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Can information and communication technologies be pro-poor?☆

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Abstract

There is over 20 years of accumulated cross-country evidence on the link between telecommunications provision and economic growth. Looking at micro-studies from a range of countries including Bangladesh, Botswana and Zimbabwe, there is also some evidence that provision of telephony has a dramatic effect on the income and quality of life of the rural poor. This paper examines cross-country evidence to discover if teledensity (the number of telephones per capita) has a pro-poor growth impact—fostering increased average incomes while reducing inequality. It also examines the impact of telecommunications rollout on quality of life variables including infant mortality and literacy. It finds that, historically, telecommunications rollout has had a positive and significant impact on *increasing* inequality and little impact on quality of life variables. A reason for this is tested and preliminarily confirmed that rollout has (historically) only benefited the wealthy. The paper will then turn to emerging evidence on the role of the Internet in poverty relief and statistics on the access gap in provision between rich and poor, suggesting that this new ICT will also be a force for income divergence. Using the results of the cross-country analysis on telecommunications, the paper will conclude with a discussion of potential policy responses (such as sector reform and universal access programs) to turn telecommunications from a source of growth that also increases inequality to a source of growth that diminishes it.

Keywords: Telecommunications; Poverty; Inequality; Economic growth

☆The views expressed do not necessarily reflect those of the World Bank, its Executive Directors or the countries that they represent.

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1. Introduction

In 1876, Alexander Graham Bell was touting his new invention (the telephone) around America, and gave a presentation at the White House. There, President Rutherford Hayes turned to him and said "That's an amazing invention, but who would ever want to use one?"

Despite Hayes' skepticism, it has long been recognized that communications might have a central role in development. John Stuart Mill, writing in 1848, noted that "it is hardly possible to overrate the value, in this present low state of human improvement, of placing human beings in contact with persons dissimilar to themselves, and with modes of thought and action unlike those with which they are familiar … Such communication has always been, and is peculiarly in the present age, one of the main sources of progress" (quoted in Hirschman, 1982).

Perhaps this is even more true today than in Mill's 'present age'. For many observers, the global economy is entering a 'digital age' and information has become a primary resource for economic development (Talero & Gaudette, 1996). At the same time, developing countries are increasingly alarmed at an emerging "digital divide", in which those without access to the latest (and most expensive) tools and technologies will find themselves unable to compete in the global marketplace. For the poorest people in developing countries, this conjures a two-headed specter—living in a country that is being left behind because of generally low access to information technologies, and falling further behind the wealthy in their own country because they themselves have no access at all.[1]

This paper focuses on evidence linking telecommunications rollout to broad-based development. It revisits past evidence on the link between telecommunications and economic growth before turning to less-studied areas—the impact of telecommunications rollout on within-country equality and quality of life. The paper turns to concluding sections on policy implications and what the discussion might mean for the Internet and development.

The results of the paper can be summarized as follows. The literature on a link between telecommunications and growth is extensive, and there is a reasonably strong consensus that telecommunications rollout does spur growth at least under some circumstances. There are also a range of micro-studies that suggest telecommunications access increases the poor's income and access to services. At the same time, across countries, telecommunications rollout at a particular time appears to be quite strongly correlated with equality of income and quality of life measures at that time.

[1] Again, the two roles for ICTs as a force for convergence or divergence, depending on who has access, have long been clear. Looking first at limited access to communications making the rich richer, the strength of the Rothschild financial network in the 19th Century was founded on two things: contacts and communications. Along with bribing and beguiling most of Europe's leading statesmen, the family operated its own system of couriers which, most famously, made Nathan Rothschild the first Londoner to hear of the news of Napoleon's defeat at Waterloo and this (at least in the popular imagination) allowed him to make a killing in the bond market. Conversely, broad-based access to technology was behind the rapid rise of the proletariat, according to Marx. In the Communist Manifesto, Marx and Engels argued that the "union of the workers … is helped on by the improved means of communication that are created by Modern Industry, and that place the workers of different localities in contact with one another. It was just this contact that was needed to centralize the numerous local struggles, all of the same character, into one national struggle between classes. But every class struggle is a political struggle. And that union, to attain which the burghers of the Middle Ages, with their miserable highways, required centuries, the modern proletarian, thanks to railways, achieve in a few years". (http://www.anu.edu.au/polsci/marx/classics/manifesto.html)

Having said that, across countries, telecommunications rollout at a point in time appears to be quite strongly correlated with *growing inequality* of income in the period following. Countries with one standard deviation higher teledensity than average at decade start will see a 6.5% increase in inequality over the decade, and countries that see a one standard deviation higher than average teledensity growth also see a 6% increase in inequality over the decade. Telephone rollout also appears to have little relationship with changes in quality of life measures.

The paper concludes that this is likely to be the result of past telecommunications rollout being concentrated at the wealthiest consumers, and argues that the Internet, at least in the short term, is perhaps even more likely to be a force for divergence. The results suggest the need for governments to follow an active program of telecommunications access rollout to the poor, a program made feasible by recent technological and policy advances.

2. Telecommunications and income growth

Why would we think that telecommunications might have an impact on income and economic growth? Madden and Savage (1998) suggest that markets are critically dependent on information flows and telecommunications are a powerful tool of information transfer.[2] Because of this, telecommunications can improve the organizational efficiency of firms and the efficiency of transactions between firms and individuals.

Added to these effects are those working within the sector itself, in particular the impact of network externalities. Such externalities are based on the fact that value of a telephone line goes up exponentially with the number of users connected to the system. A phone system with only one phone attached is worthless. A system with two phones allows for one connection to be made. A system with three allows for three connections, four phones allow for six connections, and so on. This explains the explosive growth of such networked technologies once a threshold level of users is reached. Fig. 1 shows the number of telephones worldwide in the months after Bell installed his first line in May 1877. At the start, growth was fairly stagnant—President Hay's contention that the phone was a useless toy was borne out by the fact that there was almost no-one to call. But then a threshold was reached, and the telephone became a useful tool of business. The number of telephones connected began to shoot up—in turn making the telephone an ever more useful tool, persuading ever more people to link to the network, so that the number of phones passed the 2,000,000 mark by 1900. The parallels with another networked technology—the Internet—are clear.[3] In both cases, network externalities suggest that there might be significant spillover effects

[2] We have strong empirical examples of telecommunications improving the functioning of markets: Hirschman (1967) offers the evidence that a credit market for the coffee trade developed in Ethiopia after the installation of a long distance telephone network. Garbade and Silber (1978) find improved telecommunications reduce the price differentials for the same instrument in stock markets.

[3] It should be noted that there are limits to the externality effect. Those who see most value in connecting or being connected are those likely to connect first (just as in traditional markets)—this means that even while there is exponential growth in the number of possible connections with each additional user, the marginal value of the connection does fall. Taking an extreme example, adding a fourth telephone line to a house occupied by one person is likely to have not only limited value to that person, but also a fairly small marginal impact on the value of the network. The telephone appeared to have come close to the 'personal usefulness' saturation point in the United States in the 1980s—main line per capita growth had begun to slow. The Internet, by creating demand for a second line, may have

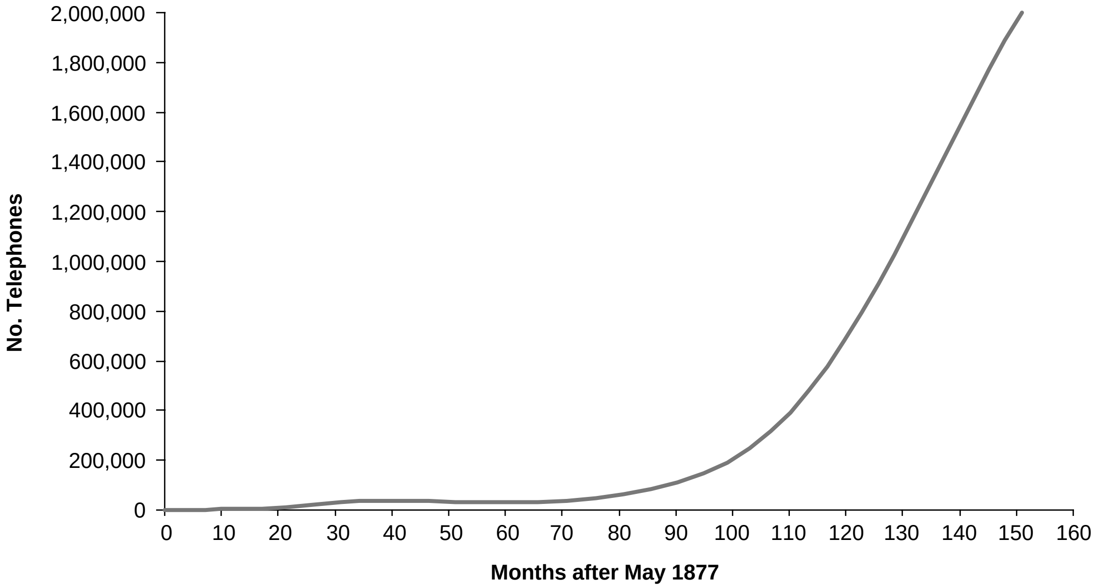

Fig. 1. Telecommunications Rollout, 1877–1900 (Source: Standage, 1999).

to investment in and rollout of networked services—that the economic rate of return of service expansion will be (ever) higher than the private rate of return.

Combined with this theoretical perspective, we already have a substantial body of anecdotal and empirical evidence at the sectoral level and below on the impact of ICTs. For example, at the micro-level, Saunders, Warford, and Wellenius (1994) note that telecom investments tend to generate internal rates of return of approximately 20%.[4] At the national level, once-developing countries such as Hong Kong, Korea, Singapore, and Taiwan used telecommunications as a key part of their overall economic strategy to build up what is now a highly competitive position in the world market for high-technology industries and services (Saunders et al., 1994). In Malaysia, a successful economic transformation has been accompanied by remarkable advancement in telecommunications infrastructure (Riaz, 1997a,b). As a negative lesson, the antiquated state of the telecommunications network in the transitional economies of Central and Eastern Europe has been identified by the OECD and the ITU as a significant impediment to regional productivity, international competitiveness, and trade performance (Madden & Savage, 1998).

(*footnote continued*)
staved off saturation, and has certainly increased demand for 'thicker pipes'—or faster network connections—as well as the benefit to others of those pipes being connected.

[4] As further micro-evidence, Antonelli (1996) argues that Italian manufacturers who were quicker in increasing their use of telecommunications services saw significantly higher productivity gains over the 1985–1988 period. At the same time it should be noted that Capello (1994) reported on the European Commission's STAR programme in Southern Italy and stated that "Although this programme has achieved the aim of stimulating a local demand for advanced telecommunications networks and services, it has hardly generated any significant regional performance. Firms located in the south do not show an improvement in their business performance related to the adoption of new telecommunications technologies".

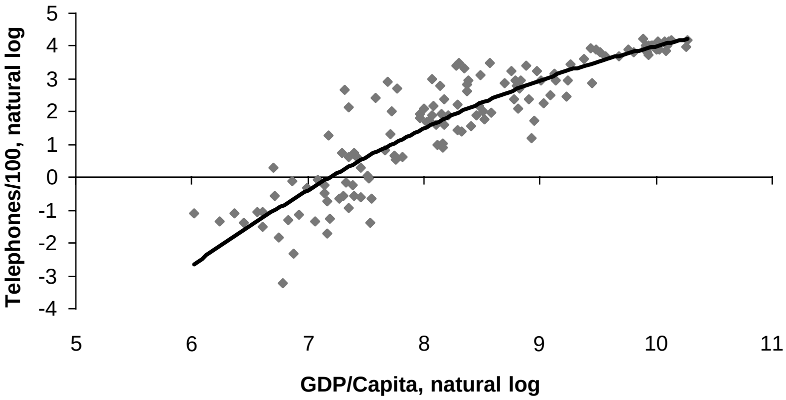

Fig. 2. 1997 GDP per capita against telephones per capita (log scales) (Data source: World Bank, 2000b).

At the cross-country level, there is certainly a close link between income per capita and the number of telephones per capita—or teledensity (see Fig. 2)—and the same is true of Internet access. However, this is largely the result of the telephone (and Internet) acting as a consumption good—as people get richer, they want a telephone. Is there a causal relationship the other way—from telecoms to growth?

A graph that looks at countries with more or fewer telephones than one would expect given their income in 1980 and GDP growth rates over the 1980–1998 period might suggest so (Fig. 3).[5] It is not the most impressive relationship, but it does appear that countries that had more telephones—or a higher teledensity—than one would expect given their income in 1980 saw higher growth rates over the next 18 years. The median growth is about a doubling of income per capita over the period. Only 29% of countries had fewer telephones than expected and faster than median growth or more telephones than expected and slower than median growth.

A large number of recent econometric studies also suggest that the quantity of telecommunications infrastructure may be connected to growth (Hardy, 1980; Norton, 1992; Canning, 1997a,b; Canning & Fay, 1993; Roller & Waverman, 2001; Madden & Savage, 1998; Riaz, 1997a,b; Easterly & Levine, 1997; Cronin, 1991; DRI, 1991; Cohen, 1992; Teknibank et al., 1993; Analysys, 1992). Others find investment in telecommunication is significantly correlated (Easterly & Rebelo, 1993).[6] Roller and Waverman's study also finds evidence of 'scale effects'—a positive and

[5] 'Expected' telephones per capita is calculated as follows: a regression is run of telephones/capita $= C + B^*$(GDP/capita), where C and B are constants; 'expected' telephones for a country is calculated by taking the country's GDP per capita and plugging that into the same equation.

[6] Looking at a few of these studies in more detail, Hardy (1980) regresses GDP per capita on lagged GDP per capita, lagged telephones per capita and the number of lagged radios over 15 developed and 45 developing nations from 1960 to 1973. According to his estimated results, Hardy concludes that telephone provision does have a significant impact on GDP, whereas the spread of radio does not. Canning and Fay (1993) give estimates of the positive impact of roads, electricity generating capacity, and telephones on economic growth through running Barro (1989) style regression using initial levels of infrastructure to explain economic growth over the period 1960–1985. Norton (1992) tests the effect of the average stock of telephones in 47 countries between 1957 and 1977 on the mean annual growth rate, controlling for the stock of telephones in 1957 and a number of macro-economic variables. He also finds that the telecommunication variable is positive and significant. Since period start telephone stock is significantly related to subsequent growth, Norton argues that the relationship "is clearly not due to reverse causality". By correcting econometric problems such

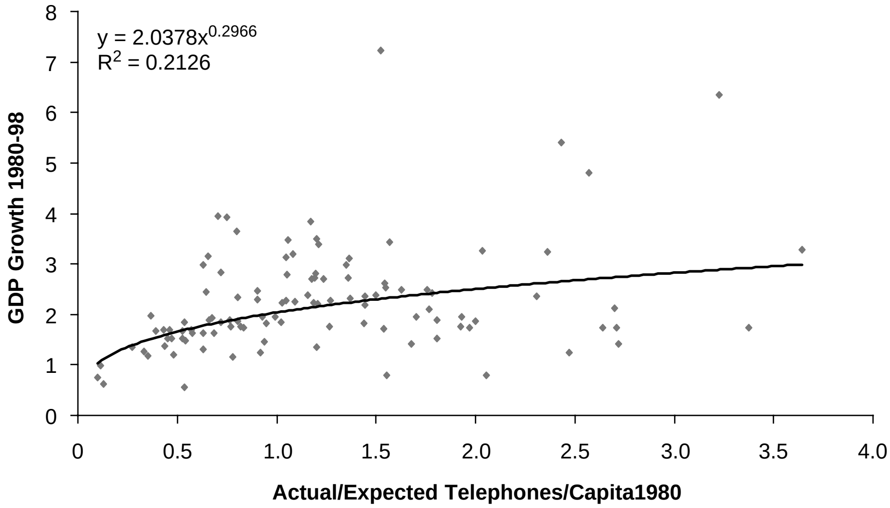

Fig. 3. A link between telecommunications rollout and economic growth? (Data source: authors' calculation from World Bank, 2000b).

significant causal link between telecommunications infrastructure and aggregate output, provided that a critical mass in countries' telecommunications has been achieved. Although contested by other studies, this might suggest the importance of the type of network effects discussed earlier.

It should be noted that these results have been disputed,[7] and it is empirically very difficult to estimate with any certainty the size of an ICT-growth relationship based on cross-country

(*footnote continued*)
as simultaneity and spurious correlation present in some earlier studies, recent works (Roller & Waverman, 2001; Canning, 1997b; Madden & Savage, 1998) lend further support to the argument that telecommunications infrastructure is positively related to economic growth. Röller and Waverman (2001) study the relation between telecommunications infrastructure and economic growth for 21 OECD countries and 35 other countries over the period 1970–1990. In order to deal with simultaneity and spurious correlation, they apply a structural setup comprised of a micro-model of supply and demand for telecommunications investments, which endogenizes telecommunications investment, and a macro-growth equation. They apply fixed effects and allow for non-linear effects of the telecommunications infrastructure. Again, they find a positive and significant causal link between telecommunications infrastructure and aggregate output, provided that a critical mass of telecommunications services has been achieved. Canning (1997a) uses physical measures of infrastructure, paved roads, electricity generating capacity, and telephones, for around 150 countries over the period 1950–1992 and finds that growth in telephones and paved roads per worker cause economic growth, while growth in electricity generating capacity does not seem to cause economic growth. Canning applies the Granger causality test and Johansen error vector correction mechanism (EVCM). Madden and Savage (1998) provide strong evidence that changes in telecommunications precede growth. Their findings also suggest (contra Roller & Waverman) that the greatest impact of telecommunications investment on growth has been in lower income economies (a similar result is found by Bougheas, Demetriades, & Mamuneas, 2000).

[7] Many researchers are skeptical about the validity of all cross-country econometric studies (Hénault (1996) and Analysys (1995) on telecommunications, and Kenny and Williams (2001) more generally). There are also dissenting voices on the presence of an impact in such studies. Munell (1992) points out that the results from many of the above studies appear to collapse once more sophisticated econometric procedures are used. By introducing state-level fixed effects, Garcia-Mila and McGuire (1992) find that the returns of telecommunications are reduced dramatically. With different econometric corrections, Kelejian and Robinson (1994) also reach the same result.

analysis.[8] Also, we have seen that it is quite likely that the impact of telecommunications on growth interacts with a number of other factors—so that we cannot answer the question 'what is the impact of telecoms rollout on growth' without further elaboration ('what is the impact of telecommunications on growth in an open trading environment, where foreign investment is welcomed, the average education level is 6 years of schooling and there are laws against telesales?'). There is also strong disagreement in the empirical literature over the presence or absence of scale effects, so we cannot even answer whether telecommunications rollout has any impact at some levels of development.[9] There is clearly a complex relationship between telecommunications rollout and economic growth. And econometric tools (and available data) are not able to measure the strength of the relationship. Nonetheless, the bulk of current evidence suggests that, at least under certain circumstances, and perhaps only after a certain scale of infrastructure has been achieved, there is a causal link.

3. Telecommunications and equity?

Dollar and Kraay (2000), in their paper on GNP growth and the poor, confirmed the close relationship between national income growth and the income growth of the poorest 20% of national populations. From this they concluded that 'growth is good for the poor'. Given that telecommunications rollout might be a (sometime) causal factor behind economic growth, it might be safe to conclude that 'telecommunications rollout is good for the poor'. The strength of that relationship will be greatly affected, however, by the direction of that telecommunications rollout—does it provide access to all, or only to the rich?

As with the theory and evidence on cross-country growth, the overall picture concerning the equity impact of telecommunications within countries is somewhat mixed. On the one hand, there is mounting anecdotal and some more formal evidence that access to ICTs amongst the poor and in rural areas increases incomes. On the other hand, there is the considerable threat of being left behind—a fate made more likely by the high relative cost of serving poor rural areas.

On the positive side, ICTs might offer some of their highest returns in rural areas (because these tend to be particularly information-starved), making them a potential tool in the fight to encourage equitable development. In Columbia, for example, a relatively inexpensive and simple

[8] This becomes clear when we look at a range of estimates from just one paper, by Seth Norton of Washington University. He used two different samples and a range of statistical tests within each sample to look at the impact of increasing teledensity on economic growth. The range of estimates that the paper provides for the growth impact of increasing the number of telephones per capita from Thailand's teledensity in 1975 to Thailand's teledensity in 1998—from about seven phones per thousand people to about 84 phones per thousand people—is between an increase of 0.35 to 4.43 percentage points being added to the growth rate each year. The upper estimate appears unbelievably large, and the range of estimates (again, just from one paper, and two samples) is very large as well. Why is this? All of the usual problems with cross-country regression analysis apply here: telecommunications rollout is correlated with and almost certainly caused by a number of other variables that are related to growth—such as institutional quality. Unless good measures of these variables have been put into the regression, the impact of telecommunications on growth is likely to be over-estimated (of course, if they are all put in, the direct impact of telecommunications might be *under* estimated).

[9] For example, Riaz (1997a) sees a complex interaction between telecoms and IT technologies, using Singapore as an illustration. Initially, the country's export dependence acted as a driver for telecommunications rollout, but subsequently this modern infrastructure enabled rapid growth in the services industry.

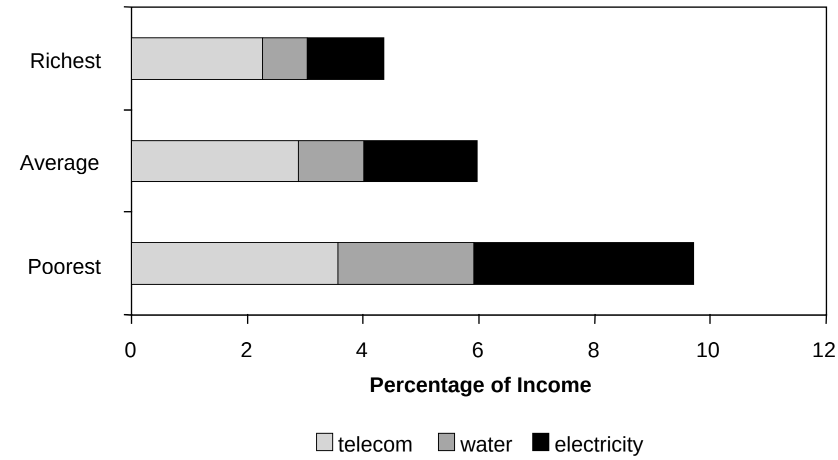

Fig. 4. Percentage of expenditure on utilities in chile (Source: De Melo, 2000).

microwave-radio telephone system along with community access points was installed in the remote region of Tumaco in 1994. Within 3 years residents of the region reported that the service had resulted in better trade and market opportunities, new business opportunities, reduced unemployment, improved health care delivery and information access, improvements in public safety and security, and an overall improvement in the level and quality of available government services (ITU, 1998a). A number of other studies have found that rural telephony improves the prices which farmers receive for their crops and significantly increases the earnings and extent of off-farm activities (ITU, 1998a,b; Duncombe & Heeks, 1999; Elbers & Lanjouw, 2001). Providing telephone access is also a means of job creation in and of itself. In the Indian State of Punjab, for example, one study found over 10,000 telecenters had sprung up by 1996, generating close to 9000 USD in gross revenue per center. In Bangladesh, the GrameenPhone network, which is putting mobile telephones in the hands of women villager operators who sell on services, is generating net incomes of $624 per operator (Bangladesh's GDP per capita, by comparison, is $262) (Lawson & Meyenn, 2000).

Because there are significant benefits to the technology, the poor do not view telephone access as an unaffordable, unnecessary luxury. Fig. 4 shows that the poor in Chile consider telecommunications such a basic service that they spend more of their income on telecommunications than on water (the average Chilean spends more of their income on telecommunications than on electricity and water combined).[10] This disproportionate expenditure is a reflection of the perceived opportunities associated with access to ICTs.[11]

However, the potential benefits of access to the poor can only be realized if that access is present. Historically this has not been the case with access focused on an urban elite. The poor

[10] This expenditure on telecommunications does not cover other forms of communication tools, such as radio, televisions, and posts.

[11] Despite appearances to the contrary, then, telecommunications is more like bread (on which the poor spend a larger percentage of their income than the rich) than caviar (on which the rich spend a larger percentage of their income than do the poor).

have limited resources to afford telephone services, and they are shut out completely in the absence of public call facilities. Further, in LDCs the poorest people are largely rural, and providing networked services to rural areas is far more expensive than to urban areas (Kenny, 2002). Recent Living Standard Measurement Surveys show that in Panama and South Africa, households in the wealthiest quintile are, respectively, 43 and 125 times more likely to have private telephones than those in the poorest quintile. In Nepal, 11% of the wealthiest households have access to a telephone, compared with 0.5% of the households in the next richest quintile (and no access below that) (World Bank, 2000a).

Thus, while ICTs might offer great opportunities for the poor in rural areas to expand earnings potential and improve access to services, their relative scarcity amongst these same groups suggests the possibility of greater inequality (see ITU, 1998a,b). One recent study of rural incomes in Ecuador (Elbers & Lanjouw, 2001) suggests some support for these two effects. Telephone connectivity was found to be strongly correlated with the extent of the non-farm sector in rural areas. In turn, the non-farm sector was correlated with both increased income and increased inequality.

The evidence on the wide ranging impact of telecommunications on all income groups in developing countries suggests two hypotheses that are worth testing—one regarding inequality and one regarding the quality of life. First, there is evidence that telecommunications can increase the income of the poor, but also that, historically, the poor have been excluded from service provision. Depending on the dominant effect, increasing teledensity could increase within-country inequality (if the benefits of access are concentrated amongst the rich) or decrease it (if the benefits of access are more widespread). Using the language of Dollar and Kraay (2000), we know that telecommunications is pro-poor to the extent that it promotes growth, but it might be 'super-pro-poor' if it promotes growth while increasing equity. Conversely, it might be 'sub-pro-poor' if it increases growth at the cost of equity.

Second, there is evidence at the micro-economic level that telephone access can significantly improve the ability to benefit from services that can have an impact on quality of life. Does increasing teledensity nationwide increase quality of life at the national level, then?

4. Data

Two different data sets are used in the regression analysis. The first data set (described in Tables 1 and 2), based on decade average data from 1960 to 2000, incorporates figures from the World Bank's World Development Indicators on GNP per capita and teledensity, and from Dollar and Kraay (2000) on inequality (INEQ, measured using the Gini coefficient). Data for all available countries is used. Some points should be made about the data selected.

National teledensity is not the best variable for measuring the poor's access to telecommunications. It is a measure of the number of telephones per capita, not the level of access to telephones (although publicly accessible telephones, with exceptions and until recently, have been rare in LDCs). Telephone access is highly concentrated amongst the rich and urban populations. This is an important point to bare in mind when interpreting regression results. Data limitations make this a difficult problem to overcome—cross-country information on telephone access by income

Table 1
Inequality and teledensity, data set description (pooled four decade statistics (1960–1990))

GNPPC	Decade average of available GNP per capita in constant 1995 USD (World Bank, 2000)
GNPPCGRO	Decade plus one average GNP per capita divided by decade average GNP per capita minus one
INEQ	Decade average of available Gini coefficient data (Dollar & Kraay, 2000)
INEQGRO	Decade plus one average Gini divided by decade average Gini minus one
TEL	Decade average of available telephones per 1000 people (teledensity) (World Bank, 2000)
TELGRO	Decade plus one average teledensity divided by decade average teledensity minus one
TELRES	Residual of regression run separately for each decade of TEL $= C + \alpha$(GNPPC)
URB	Decade average of available percentage of population in urban areas (World Bank, 2000)
URBGRO	Decade plus one percentage of population in urban areas divided by decade average percentage of population in urban areas minus one

Table 2
Inequality and teledensity, data set statistics

	Mean	Median	Maximum	Minimum	S.D.	Observations
GNPPC	5369	1549	47707	83	8440	576
GNPPCGRO	0.20	0.18	1.65	−0.62	0.33	399
INEQ	37.91	36.32	62.87	19.50	9.71	243
INEQGRO	0.037	−0.001	1.017	−0.326	0.164	153
TEL	100.8	32.8	717.7	0.1	143.9	700
TELGRO	1.06	0.68	22.55	−0.48	1.43	491
TELRES	0.00	−13.08	306.78	−366.82	72.35	546
URB	46.11	44.40	100	2.18	24.82	812
URBGRO	0.18	0.11	1.99	−0.13	0.22	609

group is not available. Some effort will be made to look at the inequality in teledensity between the largest city and the rest of the country as a very crude proxy for 'tele-inequality,' but this data is only available for the 1990s.

One variable is constructed to measure 'relative teledensity'(TELRES)—that is, the number of telephones per capita in a country compared to the number that would be expected at a given income in a given decade. This is constructed for two reasons. First, at any one point in time, as we have seen, teledensity and GDP per capita are highly correlated—this relative variable allows us to separate out the direct impact of teledensity from the impact of GDP per capita. Second, the number of telephones per capita at a given income level has changed over time as the telecommunications capital stock has increased and technology has reduced the cost of providing service. Constructing the residual by decade allows us to see the impact of 'better than expected' telecommunications provision in a pooled data set.

Turning to other variables, the Gini coefficient is used as a 'catch-all' inequality variable. The Gini coefficient is one if a country is 'perfectly unequal' (all income in the hands of the richest person) and zero if everyone in the country has the same income (perfect equality of income). It should be noted that there are concerns over the quality of the data, and with the Gini coefficient

Table 3
Quality of life and teledensity, data set description (one period 1980–1995)

GNPPC	GNP per capita, constant 1995. USD, average for 3 years surrounding date (GNPPC80 is average GNP per capita 1979–1981) (World Bank, 2000)
GNPPCGRO	Annualized growth of GNPPC 1980–1995
TEL	Teledensity (phones/1000 people) average for 3 years surrounding date (World Bank, 2000)
TELEQUIT	National teledensity/teledensity in largest city
TELGRO	Annualized growth of teledensity 1980–1995
TELRES	Residual of regression TEL $= C + \alpha$(GNPPC)
LIFE	Life expectancy, average for 3 years surrounding date (World Bank, 2000)
LIFEGRO	Annualized growth of life expectancy 1980–1995
INFMOR	Infant mortality per 1000 live births average for 3 years surrounding date (World Bank, 2000)
INFMORGRO	Annualized growth of infant mortality 1980–1995
FIVEMOR	Under-five mortality per 1000 average for 3 years surrounding date (World Bank, 2000)
FIVEMORGRO	Annualized growth of 5 year mortality 1980–1995
ILLIT	Illiteracy, percentage of adult population average for 3 years surrounding date (World Bank, 2000)
ILLITGRO	Annualized growth of illiteracy 1980–1995
PRIM	Gross primary enrollment average for 3 years surrounding date (World Bank, 2000)
PRIMGRO	Annualized growth of primary enrollment 1980–1995
SEC	Gross secondary enrollment average for 3 years surrounding date (World Bank, 2000)
SECGRO	Annualized growth of secondary enrollment 1980–1995

as a measure. The sparse availability of inequality data also forced a decade averaging approach, although such a technique clearly introduces a good deal of noise into the results.[12]

The second data set (described in Tables 3 and 4) takes averages of data from 1979 to 1981 and 1994 to 1996 to construct quality of life indicators for 1980 and 1995 and growth in those indicators between 1980 and 1995. The six quality of life indicators cover three regarding health (infant mortality, under-five mortality and life expectancy) and three covering education (illiteracy, primary and secondary enrollment). Again, a 'tele-equity' variable (TELEQUIT) is constructed from available data.

5. Results

The results of the inequality regressions are presented in Table 5. Regression results are in rows, the first column lists the dependent variable, the next six columns the coefficient and *t*-statistic (in italics) for the independent variables listed at the top of the table, the last column the R^2 of the regression. Results significant at 5% are in bold and underlined.

The first two rows look at the relationship between decade average inequality and decade average teledensity and income. The results suggest a significant relationship between the variables. The second result suggests that a one standard deviation increase in the relative

[12] There is also a fear that it might bias the results. As a rule, data is more available in more recent years, thus decade averages for incomplete data sets are likely to be biased towards the end of the decade.

Table 4
Quality of life and teledensity, data set statistics

	Mean	Median	Maximum	Minimum	S.D.	Observations
GNPPC80	6010	1677	41 633	117	9042	135
GNPPC95	6083	1561	48 447	103	9731	177
GNPPCGRO	0.007	0.006	0.087	−0.087	0.026	135
TEL80	86	29	577	0	121	182
TEL95	171	83	734	1	192	201
TELEQUIT95	0.51	0.45	5.27	0.05	0.49	166
TELGRO	0.062	0.054	0.229	−0.052	0.040	182
TELRES80	0.00	−17.01	305.79	−364.57	72.08	131
TELRES95	0.00	−33.58	278.92	−282.48	93.29	176
LIFE95	73	74	80	59	4	57
LIFEGRO	0.002	0.002	0.005	−0.002	0.002	49
INFMOR95	30	17	135	4	32	120
INFMORGRO	−0.035	−0.037	0.027	−0.097	0.020	113
FIVEMOR95	75	46	274	7	70	50
FIVEMORGRO	−0.030	−0.028	0.019	−0.071	0.021	38
ILLIT95	26	19	87	0	22	133
ILLITGRO	−0.031	−0.030	0.000	−0.082	0.015	133
PRIM95	95	99	164	18	22	153
PRIMGRO	0.003	0.000	0.053	−0.033	0.013	142
SEC95	63	63	146	5	34	145
SECGRO	0.019	0.017	0.183	−0.034	0.029	133

teledensity variable would be associated with a decrease in the Gini coefficient by 2.27 (23% of the Gini standard deviation). This result says nothing about causality, however. It might be that in more equal countries, the percentage of people who could afford a telephone increases, rather than that more telephone access reduces inequality.[13]

Given that issue, the rest of Table 5 reports the relationship between growth in the Gini coefficient across decades and period start and growth statistics for income and teledensity variables. Although it should be pointed out that this work is preliminary (there is no analysis of these results' robustness to removing outliers, changing period, sample or data sources), two results appear worthy of note: first, countries that have higher initial incomes, and countries that have higher income growth, both see significant decreases in inequality; and (most significant for this paper) countries with high initial teledensity (allowing for income) and countries that have high growth in teledensity (allowing for growth in income) over the decade see *significantly higher growth in inequality*.

[13] At a theoretical level, the extent to which equality is likely to impact the number of people able to afford (private) telephones will depend on income levels. In the poorest countries, where telephone ownership is concentrated amongst the very wealthy, increasing the income of the wealthy at the expense of the poor is likely to increase teledensity. In wealthier countries, where only the poor lack the resources to afford a telephone, increasing equality will increase teledensity. Given this data set is skewed towards middle income countries, it might be that the second channel is the stronger one in these results.

Table 5
Inequality and teledensity, regression results

D.V.	*C*	TEL	TELRES	GNPPC	INEQ	TELGRO	GNPPCGRO	R^2
INEQ	**41.170**	**−0.0256**		0.0001				0.15
	51.72	−3.25		*0.58*				
INEQ	**40.595**		**−0.0314**	**−0.0003**				0.16
	53.20		−3.66	−3.82				
INEQGRO	**0.039**	−6.38E-06						0.00
	2.14	*−0.07*						
INEQGRO	0.029		3.71E-04					0.02
	1.82		*1.68*					
INEQGRO	**0.042**					−3.52E-03		0.00
	2.14					*−0.25*		
INEQGRO	**0.054**	**9.40E-04**		**−1.91E-05**				0.13
	2.86	4.09		−4.46				
INEQGRO	**0.065**		**7.65E-04**	**−6.59E-06**				0.09
	3.37		3.06	−3.07				
INEQGRO	**0.057**					**0.050**	**−0.337**	0.20
	3.00					3.02	−5.64	
INEQGRO	**0.408**	**5.73E-04**		**−1.62E-05**	**−8.78E-03**			0.33
	6.82	2.71		−4.25	−6.16			
INEQGRO	**0.433**		3.57E-04	**−8.23E-06**	**−9.23E-03**			0.30
	7.19		*1.56*	−4.33	−6.36			
INEQGRO	**0.364**	**4.55E-04**		**−1.15E-05**	**−7.85E-03**	**0.042**	**−0.245**	0.41
	5.99	2.17		−3.04	−5.76	2.57	−4.34	
INEQGRO	**0.380**		3.32E-04	**−5.28E-06**	**−8.04E-03**	**0.041**	**−0.260**	0.40
	6.27		*1.51*	−2.75	−5.82	2.51	−4.61	

As an aside, the results also suggest an interesting feature of inequality—that countries with initially high (or low) inequality appear to converge towards average inequality levels over time (the 10th regression in Table 5 suggests that countries with a period start Gini one standard deviation above average will see that Gini fall by nine percent over the course of the decade).

Teledensity, in the first analysis, appears to be a 'sub-pro-poor' growth factor. The penultimate regression in Table 5 suggests that countries with one standard deviation higher teledensity than average at decade start will see a 6.5% increase in inequality over the decade, and countries that see a one standard deviation higher than average teledensity growth will see a 6% increase in inequality over the decade. This second result suffers from the same causality problems as the levels results reported above, nonetheless the period start teledensity to period average inequality growth result might suggest a causal relationship.

What might be driving this result? The median teledensity at period start in the data set is 33 telephones per 1000 people, suggesting that access in the median sample country was limited to the wealthy. Given this high concentration, countries with more telephones (allowing for income) or with more telephones than would be expected given their income level would, as a rule, have more telephones amongst the wealthy, rather than teledensity levels approaching universal access. If access to a telephone does increase incomes, and access in the sample countries was largely the preserve of the wealthiest, higher than average teledensity would be expected to increase inequality. A regression run to test this theory (not reported in the table) split the country sample by level of teledensity into two groups—those with teledensity above one telephone per 10 people, and those with lower teledensity. As the theory would predict, teledensity and growth in teledensity were negatively (although insignificantly) related to inequality growth in the high teledensity sample while remaining positively and significantly related to inequality growth in the low-teledensity sample.

A second result not reported in the table takes the 1990 data on inequality and runs a regression against GNP per capita, teledensity and the 1990 tele-equity variable. GNP is not significant and, as above, teledensity is negatively and significantly related to inequality. The (perhaps) surprising result is that tele-equity as measured here is significantly and *positively* related to inequality—less inequality in the provision of telephones between the largest city and the rest of the country is correlated with greater income inequality in the country. This might be a linked phenomenon to the teledensity–inequality relationship. Improved tele-equality in the sample countries only improves access from the wealthy in the largest city to a larger group of the wealthy in other towns, and so still increases inequality between the wealthy and the poor.

Turning to robustness, one important question is that of omitted variables. It might be that a factor causally or otherwise correlated with telecommunications rollout is in fact behind the growth in inequality over time in countries with more telephones. Recent econometric work has suggested some variables that correlate with teledensity (see, for example, Kenny, 2001a; Kubota, 2000; Reynolds, Kenny, & Qiang, 2001; Wallsten, 1999). Beyond income and sector policy variables (which will be discussed later), this work suggests that the broad macro-policy framework and urbanization both have a significant impact on teledensity. These factors might also plausibly be behind changes in inequality as well. Dollar and Kraay (2000) examined a range of policy and institutional variables covering macro-economic stability and policy that might have an impact on inequality (including inflation, government consumption, social spending as a percentage of government spending, primary education, trade, financial development, property rights and the rule of law and a measure of the strength of democracy), and were unable to find a variable with a robust relationship to inequality. This suggests that the teledensity–inequality result is not being driven by the presence of a policy or institutional factor that promotes telephone rollout and independently acts on inequality.[14] Dollar and Kraay did not look at

[14] Interestingly, given the results of the regression reported in Table 6, they did find countries with a large amount of arable land per capita to be comparatively unequal.

Table 6
Inequality, teledensity and urbanization regression results

	Dependent variable		
	INEQ	INEQGRO	INEQGRO
C	**37.6**	0.32	0.30
	21.00	*5.18*	*4.32*
TEL	**-0-03**	**3.82E-04**	3.34E-04
	−3.86	1.84	*1.61*
TELGRO			0.04
			2.62
GNPPC	4.31E-05	−1.88E-05	−1.44E-05
	0.29	*−5.09*	*−3.79*
GNPPCGRO			−0.20
			−3.64
URB	**0.089**	**2.84E-03**	2.13E-03
	2.39	3.82	*2.56*
URBGRO			−0.062
			−0.48
IENEQ		**−9.50E-03**	**−8.50E-03**
		−6.94	−6.34
R^2	**0.17**	**0.40**	**0.46**

urbanization, however, a potential source of inequality and a source of variations in teledensity, which will therefore be the focus of robustness checks in this paper.

Table 6 reports on three regressions that add urbanization and growth of urbanization into the equation. The results suggest that urbanization (allowing for GNP per capita) is indeed correlated with inequality and a force for growing inequality. Adding the urbanization variable also weakens the impact of the teledensity variable on growth. However, teledensity remains significant at approximately 10% in the second and third equations. At a given income level, more urbanized countries tend to have higher teledensity.[15] It is plausible to assume, then, that one of the reasons for the weakening of significance of the teledensity variable in these equations is the (probably casual) correlation between urbanization and teledensity. One of the reasons that urbanization at a given income level might drive increasing inequality, then, is that it eases the provision of infrastructure services including telephony to a wealthy minority.

[15] A regression of $\text{TEL} = C + \alpha^*\text{GNPPC} + \beta^*\text{URB}$ produces positive coefficients on income per capita and urbanization with *t*-statistics of 22.10 and 8.44, respectively.

Table 7
Quality of life and teledensity, regression results

	C	GNPPC	TEL	TELEQUIT	RSQ
LIFE	**66.82**	4.24E-05	**0.0168**		0.69
	79.96	*0.77*	4.35		
LIFE	**67.15**	**2.68E-04**		3.57	0.64
	46.33	6.87		*1.64*	
LIFE	**66.34**	6.79E-05	**0.018**	*0.01*	0.73
	51.90	*1.07*	3.74	0.01	
IMFMOR	**57.04**	7.00E-04	**−0.145**		0.49
	16.80	*1.89*	−6.97		
INFMOR	**51**	**−1.31E-03**		**−14.39**	0.30
	12.07	−4.41		−2.78	
INFMOR	**62.1**	**8.90E-04**	**−0.151**	**−11.08**	0.51
	15.66	2.06	−6.30	−2.53	
FIVEMOR	**120**	**6.50E-03**	**−0.536**		0.49
	11.90	2.18	−5.47		
FIVEMOR	**150.2**	**−1.32E-02**		**−128.19**	0.50
	10.31	−2.63		−3.76	
FIVEMOR	**138.22**	−5.75E-03	−0.298	−58.17	0.53
	8.90	*−0.91*	*−1.87*	*−1.16*	
ILLIT	**36.69**	**9.80E-04**	**−0.130**		0.37
	17.96	2.02	−6.58		
ILLIT	**33.08**	**−1.20E-03**		**−6.97**	0.16
	12.97	−2.91		*−1.68*	
ILLIT	**37.6**	**1.10E-03**	**−0.125**	−4.84	0.39
	16.15	2.27	−6.24	*−1.34*	
PRIM	**91.53**	−2.34E-04	0.035		0.05
	38.89	*−0.67*	*1.87*		
PRIM	**93**	3.55E-04		−0.01	0.02
	34.02	*1.51*		*0.00*	
PRIM	**91.48**	−2.13E-04	0.037	−1.50	0.04
	32.04	*−0.53*	*1.73*	*−0.35*	
SEC	**39.01**	**−9.00E-04**	**0.183**		0.68
	17.17	−2.72	10.32		

Table 7 (*continued*)

	C	GNPPC	TEL	TELEQUIT	RSQ
SEC	**44.36**	**1.90E-03**		**11.62**	0.40
	<u>13.84</u>	<u>6.92</u>		<u>2.41</u>	
SEC	**36.96**	**−8.40E-04**	**0.178**	4.53	0.64
	<u>14.01</u>	<u>−2.26</u>	<u>8.93</u>	*1.18*	

Table 7 turns to the relationship between the 1995 values of the six quality of life variables and teledensity. In brief, the results suggest that, allowing for GNP per capita, there is a significant relationship between higher teledensity and longer life expectancy, lower infant mortality, lower under-five mortality, lower illiteracy and higher secondary enrollment. There is some evidence that greater equality of teledensity across a country (allowing for teledensity and GDP per capita) is further associated with lower infant mortality.

Table 8, however, provides some evidence suggesting that omitted variables (or, possibly, reverse causality) might account for this relationship. The format is the same as previous tables with the exception of the third column (INITIAL) which lists the coefficient and *t*-statistic on the initial value of the dependent variable (for example, with LIFEGR, INITIAL takes the value of 1980 life expectancy). While the initial level of teledensity is (as in other studies mentioned earlier) significantly related to GNP per capita growth, the initial level and growth rate of teledensity is insignificantly related to growth in quality of life variables (the residual of the teledensity-income regression is in fact related to the growth of infant mortality). Perhaps underlying institutional factors account for both teledensity and quality of life, perhaps the negative impact of teledensity on health quality of life through inequality growth is large enough to overwhelm any positive direct association between teledensity and improvements in health quality of life, and the extent of education (as compared to the quality, for which we do not have data) does not depend significantly on information flows.

A number of points can be made regarding the results presented above. First, they are preliminary. Nonetheless, the results suggest, at least historically, that telecommunications rollout might not have 'super-pro-poor'. Indeed, it might be that, especially in the poorer developing countries, telecommunications rollout, by providing new opportunities to the wealthy in urban areas, but not to poor, rural populations, has encouraged divergence in incomes within countries. This increasing inequality might also lie behind the finding that, overall, teledensity appears to have little relationship with improvements in health quality of life variables.

Having said that, the micro-studies quoted above suggest that *where the poor have access*, telephony can play an important role in income generation and improving the quality of services related to quality of life. In other words, the lesson to take from the above analysis is that telephony *can* improve the income generating opportunities of poor people as well as their quality of life, but historically, this opportunity has not been grasped—and only the rich, with access, have benefited. This is a conclusion that provides a rationale for public intervention to support the goal of wider access.

Table 8
Quality of life growth and teledensity, regression results

	C	INITIAL	GNPPCGRO	TELGRO	TELRES	RSQ
GNPPCGRO	**0.0067**	−1.81E-08			**1.10E-04**	0.09
	2.51	*−0.07*			*3.59*	
LIFEGRO	0.0059	−5.89E-05	**0.063**	−0.0075	−5.60E-07	0.61
	0.70	*−0.53*	5.57	*−0.59*	*−0.19*	
INFMORGRO	**−0.048**	**1.25E-04**	**−0.174**	0.0977	**7.85E-05**	0.145
	9.64	2.25	*−1.63*	*1.44*	2.49	
FIVEMORGRO	−0.0233	8.68E-05	0.099	−0.248	7.62E-05	0.23
	−1.61	*1.40*	*0.33*	*−1.40*	*0.68*	
ILLITGRO	**−0.042**	**3.59E-04**	−0.03	−0.0193	−1.03E-05	0.48
	−13.94	8.49	*−0.49*	*−0.48*	*−0.50*	
PRIMGRO	**0.031**	**−3.37E-04**	0.0267	0.047	8.94E-06	0.43
	6.86	−8.47	*0.53*	*1.35*	*0.60*	
SECGRO	**0.0379**	**−3.96E-04**	**0.234**	0.02	9.46E-06	0.34
	6.24	−5.78	2.50	*0.29*	*0.32*	

6. The Internet

Cross-country evidence on the impact of the Internet on economic growth is sparse to non-existent given the fact that the technology is so young. We do, however, have some studies on the impact of IT investment, growth and inequality in the US, which suggests that the cross-country story regarding telecommunications told above might apply to the Internet as well.

First, there is widespread evidence that IT investment might be a factor behind recent increases in economic growth in the OECD (Pohjola, 1998; Gordon, 2000; David, 2000)—although it should be pointed out that the evidence of widespread total factor productivity increases linked to IT investments is fairly weak (see Kenny, 2001b, for a review). This evidence is repeated at an anecdotal and micro-level in developing countries. A number of studies suggest cases of investments in Internet technology making significant returns in government operations and in businesses (see Grace, Charles, & Zhen-wei Qiang, 2001; UNCTAD, 2001 for examples).

Further, we know that rollout to date of Internet access and use has remained highly concentrated among an urban elite—much more so than telecommunications. In Thailand, approximately 10% of the population lives in Bangkok, they have 40% of the telephones and 70% of the Internet connections (World Bank data—see http://www.worldbank.org/html/extdr/offrep/eap/eapprem/buildingamin.pdf). In Argentina, 77% of Internet users are in Buenos Aires as compared to 10% of fixed telephone lines and 8% of the population (calculated from Kirkman, Cornelius, Sachs, & Schwab, 2002; World Bank, 2001b). A recent study of Capacity Building for Electronic Communication in Africa (CABECA, 1998) found that 98% of Ethiopian Internet users had a university degree. Ethiopia is a country where over 60% of the adult population is illiterate and less than 1% of the relevant age group is in tertiary education. Overall, the number of Internet users in low-income countries in 1999 stood at a little under two per thousand people (World Bank, 2001a)—a far distance from the levels of ubiquity required to make Internet a pro-equity technology. The diffusion of the Internet in developing countries is following a similar pattern to that historically true for telecommunications rollout, then—and this suggests that it, too, might be a force for both growth and growing inequality.

In fact, four features of the Internet suggest that (without intervention) it might be even more strongly 'sub-pro-poor' than has been the case for the telephone. First, the Internet is more expensive than telephone access, requiring a computer, modem, and ISP subscription. Capital costs per computer for a rural stand-alone system for providing Internet access can run as high as US$20,000 (see Kenny, 2002 for a review). Compare this to a communications budget of perhaps 3 cents per day for those living in absolute poverty.

Second, the Internet requires a higher level of education and skill to operate than the telephone (and low skills and education are concentrated amongst the poorest). Even in the US, with far higher average education rates than the great majority of developing countries, there is evidence that IT might have benefited educated (comparatively wealthy) workers far more than the less-educated, leading to growing inequality. Since the 1970s, the US has seen a rapid increase in the demand for highly educated workers (Autor, Katz, & Kreuger, 1998). Conversely, the real wages of young men with 12 or fewer years of education *fell* by 26% between 1979–1993, and has not recovered since (Berman, Bound, & Machin, 1998).

Third, the dominant languages of the Internet are not those spoken by the poor. Igbo (Ibo), a language spoken by 17 million people in Nigeria, is all but completely absent from the Internet (see Kenny, 2002). Conversely, English remains dominant—in 1999, 72% of sites were in English (Nunberg, 2000)—but is spoken by very few of the World's poorest. A recent study conducted in a number of East Asian cities found that this is a serious issue when it comes to the utility of the Web. English speakers were two to four times more likely to use the Internet than the non-English speaking population.[16]

Finally, the Internet requires access to skilled personnel, electricity, and a critical mass of users to make it sustainable—these are especially lacking in the rural areas of LDCs, where the majority of the poor live (see Kenny (2002), for a fuller discussion of these points).

Again, however, it is important to remember that the poor can benefit from the Internet, both indirectly (as income generated by ICTs improves national living standards) and directly—if they have access. A number of SME portals and online stores for the sale of artisinal goods are making global markets work for the poor. The Internet has also proven itself a powerful tool to improve the functioning of government—improving procurement operations and budget management processes, for example. Finally, the spread of the Internet to date has been far more rapid than was the spread of previous technologies—including the telephone. Thus the length of time between the Internet's widespread use as a tool to further enrich the wealthy and its use as a tool to empower the poor might well be shorter than it has proven to be for the telephone.

[16] http://www.feedmag.com/daily/dy070799.html.

7. Conclusion and policy recommendations

Any conclusion based on such preliminary analysis must be treated with caution. Nonetheless, the results of the regression analysis fit well enough with non-statistical studies to suggest that the telephone is a source for income generation, and that those people or countries without access are likely to fall behind those with access. Further, copious studies on the ICT access gap, or 'digital divide' (see, for example, World Bank, 2000) suggest that the poor have historically been excluded from ICTs. This in turn suggests that ICTs have been a force for divergence—perhaps between, and probably within countries. In this way, ICTs have acted the same as most new technologies in terms of their impact on income differentials across countries (see Kenny, 2001b).

Having said that, a number of factors suggest that telephony could be a force for convergence of incomes and widespread improvements in quality of life in the future. The historical trend, which is continuing, is toward convergence in access to telephony across countries (Grace et al., 2001). One cause of this is that technological advance continues to make telephony increasingly affordable. As we have seen, the average teledensity at a given income level has been growing over the last four decades, and recent advances are likely to speed that process. For example, the GrameenPhone program discussed earlier relies on mobile telephony to provide access where fixed-line provision would not be viable.

The worldwide move toward private, competitive and regulated telephone provision is also playing a role in extending telephone access (Kubota, 2000; Reynolds et al., 2001; Wallsten, 1999)—as well as access amongst the poor. In 1994, Peru privatized its telecommunications system, and the privatization contracts included substantial obligations to install public telephones in rural areas. Teledensity increased from 29 to 76 lines per thousand, the number of public telephones increased sixfold and the percentage of the poorest income quintile with a telephone increased from 1% to 21% (World Bank, 2001a). Particular regulatory mechanisms to help ensure access—such as licences requiring service rollout and legalizing resale—are discussed in Dyamond, Juntunen, and Navas-Sabater (2000).

Further supporting a movement towards universal access are a growing number of successful models for providing public telephone access in LDCs. In Senegal, for example, more than 6000 privately operated telecenters have come into existence since the early 1990s.[17] Public access to a telephone has more than doubled—with the added advantage that the cost-effectiveness of each additional line was four times greater than that of a private home line (ITU, 1998). India, Peru, South Africa, and Thailand have also seen dramatic growth in privately owned and operated telecenters providing rural inhabitants with new information sources and opportunities (Ernberg, 1998) (see also Ervin, 1998; Falch, 1998; Jensen, 1999; Richardson, 1999; TeleCommons Development Group, 2000).

Finally, the Chilean reverse subsidy auction scheme provides a mechanism to subsidize the private provision of access beyond the market in a manner that keeps the cost of that provision to a minimum. Chile has achieved near-universal telephone access by auctioning subsidies to the lowest bidder to provide public telephones in unserved areas of the country at the cost of a little under $10 per newly served citizen (Kenny, 2002).

[17] For more information on telecenters in Senegal, see http://www.idrc.ca/acacia/engine/eng_6.htm: http://www.telecom-plus.sn/observatoire/Obtcp.htm: and http://www.sonatel.sn/c-telece.htm.

Together, these four factors suggest that many developing countries could rapidly move toward teleaccessibility for the great majority of their citizens. In turn, this would help to ensure that telephony moved from being a 'sub-pro-poor' to a 'super-pro-poor' tool of development.

A program to widen access would have four parts (not necessarily in this order). First, privatization of the state fixed monopoly. In order to maximize access, bids could be evaluated on the basis of rollout plans rather than or as well as highest purchase offer. Bolivia's telecommunications privatization plan was designed to be fiscally neutral, with companies bidding on the basis of investment plans rather than payments to the treasury. Second, the introduction of fixed and wireless competition, including wireless local loop services, with licences awarded on the basis of rollout plans. In Uganda, for example, the Second National Operator's bid evaluation criteria included a network rollout plan in addition to the bid price. Third, a strong regulatory regime to ensure, in particular, fair interconnection and revenue sharing arrangements. Regulations should also guarantee the right to resell services. Further, and after the introduction of well-regulated private competition, governments should create a universal access fund, preferably supported from general government revenues (as in Chile), to provide reverse-auctioned subsidies to support access rollout in uneconomic areas.

Turning to the Internet, in the absence of an active policy stance covering access, training and content development aimed specifically at the poor, it is likely that the new technology will also be a force for income divergence. On the other hand, given the barriers mentioned above, it is likely that such a program would be both complex and very expensive (Kenny, 2002). Depending on one's view of the benefits of direct Internet access for the poor in LDCs, this program could be a distraction from more important priorities or a vital step towards equality of opportunity. The answer to this question is left to other researchers.

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