample (figure 4), mobile owners were involved in more community groups.

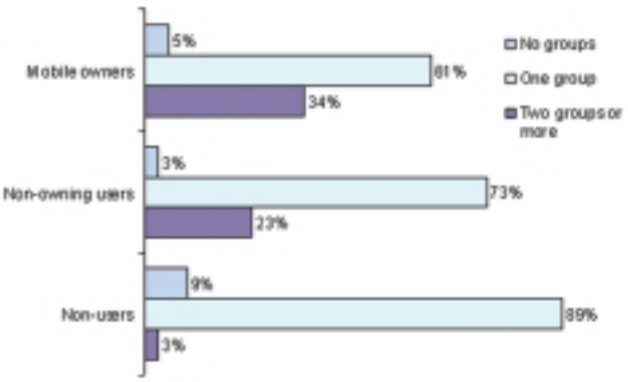


Figure 4. Membership of groups in Tanzania, by mobile ownership and use

In South Africa, there were differences in group membership according to mobile phone ownership and age, income, education level, gender, the amount of face-to-face contact with family, and which community respondents lived in. Using regression analysis, it was possible to identify independent relationships between group membership and age, highest educational level achieved, community, and mobile phone ownership. Older respondents were more likely to be members of two groups or more. Respondents who had been to high school or university were more likely to be multiple group members than those who had stopped their education at primary level. Mobile phone ownership also had an independent, positive relationship with multiple group membership: controlling for all the other factors involved, mobile phone owners were more likely to be members of two or more community groups.

In the Tanzania survey, there were statistically significant differences in the number of social or community groups respondents were members of according to community, age, income, mobile phone ownership and the length of time respondents had lived in their communities. Regression analysis showed that group membership was related independently to the length of time lived in the community and, as with the South Africa survey, mobile phone ownership.

Further data showed that mobile phones were used frequently to communicate with group members outside of formal group meetings. Although the relationship between mobile ownership and group membership is a strong one, suggesting that on this measure mobile owners are more willing to invest in social capital than non-owners, the direction of the causal relationship is unclear. Are mobile users more likely to join groups, or are group members more likely to get mobiles?

How mobiles are used in the communities

We asked a number of questions aimed at understanding how mobiles were being used for communication with certain groups and for certain purposes, and how this compared to other commonly used means of communication. The structural element of social capital is social networks, made up of people and the links between them. To use the phraseology of American sociologist Mark Granovetter, links can either be strong links or weak links[19]. Strong links are those between close friends and family, people who are regularly in contact and have a lot in common. Weak links are those between acquaintances or distant friends in irregular contact. Both types of links are crucial. The strong links provide support and are particularly important at the beginning and end of life, while weak links become more important in adult life, delivering new social and economic opportunities such as leads about job openings, and creating competitive advantage.

Ideally there is a balance of strong and weak links: relationships that offer support as well as relationships that offer opportunities. If, in a particular community, there is a wealth of strong links and very few weak links, this can lead to social exclusion and stagnation. This is characteristic of traditional, tight-knit communities. In contrast, if a community has very few strong links but many weak links, opportunities for social or economic advancement might abound, but there is likely to be no sense of community cohesion or neighbourhood spirit, as sometimes found in suburbs. We hoped the surveys in South Africa and Tanzania would indicate how people were using mobiles to manage strong and weak links.

The table for the South Africa survey (table 4) shows the proportion of people using each method of communication frequently or very frequently with different groups. Face-to-face communication was the most common method for all groups, and as expected communication was most frequent with family members, close friends and others within the community. Face-to-face communication with others outside of the community, businesses or tradesmen, teachers, doctors and police was less frequent.

The use of mobile phones to manage these strong links (family, close friends, others in the community) and weak links (all the others) was broadly the same as use of fixed-line phones. Remember that for most communities surveyed in South Africa, the proportion of people with access to landline phones was only a little less than those with access to mobile phones. However, fixed line and mobile phone usage diverged when it came to contact with family and close friends. In both cases, but especially with family contacts, mobiles were used significantly more than landlines. This suggests that mobile phones were being used more to manage strong links, the links that make up tight-knit support networks, than for weak links. Although they were also being used for weak links, the frequency of mobile use did not differ from the use of fixed-line phones for this purpose.

This suggests that mobile phones were helping to meet a demand for more communication with family, friends and neighbours that is not otherwise satisfied, even if landlines are present in the community. Although mobiles were being used to manage weak links too, there is no suggestion from this data that they were satisfying unmet demand.

South Africa	Family	Close friends	Others in the community	Others outside of community	Businessmen or tradesmen	Govt services (inc doctors, Teachers	Police or security
Face to face	81%	77%	81%	25%	19%	28%	16%
Using a landline phone	16%	18%	7%	11%	4%	6%	9%
Using a cell phone to call	33%	26%	8%	11%	3%	6%	5%
Using a cell phone to text	13%	13%	4%	4%	1%	2%	2%

Table 4. Percentage communicating frequently or very frequently with these groups, using each communication medium, South Africa (242-250).

Key to tables 4 and 5

- Under 5 per cent using this maximum to communicate frequently or very frequently with this group
- Between 5 and 10 per cent
- Between 11 and 20 per cent
- Between 21 and 40 per cent
- Between 41 and 70 per cent
- Over 71 per cent

Tanzania	Family	Close friends	Others in the community	Others outside of community	Businessmen or tradesmen	Govt services (inc doctors, Teachers	Police or security
Face to face	87%	89%	96%	22%	39%	66%	38%
Using a landline phone	2%	2%	1%	3%	3%	2%	–
Using a cell phone to call	50%	42%	17%	43%	21%	8%	5%
Using a cell phone to text	33%	32%	13%	28%	13%	5%	2%

Table 5. Percentage communicating somewhat or very often with these groups, using each communication medium, Tanzania (223-4)

In the Tanzania survey (table 5) as with South Africa, face-to-face communication was the most common method of communicating, and communication was most frequent with family, close friends and others in the community. There are a number of notable differences though. In the Tanzanian sample, face-to-face communication with businessmen, tradesmen, doctors, teachers and police was relatively higher. It is also obvious that fixed-line telephones did not play a significant role in these communities. When it comes to the use of mobile phones, as with the South Africa survey, mobiles were used a lot for contact with family and close friends – strong links. But there were also reasonable levels of usage to contact others outside of the community and businessmen or tradesmen – weak links.

Responses to the question "In the past year, have you made a call or sent an SMS about business, education or training opportunities outside your community?" reinforce the suggestion that mobiles were used by respondents in our surveys to manage weak links. Around a fifth of mobile phone users in both surveys replied in the affirmative. So in the Tanzania survey as with the South Africa survey, mobiles were used to manage strong links with close friends and family, but they were also used for weak links, contacts that may offer social and economic opportunity.

These findings were reinforced by answers to another question in the surveys, "Do you use cell phones to speak to people instead of travelling to see them?". In Tanzania, 91 per cent of mobile users answered positively. Just over two-thirds of these calls (68 per cent) were not to family or friends, but fell into the "other" category. In South Africa in contrast 77 per cent of people used mobiles to speak to people instead of travelling to see them, and the majority of these calls were to family, friends or both (99 per cent in total). Only one per cent of these calls fell into the "other" category.

If mobiles were being used to manage strong links, it is legitimate to wonder if calls were replacing face-to-face communication. In the South African sample, there was a small, statistically insignificant reduction in the amount of face-to-face contact mobile owners had with family members. The same was the case for the Tanzania survey. However, in this case mobile owners had a lot less face-to-face communication with others outside the community, a difference that was statistically significant.[20]

Therefore there may be a limited substitution effect operating in these two samples. Investigating this relationship further would be a fruitful area for further research, as most previous studies suggest that communication over phones or using the internet, does not substitute for face-to-face contact, but rather supplements it. We do know from our two African surveys that people who use their mobile to talk to people instead of meeting them said that their relationships with distant people had improved because of mobiles – 79 per cent in the South African survey and 85 per cent in the Tanzanian.

The "social halo" effect of mobiles

Results from both surveys showed a high degree of sharing mobile phones, suggesting that the devices are a social amenity as well as being a communications tool. This can be an important contributor to social capital as well. Alex McGillavrey of the New Economics Foundation, who has written widely on the role of new technologies in building trust, has talked of the social facility of his chainsaw in the small French village where he lives. Many people in the locality need a chainsaw on occasion but not often enough to warrant owning one, instead borrowing the chainsaw that McGillavrey bought. The chainsaw therefore facilitates social contact within the local community but also initiates a network of reciprocity: McGillavrey is doing people favours which at some point in the future they are likely to return.

Our survey results show something similar happening with mobile phones in the communities studied. In South Africa, over half of mobile owners said that they allowed family members to use their handset for free, and almost a third did the same for friends. There was also ample evidence of people making and receiving calls and texts on behalf of others.

We see a similar pattern in the Tanzania survey, again with over half of respondents with their own phone letting family members use it for free, and with a similar proportion doing the same for friends (higher than in the South Africa survey). In both samples there was a negligible amount of charging others to use handsets. However, in Tanzania a large proportion of the non-owning users were paying to use others' handsets. This took the form of paying for phonecards and then using the cards with other people's handsets, at no charge to the owner.

Social attitudes

People's attitudes to others and their feelings about the community in which they live emerge from the network of relationships they are part of. In particular, levels of "generalised" or "extended" trust are an area of research focus: how willing people are to trust others in general. The level of trust is considered a key indicator of social capital.

Measuring the cognitive aspects of social capital, as we are here, also helps us to distinguish between positive and negative social capital. Social capital should not be understood as a good thing in itself, but rather as a neutral social resource that allows people to do things. As such a resource, it can be used for positive ends or for negative ends, and deciding which is which is a subjective process. The example of mafia networks is often given to illustrate how a high level of social capital in a particular network can have negative results for the wider community.

We chose a standard measure of trust for inclusion in our surveys, and eight other measures that would indicate whether or not respondents had access to a high level of social capital.

In South Africa, in answer to the question, "Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?," overall 63 per cent of respondents said they thought that people could be trusted. This was a surprisingly high level, more than twice the level expected on the basis of results from the same question asked in South Africa as part of the World Values Survey. This may be peculiar to rural communities in South Africa, or the communities surveyed may be untypical of the country as a whole. There were no significant differences in answers to this question according to whether people owned or used mobiles.

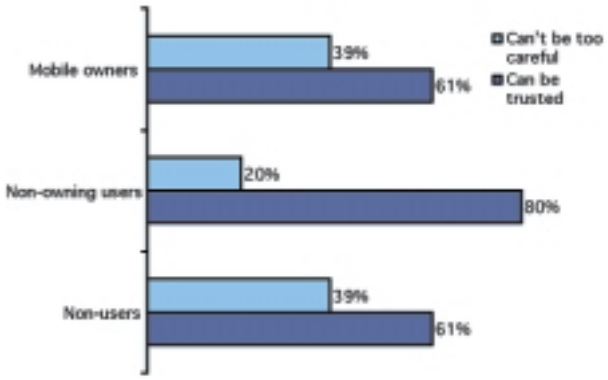


Figure 6. Generalised trust by mobile ownership and usage, South Africa.

Overall the response to this question in the Tanzania survey was also surprisingly positive. There were small differences in the amount of reported trust depending on mobile ownership and use, with mobile owners actually coming out slightly less trusting than others. The differences were not statistically significant, however.

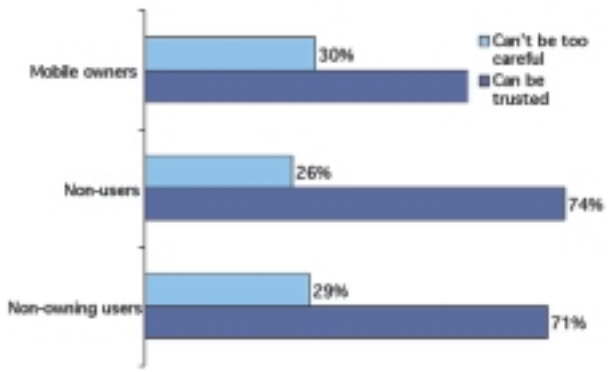


Figure 7. Generalised trust by mobile ownership and usage, Tanzania

Since trust is regarded as a primary indicator of social capital, the answers to this question in both surveys should be taken as inconclusive of any relationship between mobile phones and social capital. However, of the eight other measures we collected in this research, there were some statistically significant relationships, all of which indicated a more positive social outlook from mobile phone owners.

In South Africa, there were significant differences in the answer to the question, "All things considered, how satisfied are you with your life as a whole these days?." Overall, 52 per cent of respondents told us they were satisfied or very satisfied with their life these days. Mobile owners were more satisfied and non-owners who do not use mobiles were a lot less satisfied, with the difference statistically significant at the 99 per cent level.

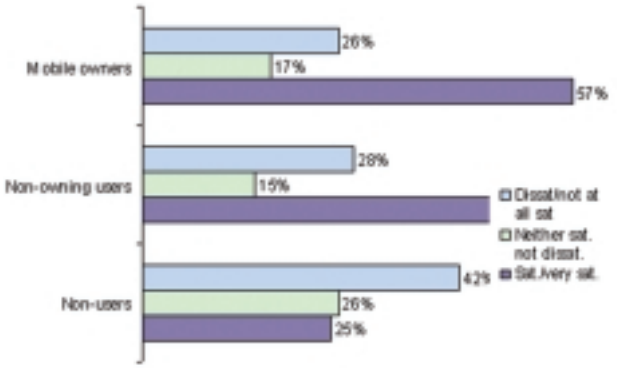


Figure 8. Life satisfaction by mobile ownership and usage, Tanzania (252)

A logistical regression was run on the life satisfaction variable for the South Africa sample. The analysis suggested significant relationships between life satisfaction and income[21], age, amount of face-to-face family contact, membership of social groups and mobile ownership. The regression showed that mobile phone ownership had a positive influence on life satisfaction, controlling for all other factors including income. There was also a relationship between life satisfaction and the community lived in.

Mobile owners in the South Africa survey responded more positively to the question, "Do you feel you have control over the way your life turns out? Do you have no control at all, some control or a great deal of control?," a difference that was statistically significant at the 95 per cent level.

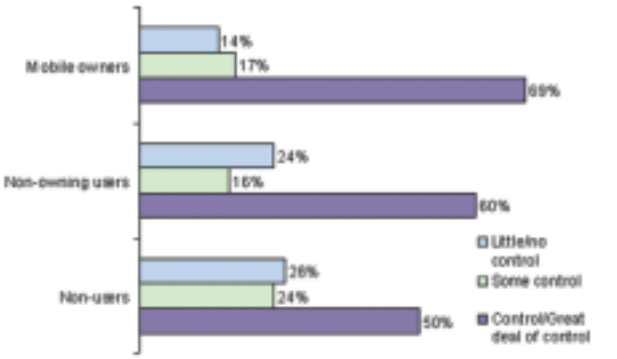


Figure 9. Feelings of control over life, by mobile onwership and usage, South Africa.

In addition to a relationship with mobile ownership, there were differences in feelings of control according to income, gender, and the amount of face-to-face contact with family members. Each of these apart from gender had a positive influence on feelings of control over the way that life turns out, independent of each other and other factors.

On the other measures tested in the South Africa survey, mobile owners tended to answer more positively than non-owning users and non-users, but the differences were not large enough to be statistically significant, given the relatively small size of the overall sample.

Turning to the Tanzanian results, the picture is somewhat different. We asked seven other social attitude questions as well as the trust question discussed above. On three of the measures, mobile owners gave slightly less positive answers than non-owners and non-owning users. However, the differences in these measures were not found to be statistically significant.

There were two questions on the Tanzania survey where there was a statistically robust relationship between positive social attitudes and mobile phone ownership. The first of these was the question, "How well do people in your community get along these days?."

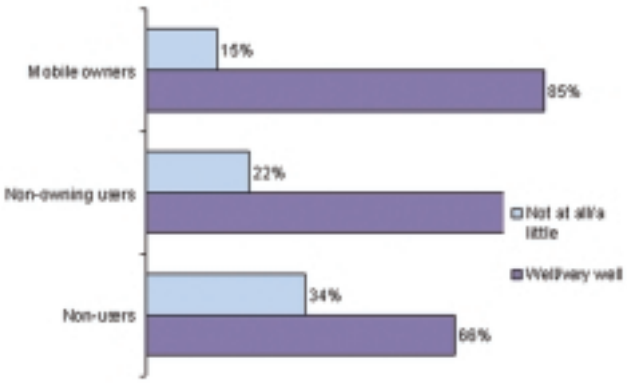


Figure 10. Perceptions of community harmony by mobile ownership and usage, Tanzania.

There were differences in perceptions of community cohesion according to the different communities surveyed, age, income and level of group membership as well as mobile ownership. Mobile phone ownership was the only independent factor influencing views on community cohesion. In other words, mobile phone owners were more likely to say their community got on well or very well, independent of other factors such as income levels. The difference between mobile owners and non users is significant at the 95% level.

Mobile owners were also much more likely to say that they had helped somebody in their community in the last six months (figure 11). The difference was significant at the 99% level.

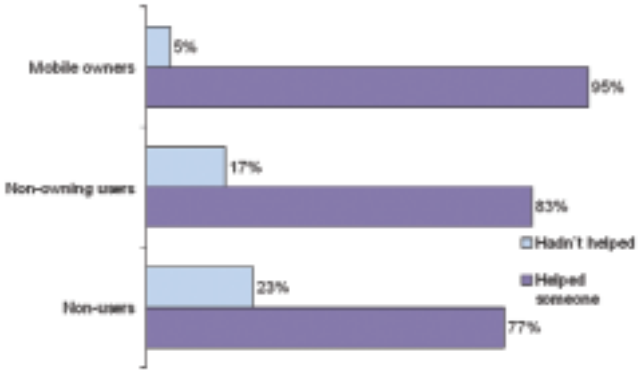


Figure 11. Willingness to help others, by mobile ownership and usage, Tanzania.

Apart from differences in community helpfulness between mobile users and non-users, there were also differences according to the community surveyed and gender. Further analysis showed that mobile phone ownership and community were the significant independent factors explaining whether respondents said they had helped someone in their community in the past six months.

To review the results of our analysis of the relationship between mobile phones and social attitudes, in the South Africa survey mobile phone ownership was positively associated with life satisfaction, independent of other social and economic factors tested such as income and age. There was a similar relationship between mobile ownership and feelings of control over how respondents' lives turned out. There were no other statistically valid differences between mobile owners, non-users and non-owning users in this survey. To speculate for a moment, these relationships point towards a role in personal empowerment for the mobile phone with the people surveyed. Possibly because fixed-line infrastructure was available in the South African communities and readily accessible for most people, the value of the mobile phone in this context might be related to the specific facilities of the mobile – personal ownership (not necessarily a household resource) and portability – rather than the simple fact of connectivity. Whether this is the case, and whether it is representative of rural South African communities in general, would have to be tested further.

In the Tanzania survey, there was a significant relationship, independent of other factors, between mobile phone ownership and perceptions of community cohesion, as well as whether respondents had helped somebody in the community in the past six months. Again, to speculate, these results may suggest that mobile ownership has a relationship with community participation. This speculation is supported perhaps by the existence of a statistically strong relationship between mobile ownership and membership of community groups in the Tanzanian sample. Here, it may be the simple connectivity that is key. In the Tanzanian communities surveyed fixed-line networks and other types of communications infrastructure were rare.

The suggestion is that the specific qualities of mobile phones (portability, individual ownership) were less important in these places than the simple fact of remote connectivity. Again, this is a hypothesis that would need to be tested further.

It is important to note at this point that the relationships explored here relate to mobile phone owners and not non-owning users. Non-owning users in the Tanzania and South Africa surveys (the former a reasonably sized subgroup, the latter rather small) in general resembled non-users, in their responses to the social attitudes questions. However, this is likely to be because mobile owners use their phones a lot more than people who borrow or pay to use others', rather than to any separate, intrinsic value of ownership.

A key question, then, is whether the role of the mobile phone is the same for mobile owners and people who use mobiles but do not own them. In both countries, mobile phone owners used their phones a lot more than non-owning users. In the South African sample, over three-quarters of mobile owners used their phone to make or receive calls four times a week or more. The equivalent figure for non-owning users was just 24 per cent. The pattern was similar in the Tanzanian sample.

South Africa	Mobile owner (169)	Non-owning user (25)
No mobile use	5%	28%
Use mobile 1 – 3 times a week	19%	48%
Use mobile 4 times a week or more	76%	24%

Table 6. Frequency of mobile phone use by mobile ownership and usage, South Africa.

Tanzania	Mobile owner (95)	Non-owning user (93)
No mobile use	–	10%
Use mobile 1 – 3 times a week	24%	74%
Use mobile 4 times a week or more	76%	16%

Table 7. Frequency of mobile phone use by mobile ownership and usage, Tanzania.

As expected, there was a strong relationship in both samples between mobile ownership and how often people said they used their phone to make and receive calls. The reduced frequency of usage for non-owners applied to calls made or received in all the different categories we asked about. For example, table 8 shows that 78 per cent of mobile owners made or received calls frequently or very frequently with family members. For non-owning users this was just 40 per cent. Mobile phone contact with doctors, teachers and police or security forces was practically non-existent for non-owning users, whereas an appreciable proportion of mobile owners were using their phones for this purpose. Non-owning users also used phones markedly less to contact others within the community.

		Family	Close friends	Others in the community	Others outside of community	Businessmen or tradesmen	Govt services (e.g. doctors, Teachers	Police or security
Owner (95)	Calls	78%	71%	35%	67%	36%	18%	11%
	SMS	58%	55%	26%	47%	14%	9%	4%
Non-owning user (93)	Calls	40%	28%	6%	33%	14%	1%	2%
	SMS	20%	22%	5%	18%	5%	1%	–

Table 8. Use of mobiles frequently/very frequently to contact different groups, by mobile ownership and usage, Tanzania.

Mobile owners used their phones for a wider variety of purposes. Table 9 shows that phone use for religious purposes, arranging meetings and doing business is quite high for mobile owners, but much lower for non-owning users, with the exception of "business reasons". Although over two-thirds of non-owning users used their phones on a weekly basis to contact friends and family, only three per cent did this daily, a much lower frequency than for mobile owners.

	Owners (95)	Non-owning users (93)
Contact with family and friends	96% (daily – 61%)	69% (daily – 3%)
Religious reasons	12%	3%
Arranging meetings	17%	2%
Business reasons	25%	11%
Safety reasons	2%	–
Information on employment	1%	–
Finding out about community activities and events	4%	–
Educational purposes	4%	1%
Information on health issues	1%	–
Shopping	4%	1%

Table 9. Percentage using cells phones weekly or more, Tanzania. Differences are statistically significant at the 95% level or above in the first three cases.

There are also important differences when it comes to managing weak links. Table 10 below shows that a third of mobile owners in the Tanzanian sample had made a call or sent a text message in the past year regarding an employment, educational or training opportunity, and 28 per cent had received one. This was much lower for non-owning users.

	Owners (95)	Non-owning users (93)
Made a call re business/training/ education opportunities	33%	8%
Received a call re business/training/ education opportunities	28%	8%

Table 10. Percentage making and receiving calls re business, training or educational opportunities, Tanzania.

We can say therefore that, while we saw earlier how mobiles are used to manage strong links with family and friends, non-owning users in the Tanzanian communities surveyed did this much less than mobile owners. Furthermore, where mobiles are used to manage weak social links, ownership seems to be more important than simple usage for this purpose.

Conclusions

The research suggests there are some links between social capital and mobile phone ownership and use in rural communities in South Africa and Tanzania. Access to mobile phones was high, as was frequency of usage, even in the South African communities which had ready access to fixed-line telephones. This places mobile phones at the heart of communication in these communities.

In both countries there was a high degree of sharing mobiles for free with friends and family (and sometimes for money). This indicates that mobiles may be acting as a social amenity, a tool to be shared and a focus for social activity, as well as a tool for communications.

Mobile phones were being used to mediate both strong links (with family, close friends and others in the community), essential for maintaining support networks, and weak links ("others outside the community", businessmen, tradesmen, government officials such as teachers and doctors, as well as the police), providing access to information and possible social and economic opportunities. Weak links are seen as particularly important in the relationship between social capital and desirable macro-level outcomes, and even more so perhaps in a developing world context, where communities can be very tight-knit given their paucity of connections to the outside world.

With regard to weak links, mobiles were used for contact with others outside of the community, businessmen, tradesmen, doctors, teachers and police. This was particularly prevalent in the Tanzanian case. Also in Tanzania, over 90 per cent of mobile users replying to the surveys said they used mobiles to speak to people rather than travelling to visit them, and two-thirds of those calls were not to family or friends, suggesting they might be associated with weak links rather than strong links. Around a fifth of respondents in both surveys had made and received calls in the past year relating to business, training or educational opportunities.

With regard to strong links, mobiles were being used intensively in both surveys for contact with close friends and family. Although there was some evidence to suggest that contact by mobile was replacing some face-to-face contact, a majority of respondents said that the use of mobiles to contact people far away rather than travelling to see them had improved their relationships.

We can conclude therefore that, within the parameters of the two surveys, mobiles were facilitating participation in social networks, helping to maintain both strong and weak links, including participation in community group activity. They were thus enabling people to invest in and draw on social capital.

There was evidence to suggest that mobile phone owners were more willing to invest in social capital and to draw on it. Mobile owners were significantly more likely to be members of community groups such as religious organisations, sports teams and political parties, in both surveys. In the Tanzania survey, there was also a statistically robust relationship between mobile ownership and willingness to help others in the community.

In the Tanzania survey, mobile owners appeared more likely to think that the community they lived in was functioning well. In the South Africa survey, mobile owners reported higher life satisfaction and greater feelings of control over how their lives turned out. For other social attitude questions, including measures of generalised trust, no solid relationship with mobile ownership or use was established. Significant differences were related to ownership of mobiles, rather than using other people's mobiles. This is likely to be due to the fact that in both surveys, mobile owners used their phones more and for a wider variety of purposes than non-owning users.

In conclusion, social capital offers a helpful framework for understanding the social impact of mobile telephones in rural communities in South Africa and Tanzania. The unrepresentative nature of the surveys limits the generality of the results. They concern the individual social capital of mobile owners. The next research step would be to investigate the aggregate effect on communities of mobile ownership and use, and look for examples of a relationship between mobile penetration and community social capital. This would require survey work in communities that do not yet have mobile networks, representative sampling and data collection over an extended period.

References

Aldridge & Halpern (2002), *Social capital: a discussion paper*, PIU, UK Cabinet Office http://www.cabinet-office.gov.uk/innovation/reports/reports.shtml

Anderson, B (2004) *Information Society Technologies, Social Capital and Quality of Life* e-Living D11.4b

Buchanan, M., (2002) *Small World: Uncovering Nature's Hidden Networks*, Weidenfield and Nicolson.

Dasgupta, P., (2002) "Social Capital and Economic Performance: Analytics" in Ostrom, E. and Ahn, T., (ed.s), *Social Capital*: A Reader, Elgar

Dasgupta. P., (2004), The Economics of Social Capital, http:// www.econ.cam.ac.uk/faculty/dasgupta/ecsoccap.pdf

Davies, W., (2003) *You don't know me but…Social Capital and Social Software*, iSociety

De Sola Pool, I. (ed.) (1977). *The Social Impact of the Telephone*. MIT press

Fukuyama, F. (1999), *The Great Disruption: Human nature and the reconstitution of social order* New York: The Free Press.

Glaesar, E.L. et al., "An Economic Approach to Social Capital" in *The Economic Journal* 112

Granovetter, M., (1973), "The strength of weak ties", in *American Journal of Sociology* 78

Hampton, K. (2003) "Grieving for a lost network: collective action in a wired suburb" in *The Information Society*" 19 (5), 1-13.

Hanifan, L.J. (1920) *The Community Center*, Boston: Silver Burdett.

Harper, R., (2001) *Social Capital. A review of the literature*, National Statistics Office

Harriss, J., (2001) *Depoliticizing Development. The World Bank and Social Capital*, Anthem

Johnson, S. (2001), *Emergence: the connected lives of ants, brains, cities and software*, Allen Lane, London

Katz, James E., Aakus, Mark. (2002) *Perpetual Contact: Mobile Communication, Private Talk, Public Performance*. Cambridge

Keser et al, (2002), *Trust, the internet and the digital divide*, IBM, New York

Kopomaa, T. (2000) *The City in Your Pocket: Birth of the Mobile Information Society*. Helsinki, Gaudemus

Lasen, A. (2002) *The Social Shaping of Fixed and Mobile Networks*: A Historical Comparison. University of Surrey

Ling, R., (2004) *Social Capital and ISTs*, e-Living D11.4a

Narayan and Pritchett, (1997), *Cents and Sensibility: Household Income and Social Capital in Rural Tanzania*, World Bank.

National Economic and Social Forum, Forum Report No.28 (2003) *The Policy Implications of Social Capital*

Perri 6, (1997) *Escaping poverty: from safety nets to networks of opportunity*, London: Demos

Plant, S. (2001) *On the Mobile: The Effects of Mobile Telephones on Social and Individual Life*. Motorola

Productivity Commission, (2003) *Social Capital: Reviewing the concept and its policy implications*, Commonwealth of Australia

Putnam, R. (2000), *Bowling Alone: The collapse and revival of American Community*, Simon and Schuster

Szreter, S. (2000) 'Social Capital, the Economy, and Education in Historical Perspective' in Baron, S., Field, J. and Schuller, T. (ed.) Social Capital , OUP, Oxford

Uphoff, N (1999) *Understanding Social Capital: Learning from Analysis and Experience of Participation* in Sera/Dasgupta World Bank

Willey, M. and Rice, S. (1933) Communication agencies and social life, McGraw-Hill, New York

Woolcook, M. (1998), "Social Capital and Economic Development: Towards a theoretical synthesis and policy framework" in *Theory and Society*, 27: 151-208.

Notes

[1] Putnam, 2000 p.000. Putnam also quotes here L. J. Hanigan

[2] Fukuyama, 1999 p.1

[3] Woolcock, 1998, p.153

[4] Dasgupta 2004, p. 28

[5] Harper, 2001.

[6] Narayan and Pritchett, 1997

[7] Keser et al., 2002

[8] A paper was commissioned by the Australian government in 2003 from the Productivity Commission to investigate the policy implications of social capital. The National Economic and Social Forum of Ireland produced a similar report for the Irish government in the same year. It recommended that a government department be chosen to lead on developing social capital related policies.

[9] PIU p.69

[10] Katz and Rice, 2002

[11] Hampton 2002, p.10

[12] De Sola Pool 1977

[13] Willey and Rice 1933

[14] Ling, 2004, p.2

[15] Anderson, 2004, p.24

[16] Plant, 2001.

[17] The categories offered to respondents were different for this question between South Africa and Tanzania. Therefore, direct comparison between the two countries is not possible.

[18] Respondents in South Africa were not asked about access to payphones or community service phones.

[19] Granovetter, 1973.

[20] 12 per cent of mobile owners said they had regular face to face contact with "others outside of the community" compared to 40 per cent of non-users.

[21] Approximately 20 per cent of the sample in South Africa refused to state their income level. This subgroup was cross-tabulated with all other socio-economic variables to verify that they had no particular characteristics in common. They were then coded together with the higher income subgroup so that the answers for this subgroup could be inlcuded in the regression model.

Bibliography

This bibliography contains the specific references cited in the report, and in addition other references relevant to the role of mobile telephony on economic and social development.

Accenture, Markle Foundation, and UNDP, *Final Report of the Digital Opportunity Initiative*, July 2001.
http://www.opt-init.org/framework/DOI-Final-Report.pdf
Ashurst, Mark, 'Africa: Now, a 'Quiet Revolution': Mobile Phones Leapfrog an Obstacle to Development' , Newsweek International, August 27, 2001
Asian Development Bank, *Towards Universal Access: Socioeconomic Impact Study of Rural Telecommunications in Thailand. Volume 1: Main Report*, Midas Agronomics Report T.A. 2381, 30 November 1996.
Azam, Jean-Paul, Magueye Dia and Tchétché N'Guessan, 'Telecommunications Sector Reforms in Sénégal', World Bank 2002. http://econ.worldbank.org/files/18861_wps2894.pdf
Batchelor, Woolnough and Scott, 'The Contribution of ICTs to Pro-Poor Growth', OECD Discussion Paper DCD/DAC/POVNET(2004)15, September 2004.
http://www.gamos.org/files/oecd/MDGS_POVENT_15.pdf
Bayes, A, von Braun, J and Akhter, R., *Village Pay Phones and Poverty Reduction: Insights from a Grameen Bank Initiative in Bangladesh*, ZEF, Berlin, 1999.
http://www.zef.de/publications/publ_zef_dp.htm#8
Beardsley, Scott, Ingo Beyer von Morgenstern, Luis Enriquez, and Carsten Kipping, *Telecommunications Sector Reform: A Prerequisite for Networked Readiness*, Chapter 11 of Kirkman and Sachs (2002).
http://www.cid.harvard.edu/cr/pdf/gitrr2002_ch11.pdf
Blattman, Christopher, Robert Jensen and Paul Roman, *Assessing the Need and Potential of Community Networking for Developing Countries: A Case Study for India*, MIT Working Paper February 2002.
http://edevelopment.media.mit.edu/SARI/papers/CommunityNetworking.pdf
Boston Consulting Group, *Options on the Future: The Role of Business in Closing the Digital Divide*, January 2002.
Bruns, Bryan et al, *Village Telephones: Socio-economic Impact and Implications for Rural Futures*, paper presented at 6th International Conference on Thai Studies, October 1996.
http://www.cm.ksc.co.th/~bruns/rurtel.html
Camp, Jean L and Brian L Anderson, *Grameen Phone: Empowering the Poor through Connectivity*, The Magazine on Information Impacts, December 1999.
http://www.telecommons.com/villagephone/Camp_article12_99.htm
Cohen, Nevin, *Grameen Telecom's Village Phones*, World Resources Institute June 2001.
http://www.digitaldividend.org/pdf/grameen.pdf
Comin, Diego and Bart Hobijn, *Cross-Country Technology Adoption: Making the Theories Face the Facts*, Federal Reserve Bank of New York Staff Report no. 169, June 2003.
http://www.ny.frb.org/research/staff_reports/sr169.html
Department for International Development, *Balancing Act: African ICT Infrastructure investment options*, prepared by Balancing Act, 2004.
Department for International Development, *The Impact of the New Economy on Poor People and Developing Countries*, prepared by KPMG Consulting, July 2000.
http://www.globalisation.gov.uk/BackgroundWord/NewEconomyOnPoorPeopleDevelopingCountriesKPMG.doc
Dholakia, Nikhilesh and Nir Kshetri, *The Global Digital Divide and Mobile Business Models: Identifying Viable Patterns of e-Development*, University of Rhode Island working paper 2002.
http://ritim.cba.uri.edu/working%20papers/Global-Digital-Divide-e-Development-Models-v7%5B1%5D.pdf
Dorj, Thinley, 'IP Based Rural Access Pilot Project', 2001.
http://www.bhutan-notes.com/clif/bt_rural_access_pilot.html
Duncombe, Richard and Richard Heeks, *Information, ICTs and Small Enterprise: Findings for Botswana*, Development Informatics Working Paper no. 7, IDPM, University of Manchester, 1999.
http://idpm.man.ac.uk/publications/wp/di/di_wp07.shtml
Karen Eggleston, Robert Jensen, and Richard Zeckhauser, *Information and Communication Technologies, Markets, and Economic Development*, Chapter 7 in Kirkman and Sachs (2002).
http://www.cid.harvard.edu/cr/pdf/gitrr2002_ch07.pdf
ELDIS ICT & Development portal
http://www.eldis.org/ict/ictcountry.htm
Ernberg, Johan, *Universal Access for Rural Development*, ITU, December 1998.
http://www.itu.int/ITU-D/univ_access/telecentres/papers/NTCA_johan.doc
Forestier, Emmanuel, Jeremy Grace and Charles Kenny, 'Can Information and Communication Technologies be Pro-Poor?', *Telecommunications Policy*, 26 (2002), pp 623-646.
Gebreab, Amare, 'Getting Connected: competition and diffusion in African mobile telecommunications markets', World Bank 2002. http://econ.worldbank.org/files/15963_wps2863.pdf
Grace, Jeremy, et al, *ICTs and Broad Based Development: A Partial Review of the Evidence*, World Bank Working Paper February 2001.
http://poverty.worldbank.org/files/10214_ict.pdf
Grajek, Michal, 'Estimating Network Effects and Compatibility in Mobile Telecommunications', Wissenschaftszentrum Berlin für Sozialforschung, December 2003.
http://skylla.wz-berlin.de/pdf/2003/ii03-26.pdf

Guislain, Pierre, et al, *Connecting Sub-Saharan Africa: A World Bank Group Strategy for ICT Sector Development*, World Bank January 2005.
http://info.worldbank.org/ict/ICT_ssp.html
Hammond, Allen L., *Digitally Empowered Development*, Foreign Affairs, 80, 2, 96-106 (2001).
http://www.digitaldividend.org/pdf/0201ar04.pdf
Hardy, A, 1980 "*The role of the telephone in economic development" Telecommunications Policy*, 4(4) pp278-286.
Hudson, Heather, *The Economic and Social Benefits of Rural Telecommunications*, unpublished report to World Bank, 1995.
http://www.usfca.edu/fac-staff/hudson/papers/Benefits%20of%20Rural%20Communication.pdf
ITU, *African Telecommunication Indicators* 2004, Geneva 2004.
ITU, *World Telecommunication Development Report*, Geneva 2003. http://www.itu.int
ITU, *Mobile Overtakes Fixed: Implications for Policy and Regulation*, Geneva 2003.
http://www.itu.int/osg/spu/ni/mobileovertakes/Resources/Mobileovertakes_Paper.pdf
ITU, *World Telecommunication Indicators Database*, 2003 update.
http://www.itu.int/ITU_D/ict/publications/world/world.html
ITU, *World Telecommunication Indicators 2000/01*, March 2001.
ITU, *World Telecommunication Development Report*: Mobile Cellular, Geneva 1999. http://www.itu.int
ITU, *The Mobilization of Bangladesh*, 13/10//99.
http://www.itu.int/newsarchive/wtd/1999/iht10/tem-04.html
Jha, R and S. Majumdar, 1999. "*A Matter of Connections: OECD Communications Sector Productivity and the Role of Cellular Technology Diffusion, Info. Economics & Policy 11"*, pp243-269.
Kenny, Charles, *The Costs and Benefits of ICTs for Direct Poverty Alleviation*, January 2002.
http://inet2002.org/CD-ROM/lu65rw2n/papers/u02-a.pdf
Khalil, Mohsen, *Wireless Opportunities for Developing Countries and the Role of the World Bank Group*, (presentation) June 2003.
http://www.w2i.org/pages/wificonf0603/speaker_presentations/W2i_Khalil_Presentation.pdf
Kirkman, Geoffrey and Jeffrey Sachs, eds, *Global Information Technology Readiness Report 2001-02*, Oxford University Press 2002.
Kirkman, Geoffrey, Carlos Osorio and Jeffrey Sachs, *The Networked Readiness Index: Measuring the Preparedness of Nations for the Networked World*, 2002 (Chapter 2 of above).
http://www.cid.harvard.edu/cr/pdf/gitrr2002_ch02.pdf
Laffont, Jean-Jacques and Tchétché N'Guessan, 'Telecommunications Reform in Côte D'Ivoire', World Bank 2002.
http://econ.worldbank.org/files/18862_wps2895.pdf
Laperrouza, Marc, *China's Information and Communication Technology Policy-Making*, Evian Group Compendium, April 2002.
Latchem, Colin and David Walker, *Telecenters: Case Studies and Key Issues*, Commonwealth of Learning, 2001.
http://www.col.org/telecentres/
Also Development Gateway portal on telecenters at
http://www.developmentgateway.org/node/133831/sdm/docview?docid=441647
Lopez, Asbel, *The South Goes Mobile*, UNESCO Courier, July/August 2000.
http://www.unesco.org/courier/2000_07/uk/connex.htm
Madden, G and SJ Savage, *CEE Telecommunications Investment and Economic Growth*, Information Economics and Policy, Vol 10, pp173-195, 1998.
Mansell, Robin, *Digital Opportunities and the Missing Link for Developing Countries*, Oxford Review of Economic Policy, Vol 17, No. 2, pp282-295, 2001.
http://icg.harvard.edu/~ss98em/Readings/Mansell-Digitl_misng_links.pdf
Mansell, Robin and W.E. Steinmueller, *Mobilizing the Information Society: Strategies for Growth and Opportunity*, Oxford University Press 2000.
Nadiri, M Ishaq and Banani Nandi, *Telecommunications Infrastructure for Economic Development*, NYU working paper, January 2003.
http://userpage.fu-berlin.de/~jmueller/its/conf/helsinki03/abstracts/Nandi_Nadiri.pdf
Navas-Sabater, Juan, Andrew Dymond and Niina Juntunen, *Telecommunications and Information Services for the Poor*, World Bank Discussion Paper no. 432, April 2002.
http://rru.worldbank.org/Documents/1210.pdf
Pigato, Miria, 'Information and communications technologies, poverty and development in Sub-Saharan Africa and South Asia', World Bank working paper 2001.
http://www.worldbank.org/afr/wps/wp20.pdf
Pitt, Alexander and Christine Zhen-Wei Qiang with Seth Ayers, *The Contribution of ICTs to Growth, World Bank*, November 2003. Summary at http://www.developmentgateway.org/download/223526/Contribution_of_ICT_to_Growth_Viewpoint_December2003.pdf
Pralahad, C.K. and Allen Hammond, *Serving the World's Poor, Profitably*. Harvard Business Review September 2002. Earlier version
http://www.digitaldividend.org/pdf/serving_profitably.pdf
Proenza, Francisco, *Telecenter Sustainability: Myths and Opportunities*, Journal of Development Communication, December 2001. Available at:
http://www.fao.org/WAICENT/FAOINFO/AGRICULT/ags/Agsp/pdf/ProenzaTelecenter.pdf
Quadir, Iqbal Z, *Connecting Bangladeshi Villages*. Unpublished paper presented at the Telecommunications for Rural Development Conference, November 1998, University of Guelph, Ontario, Canada. (Updated Feb 2000).
http://www.telecommons.com/villagephone/quadir.html
Reck, Jennifer and Brad Wood, *What Works: Vodacom's Community Services Phone Shops* (World Resources Institute), August 2003.
http://www.digitaldividend.org/pdf/vodacom.pdf
Riaz, Ali, 'Telecommunications in Economic Growth of Malaysia'., Journal of Contemporary Asia. Vol. 27, No. 4. December 1997.

Richardson, Don, *Towards Universal Telecom Access for Rural and Remote Communities*, TeleCommons Development Group, February 2002. http://www.telecommons.com
Richardson, Don, Ricardo Ramirez and Moinul Haq, *Grameen Telecom's Village Phone Programme: A Multi-Media Case Study*, TeleCommons Development Group, March 2000. http://www.telecommons.com/villagephone/finalreport.pdf
Rodriguez, Francisco and Wilson Ernest.J., *Are Poor Countries Losing the Information Revolution?*, World Bank infoDev Working Paper 26651, May 2000. http://www.infodev.org/library/WorkingPapers/wilsonrodriguez.doc
Roeller, L.H. and Waverman, L, 2001 "*Telecommunications infrastructure and economic development: a simultaneous approach*" American Economic Review 91 (4), pp 909-923.
Rossotto, Carlo Maria, Khalid Sekkat and Aristomene Varoudakis, *Opening up telecoms to competition and MENA integration in the world economy*, World Bank Discussion Paper 27024, July 2003. http://lnweb18.worldbank.org/mna/mena.nsf/Attachments/WP+33/$File/WP33.pdf
Rossotto, Carlo Maria, Michel Kerf and Jeffrey Rohlfs, 'Competition in Mobile Telecommunications', *Public Policy for the Private Sector*, Note 184, World Bank August 1999. http://www1.worldbank.org/viewpoint/HTMLNotes/184/184rosso.pdf
Saunders, R., Warford, J. and Wellenius, B., *Telecommunications and Economic Development*, 2nd Edition. Johns Hoplins University Press (for World Bank), 1994.
Sciadas, G, ed., *Monitoring the Digital Divide – and Beyond*, Orbicom, 2003. http://www.orbicom.uqam.ca/projects/ddi2002/index.html
Skuse, Andrew, 'Information and communication technologies, poverty and empowerment', Department for International Development, Social Development Dissemination Note No. 3, July 2001. http://www.dfid.gov.uk
Sridhar, K.S. and Sridhar, V. "Telecom Infrastructure and Economic Growth: Evidence from Developing Countries" (2003) http://www.nipfp.org.in/working%20paper/wp14.pdf
Stiglitz, Joseph, 'Economic Organisation, Information and Development' in J. Behrman & T.N. Srinavasan, eds, *Handbook of Economic Development*, North Holland, 1989.
Thioune, Ramata Molo, *Information and communication technologies for development in Africa*, (3 volumes), CODESRIA/IDRC 2003.
Torero, Maximo, *The Access and Welfare Impacts of Telecommunications Technology in Peru*, Center for Development Research (ZEF), Universitaet Bonn, Discussion Papers on Development Policy No. 27, June 2000. http://www.grade.org.pe/download/pubs/MT-zef_dp27-00.pdf
Torero, M, Chowdhury, S and Bedi, A, (2002) "Telecommunications infrastructure and economic growth: a cross-country analysis", forthcoming in *ICTs and Indian Economic Development*, eds A Saith and M Vijayabhaskar, Sage Publications 2005.
UNCTAD, *E-Commerce and Development Report*, 2003. http://r0.unctad.org/ecommerce/ecommerce_en/edr03_en.htm
United Nations Development Program, *Human Development Report 2001*: *Making New Technologies Work for Human Development*, Oxford University Press 2001. http://hdr.undp.org/reports/global/2001/en/
Wallsten, Scott, *An Empirical Analysis of Competition, Privatization, and Regulation in Telecommunications Markets in Africa and Latin America*, World Bank Working Paper 2136, June 1999. http://www.worldbank.org/html/dec/Publications/Workpapers/wps2000series/wps2136/wps2136-abstract.html
Wauschkuhn, Markus, *Telecommunications and Economic Development in China*, University of Bremen Institut für Welwirtschaft und Internationales Management, Berichte aus dem Arbeitsbereich Chinaforschung 16, May 2001. http://www.iwim.uni-bremen.de/publikationen/pdf/c016.pdf
Wellenius, Björn, *Closing the Gap in Access to Rural Communication*: *Chile 1995-2002*, World Bank infoDev Working Paper, November 2001. http://www.infodev.org/library/WorkingPapers/chile_rural/Chile%20-%20final%2017%20december%2001%20-%20revised.pdf
Wellenius, Björn, *Extending Telecommunications Beyond The Market: towards a universal service in competitive markets*, World Bank 2000. http://rru.worldbank.org/viewpoint/HTMLNotes/206/206welle.pdf
World Bank, *The Network Revolution and the Developing World*, (report prepared by Analysys), infoDev Group, August 2000. http://www.infodev.org/library/WorkingPapers/400.doc
World Bank, *World Development Report 1998/99: Knowledge for Development*, 1998. http://www.worldbank.org/wdr/wdr98/contents.htm
World Economic Forum, *Global Information Technology Report 2002-2003 – Readiness for the Networked World*, 2003. http://www.weforum.org/site/homepublic.nsf/Content/Global+Competitiveness+Programme%5CGlobal+Information+Technology+Report%5CGlobal+Information+Technology+Report+2002-2003+-+Readiness+for+the+Networked+World
including chapters on ICT in Africa. http://www.weforum.org/pdf/Global_Competitiveness_Reports/Reports/GITR_2002_2003/ICT_Africa.pdf and the Arab world http://www.weforum.org/pdf/Global_Competitiveness_Reports/Reports/GITR_2002_2003/Arab_World.pdf

Other Web References

http://www.infodev.org/
ICT data and information for developing countries at a glance: http://www.worldbank.org/data/countrydata/ictglance.htm
http://info.worldbank.org/ict/
http://www.developmentgateway.org/node/130667/?