Research Report

Telecommunications, Public Health, and Demand for Health-Related Information and Infrastructure

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Abstract

The paper investigates the proposition that complementarities exist between information technologies and public health promotion. The results of the cross-country analysis indicate that an increase in the stock of telecommunications infrastructure is positively correlated with an improved health status of the population. To integrate more realism into the macrolevel analysis, the paper utilizes household surveys conducted in two emerging market economies: Bangladesh and Laos. The analysis at the household level shows that a basic telephone service offers opportunities in delivering timely information on health services to households with relatively greater demand for this type of information. Telephone access is also associated with an increased demand for telecommunications infrastructure and medical facilities.

Introduction

A traditional chief in South Africa was asked the following question: "If you had the possibility of choosing between a telephone line, a school, or a clinic for your village, what would you choose?" The chief replied: "The telephone line, so that I can lobby ministers in the capital about the clinic and the school." While this is an anecdotal story, it captures the central message of this paper: when wisely applied, information and communications technologies (ICTs) can become enabling tools that empower the poor and offer opportunities to improve provision of public goods and services that are of value to rural and impoverished populations.

The objective of this paper is to investigate the proposition that complementarities exist between ICTs and public health status.[1] In addition, the paper seeks to assess the link between ICTs, on the one hand, and the demand for health-related information, telecommunications infrastructure, and medical facilities, on the other. To accomplish these objectives, the paper draws on macrolevel as well as on microlevel data.

There are two important features of this study. First, its objective is to offer empirical evidence from developing countries. To date, research on the role of ICTs has to a large extent focused on developed countries, mainly due to better availability of adequate data, particularly panel data. Yet the actual and potential role of ICTs in the public health promotion

1. In the absence of careful empirical work, it is not possible to say whether externalities or complementarities are more important to evaluate the role of ICTs in the public sector, but I would expect that the second is more important than the first.

has no doubt important implications in developing countries and in particular for the poor. For instance, using ICTs for malaria eradication campaigns and to raise HIV/AIDS awareness of marginalized populations can contribute to reduction of poverty persistence, and so will not only improve population health, but also improve the distribution of income. Today a consensus is emerging on the fact that provision of public health services is necessary even for a strategy that focuses mainly on growth and income (Deaton 2003).

Second, I focus on the role of telephony. When considering the role of ICTs in the public health sector in the developing world and in particular for the poor, one should not forget the "old" ICTs such as telephone, radio, television, and printed materials. The availability of sufficient numbers of—private or public—telephones is indispensable. First of all, the existence of well-functioning telephone networks is necessary for the use of e-mail and the Internet. Second, access to health information and global communications can be gained not only through the "new" ICTs—which currently dominate the debate and political activities—but also through traditional media and means of communication.

The rest of this paper is organized as follows. The second section gives an overview of related research. The third uses a cross-country framework to analyze the intersection of telecommunications with public health promotion. The microeconomic analysis in the fourth section uses household surveys on residential telephony conducted in Bangladesh and Laos to identify the determinants of the demand for faster information on health services and medication, as well as the determinants of the demand for telecommunications infrastructure and medical facilities. The last section summarizes findings and policy implications.

Relevant Literature

The Millennium Declaration, adopted by 189 member states of the United Nations at its 55th General Assembly in September 2000, acknowledges that ICTs are important tools for improving the delivery of health care and improving public health. Nevertheless, few studies provide direct evidence about the role of telecommunications in public health promotion. This overview of the literature tries to be as encompassing as possible, yet remains incomplete because the evidence is still scarce.

Athey and Stern (2002) are among the handful of analysts who explicitly analyze the productivity of technology and the potential benefits of the emergency response systems. The authors find that the impact ICTs have on the improved timeliness of service provision can be associated with significant improvements in the health status of cardiac patients. According to Oldham et al. (2002), telephones can be used for managing same-day demand, follow-up appointments, and other queries in primary healthcare. The authors report 30–50% reduction in the need for face-to-face consultation as a result of telephone management.

The literature on the demand for telecommunications infrastructure is more extensive. Various arguments have been extended to defend sustained investment in provision of telecommunications infrastructure. As indicated by Wilson (2004), a strong and modern national communications system has become a requirement for investment, both foreign and local. Chinn and Fairlie (2004) suggest that public investment in telecommunications infrastructure can mitigate the gap in PC and Internet use. Yet another justification for continued investment in rural telecommunications infrastructure is that rural telecommunications projects seem to be welfare enhancing, since households' willingness to pay for access to telephone services are usually higher than the prevailing tariff rates (Estache et al. 2002; Torero et al. 2003). This paper contributes to the existing literature by examining how the transition from not having to having a telephone influences the demand for telecommunications infrastructure.

Telecommunications and Health Promotion: Cross-Country Evidence

The World Health Organization claims that "40 percent of health is exchanging information." The intuition behind the potential role of ICTs in public health promotion is straightforward. Where the state of the ICT infrastructure is rudimentary, communication is limited. The transaction costs of gathering information and searching for proper health services are high. As the ICTs improve, the costs of information acquisition will fall and individual health will presumably improve. Indeed, if the ICTs do have an impact on a nation's health, it will be through the improvement of the capabilities of individuals and medical organizations to communicate with each other rapidly over increased distances.

My objective in this section is to bring empirical evidence from developing countries on the potential complementarities between an increase in the stock of telecommunications infrastructure and an improved health status of the population as measured by higher life expectancy and lower child mortality rates.[2] In particular, I use empirical evidence over 20 years, the period 1980–2000, to examine the impact of an "old" ICT—telephone—on public health promotion.[3]

Data and Correlations

The data gathered consist of data on general health and economic variables, as well as country characteristics: life expectancy at birth, infant (aged 0 to 1 year) and child (aged 0 to 5 years) mortality rates, physicians and hospital beds per 1,000 people, real Gross Domestic Product (GDP) per capita, population, adult and female illiteracy rates, immunization against measles and DPT (diphtheria, pertussis or whooping cough, and tetanus), percent of urban population, the poverty headcount and the Gini index,[4] and the like. All these data are available from the World Development Indicators (2004) database. I have also collected data on a number of telecommunications indicators—main telephone lines and telephone subscribers per 100 inhabitants, waiting list for mainlines, income from telephone services, investment in telecommunications, etc. These data are drawn from the International Telecommunication Union (ITU) statistical yearbooks.

Before turning to the econometric estimation, I present some broad averages and examine simple correlations. Table 1 defines the most important variables used in this study and presents summary statistics for developing countries. The annual growth rate for life expectancy at birth over the period 1980–2000 was 0.31%, while for mainlines it was 6.81%.[5] During the two decades, the developing countries achieved significant progress in vaccination coverage of children and in the fight against illiteracy. The share of urban population increased at an average annual rate of 1.4%.

Overall, the improvement in life expectancy is positively associated with the increase in the number of mainlines, producing a correlation of 0.34. The decrease in child mortality is negatively related to telecommunications investment: the correlation coefficient is –0.20. Naturally, there is a possibility of spurious correlations since country-specific telecommunication improvements may be correlated with other health-promoting measures such as income, investment in human capital, health expenditure, and so forth. The following econometric analysis makes an effort to control for the effect of other relevant factors.

An Econometric Model of Telecommunications Investment, Aggregate Health, and Wealth

The following equation is used to evaluate the potential impact of ICTs on aggregate health:

$$HEALTH_i = f(TELECOM_i, GDP_i, Z_i), \qquad (1)$$

where $HEALTH_i$ is a social indicator reflecting improvements in health status for country *i,* which is a function of an increase in the stock of telecommunications infrastructure, $TELECOM_i$; GDP_i per capita; and a vector of socioeconomic variables, Z_i.

Two indicators are used to gauge *HEALTH:* the annual growth rate of life expectancy at birth and the annual growth rate of child mortality. *TELECOM* is proxied by the annual growth rate of mainlines per 100 inhabitants, while *GDP* per capita is measured in constant 1995 US$. The regressions include the following set of control variables, *Z:*

- *Annual growth rate of adult illiteracy.* Many studies show a strong inverse relationship be-

2. The list of core indicators for public health status include life expectancy at birth, child mortality rate, infant mortality rate, maternity mortality ratio, births attended by skilled health personnel, contraceptive prevalence rate, and HIV infection rate.

3. The actual number of countries used in the analysis depends on data availability.

4. The poverty headcount index is the ratio of the number of those considered poor to total population. The Gini index is a measure of inequality. It is derived from the Lorenz curve (a graph that shows the cumulative share of income received by cumulative shares of population) and measures the area between perfectly equal distribution and actual distribution.

5. Countries with negative growth rates for life expectancy are Belarus, Botswana, Burundi, Central African Republic, Congo DR., Cote d'Ivoire, Iraq, Kazakhstan, Kenya, Lesotho, Liberia, Malawi, Mozambique, Namibia, Russia, Rwanda, South Africa, Swaziland, Tanzania, Uganda, Ukraine, Zambia, and Zimbabwe. The only countries with negative growth rates for mainlines are: Congo D.R. and Liberia.

Table 1. Variable Description and Summary Statistics: Developing Countries, 1980–2000

Variable	# of observations	Mean	Standard deviation	Minimum	Maximum
Annual growth rate of life expectancy at birth	142	0.31	0.54	−1.98	1.56
Annual growth rate of child mortality rate (children aged 0–5 years)	105	−2.98	1.98	−7.07	1.23
Annual growth rate of main telephone lines per 100 inhabitants	141	6.81	3.84	−4.48	21.70
Annual growth rate of GDP per capita (GDP in constant 1995 US$)	109	0.48	2.16	−7.27	8.29
Annual growth rate of adult illiteracy	118	−3.05	1.44	−8.04	−0.24
Annual growth rate of immunization for DPT	86	7.41	8.53	−2.04	61.85
Annual growth rate of urban population	146	1.38	1.23	−1.10	6.20
Poverty headcount (% of population) per most up-to-date value	71	35.62	16.93	4.6	68.0

Notes: The annual growth rate is computed as a compounded annual growth rate over the period 1980–2000 and is given as a percent. If data for 1980 or 2000 were not available, observations in the range of 2 years after 1980 or 2 years before 2000 (1981–1982 and 1998–1999) were used.
Sources: World Development Indicators *(2004), ITU statistical yearbooks, and author's own calculations.*

tween adult or female illiteracy and public health status (e.g., Schultz 1993; Gupta et al. 1999).

- *Annual growth rate of immunization.* There is evidence that increased immunization of children has a positive impact on the health status of the population (Hojman 1996). The share of children under one year of age immunized for DPT is therefore used as a control variable.[6]
- *Poverty headcount index.*[7] As noted by Deaton (2003), if a rich country has a lot of poor people, it will have low average health relative to its per capita income. Data limitations prevent including the average growth rate of the poverty headcount index. Instead, the most up-to-date value is used.
- *Annual growth rate of urbanization.* Schultz (1993) finds that mortality is higher for rural, low-income, agricultural households, suggesting that increased urbanization is associated with an improved health status of the population.

Data limitations prevent adding other control variables that may affect indicators of health status. In particular, public spending on health care is omitted since data are not available for the entire study period.[8] Similarly, data limitations prevent including control variables that capture the factors adversely affecting health caregivers (e.g., the impact of the AIDS epidemic in Africa).

Equation (1) is estimated in a linear form using ordinary-least-squares (OLS) and two-stage-least-squares (2SLS) regressions. The 2SLS technique is used primarily to address the problem of reverse causality. In addition, 2SLS regressions address potential problems of measurement errors in variables.

6. Using immunization against measles yields similar results. The two types of immunizations are highly correlated, and therefore, only one was included in the regressions.
7. The poverty headcount index is highly correlated with regional dummies, especially with the dummy variable for Africa. Since the number of observations is relatively small and the focus of this study is to explain cross-country variation in life expectancy and child mortality rates without regard to geography, the poverty headcount index was included in the regressions instead of regional dummies.
8. I performed regressions including public health expenditure for the years for which data were available. The coefficient on this variable was statistically insignificant.

The number of observations in the regressions varies, depending on the availability of data for the variables used. The number of observations for the 2SLS specifications is relatively low.[9] Since the White's heteroskedasticity-consistent estimators tend to be too optimistic in small samples, the standard errors for the coefficients are based on the Davidson and MacKinnon (1993) heteroskedasticity-consistent covariance matrix.[10]

Table 2 reports the results of regressions with annual growth rates of life expectancy and child mortality over the period 1980–2000 as dependent variables. On average, the explanatory variables account for about 40% of cross-country variation in the change of life expectancy and child mortality rates. In all of the regressions, the coefficient on the growth rate of mainlines carries the expected—positive in the life expectancy regressions and negative in the child mortality regressions—sign and is statistically significant at a level of at least 10%.

This interpretation relies on the assumption that there are no omitted time-varying and region-specific effects correlated with the growth rate of mainlines. That is, the estimates could potentially confound the effects of improvements in telecommunications infrastructure if the allocation of other governmental programs was correlated with telecommunications investment.[11] To account for this possibility, I reestimated the regressions, controlling also for the growth rate in government consumption expenditure, as well as for access to sanitation and safe water. Controlling for these variables did not diminish the explanatory power of the growth rate of mainlines, suggesting that the coefficients are not overestimating the effect of telecommunications investment on public health promotion.[12]

The regression results show that immunization and urbanization are important in explaining variances in the change of public health indicators. In line with the empirical literature on determinants of health status, increases in immunization rates have a positive and significant effect on improved life expectancy. On the other hand, rather surprisingly and contrary to Schultz (1993), increased urbanization has a negative impact on public health promotion. This could be an alarming finding in view of the fact that demographers expect nearly 2 billion people to be added to the world population between 2000 and 2030, almost all of them in cities in Africa, Asia, and Latin America (Sheehan 2002).

The coefficients on GDP per capita and adult illiteracy are statistically insignificant. The regressions also fail to find a statistically significant impact of poverty on public health indicators. This could be due to a differential impact of the explanatory variables on poor and nonpoor groups, which are not captured by the aggregated health indicators.[13] Another reason could be the use of the most up-to-date values instead of growth rates for the poverty headcount index, which might further exacerbate measurement errors.

Overall, two conclusions can be drawn from the regression results shown in Table 2. First, despite the lack of data on some control variables, the regressions explain a significant part of the cross-country variation in the change of both public health indicators. Second, telecommunications investment seems to be associated with an improved health status of the population. I now attend to investigating the link between telecommunications and the demand for health-related information, telecommunications infrastructure, and medical facilities.

Telecommunications and the Demand for Health-Related Information and Infrastructure: A Microeconomic Approach

A microlevel study can integrate more realism into the macrolevel analysis presented above. At the same time, it can obtain valuable insights from the individual data that are masked by the aggregate statistics. For this purpose, I use household surveys conducted in rural regions in two emerging market economies: Bangladesh and Laos. Both surveys included rural communities with and without public telephones, where a lack of public telephone service

9. The list of countries included in the regressions is given in the Appendix.
10. Regression disturbances whose variances are not constant across observations are heteroskedastic.
11. I am indebted to an anonymous referee for this observation.
12. These results are available from the author on request.
13. This possibility is not addressed here because of lack of data on disaggregated health indicators for poor and nonpoor groups.

Table 2. Health and Telecommunications: Developing Countries, 1980–2000

	Annual growth rate of life expectancy		Annual growth rate of child mortality rate	
	OLS	2SLS	OLS	2SLS
Annual growth rate of main telephone lines per 100 inhabitants	0.081* (0.043)	0.090* (0.047)	−0.203** (0.092)	−0.202** (0.092)
Annual growth rate of GDP per capita in constant 1995 US$	−0.066 (0.068)	−0.081 (0.074)	0.245 (0.117)	0.276 (0.196)
Annual growth rate of adult illiteracy (% of population 15 years and older)	0.088 (0.063)	0.075 (0.057)	−0.242 (0.225)	−0.293 (0.235)
Annual growth rate of immunization for DPT (% of infants in total population)	0.037*** (0.013)	0.034** (0.016)	−0.070 (0.051)	−0.078 (0.060)
Annual growth rate of urban population (% of population)	−0.265** (0.115)	−0.262* (0.136)	0.978*** (0.284)	1.139*** (0.320)
Poverty headcount (% of population) per most up-to-date observation	0.002 (0.008)	0.007 (0.008)	0.006 (0.021)	0.014 (0.020)
Constant	0.042	−0.124	−3.571**	−4.250**
Adjusted R-squared	0.379	0.367	0.417	0.411
Number of observations	40	35	37	33

*Notes: The annual growth rates are compounded annual growth rates. Davidson/MacKinnon heteroskedasticity-consistent standard errors are shown in parentheses. The instruments used in the 2SLS regressions are the annual growth rates of telephone subscribers per 100 inhabitants, square of GDP per capita, female illiteracy rate, population, dummy variable for African countries, and the Gini index. *** indicates significance at the 1% significance level; ** indicates significance at the 5% significance level; * indicates significance at the 10% significance level.*

was primarily due to a supply constraint. The surveys followed a two-stage stratified random sampling process: (1) selecting the strata, and (2) selecting the households from each stratum. The households were stratified based on the ease of access to telecom services. Access was defined in terms of distance to be travelled to access telecom services.[14]

The surveys gathered detailed information about usage of telephone services by rural households. In addition, the surveys collected information on health expenditures and on socio-economic characteristics of the sampled households. These data on individual- and household-level characteristics offer a unique opportunity to test hypotheses linking ICTs to the demand for information on public health services, as well as to the demand for telecommunications infrastructure and medical facilities.

The main goal of the empirical analysis is to obtain a consistent estimate of β_1 in the context of the following model:

$$INFOij = \beta_0 + \beta_1 HEALTH\_EXP_{ij} + \gamma X_{ij} + \epsilon_{ij} \quad (2)$$

where *INFO* is an indicator of the usage of telephone services to obtain health-related information or of the households' demand for telecommunications and medical infrastructure; *HEALTH_EXP* is the share of medical expenditure in total expenditure as a proxy for the households' demand for health services and medication; *X* is a vector of all other variables that can influence *INFO;* ϵ_{ij} are error terms assumed to be independently and identically distributed over *i* and *j* with mean zero; the subscript *i* refers to households and *j* to provinces.

Medical and Telecommunication Expenditures

Before proceeding to a more rigorous analysis, I present a concise analysis of the share of medical and telecommunication expenditures of total expenditures. This is a relevant piece of information for ICT-related development strategies given the impor-

14. The surveys were conducted by staff members of the Center for Development Research, University of Bonn. Detailed information on these surveys is available from the author on request.

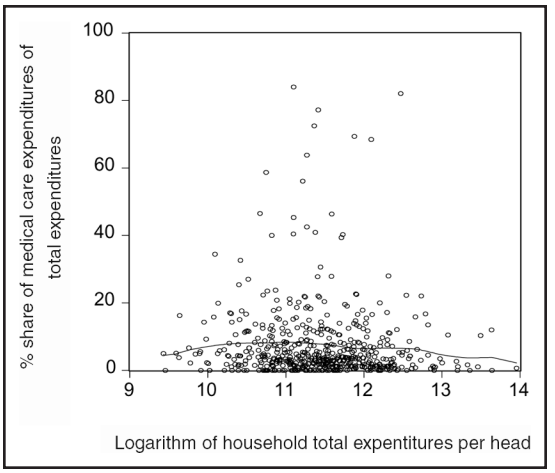

Figure 1a. Percentage share of medical care expenditures of total expenditures—all households.

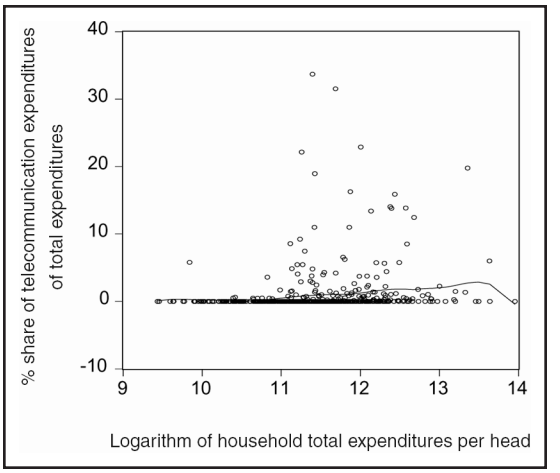

Figure 1b. Percentage share of telecommunication expenditures of total expenditures—all households.

tance that these shares have in explaining the use of the telephone to obtain information on medical care or to explain the households' demand for health-related information and for infrastructure, as will be shown later. I use data from the survey carried out in Laos. Using data from the survey conducted in Bangladesh produces similar results and these are omitted to conserve space. Tables A.1–2 in the Appendix present data on distribution of the medical and telecommunication expenditures by quintiles of total expenditure per head for both countries.[15]

Figures 1a and 1b show the percentage share of medical and telecommunication expenditures in the total as a function of the logarithm of total household expenditures per head, a measure of the overall living standard of the household. The graphs are calculated using nonparametric regressions. The share of medical care expenditures is relatively uniform at lower and middle expenditure levels, and declines for the wealthiest households. This is consistent with empirical studies showing low-income elasticity of demand for medical services (e.g., Andersen and Benham 1970). Figure 1b shows contrasting results for the share of telecommunication expenditure: this share is low for the poorer households and increases significantly at the higher expenditure levels. Telecommunication services can be regarded as "luxury" goods for rural households in Laos in the sense that purchases of these services seem to increase more rapidly than income.

To illustrate this issue further, Figures 2a and 2b show the results of nonparametric regression for the corresponding shares of medical and telecommunication expenditures in the total only for households that use telephones. Again, the share of medical expenditures is higher among poorer households than among better-off households. Overall, the share of medical expenditures for the households that use telephones is lower than for all households, which is to be expected since on average wealthier households are more likely to use telephones. The distribution of the shares of telecommunication expenditures in the total is more volatile. If we abstract from the "outliers" at both tails in Figure 2b, the share of telecommunication expenditures seems to increase at lower expenditure levels and then gradually decrease for relatively rich households. As expected, the share of telecommunication expenditures for the households that use telephones is significantly higher than for all households.

This analysis is only suggestive. The curves in Figures 1 and 2 make no attempt to control for other factors—such as education, wealth, or the public provision of services—that are likely to be positively correlated with both household total expenditures and the outcome, so that the effects of the expendi-

15. One should note, however, that the survey results are not directly comparable between the two countries because of differences in the formulation of the questions on medical and telephone expenditures.

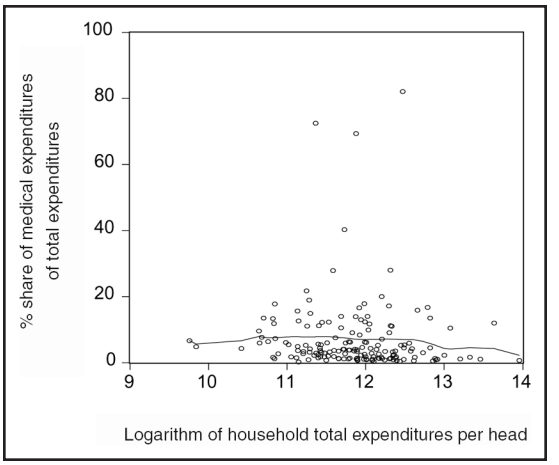

Figure 2a. Percentage share of medical care expenditures of total expenditures—households that use phone.

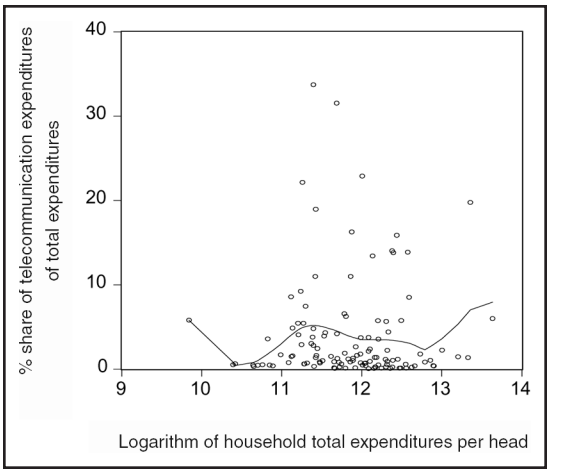

Figure 2b. Percentage share of telecommunication expenditures of total expenditures—households that use phone.

tures are almost certainly overstated. Nevertheless, the graphs illustrate that poorer households spend on average a higher share of their income for health-related purposes than wealthier ones, while wealthier households spend on average a higher share of their income on telephone services. In the analysis that follows, I use the share of health and telephone expenditures as a measure for the relative importance of medical and telephone services for households. The main question to investigate is whether households for which medical services are relatively more important are more likely to use telephones to obtain health-related information. The next important question to examine is what determines the household demand for telecommunications infrastructure and medical facilities.

Evidence from Bangladesh

Bangladesh has been selected as a case study due to the uniqueness it displayed in an innovative program for expanded telecom infrastructure, in which Grameen Bank of Bangladesh, a village-based microfinance organization, leased cellular phones to women in rural areas (for more on this initiative, see Bayes et al. 1999). The survey was conducted during January and February of 2001 in six rural regions. A total of 284 households was surveyed. In this section, the effects of the expanded telecommunications infrastructure on faster provision of information on health services are assessed from the perspective of the buyers of telecom services, that is, the users of the telephones.[16]

The questionnaire on telephone usage contained a question that asked respondents to give examples of ways in which a telephone conversation saved their households valuable time. Seventeen percent of the households that used telephones mentioned health-related calls as a way to save valuable time.[17] I use this variable as a proxy for the usage of the telephone to obtain faster information on health services.

To account for the sample selection bias, I use Heckman's (1979) two-step estimation procedure. In the first stage, I use the whole sample of 282 randomly selected households with nonmissing observations to estimate a probit equation, that is, to estimate the probability of being a telephone user as a function of a number of individual and household characteristics. As expected, the household head be-

16. According to Bayes et al. (1999), during discussions with focus groups and interactions with social workers, it was revealed that one of the greatest benefits brought about by the cellular phones was the capability to call doctors and clinics rapidly.

17. Other choices to answer the question on using the telephone to save valuable time included business- and money-related calls, talking to relatives or friends, emergencies, land transaction, remittances, livestock- and poultry-related calls, getting information on markets (e.g., prices), and on employment opportunities.

Table 3. "Heckit" Estimation for Bangladesh

	Telephone user	Saved time on health info
Age of household head	0.001 (0.008)	
Household head works in agriculture	−0.275 (0.199)	
Household head is literate	1.124*** (0.353)	
Household head is male	−0.619* (0.373)	
Household expenditure per equivalent person[1]	0.011*** (0.003)	
Land owned[1]	1.407*** (0.448)	
Nonland fixed assets[1]	0.002** (0.001)	
Share of health expenditure in the total[2]		1.212*** (0.390)
Share of telephone expenditure in the total[2]		−0.494 (0.465)
Constant		0.115* (0.064)
λ		−1.570** −0.045
Adjusted pseudo R-squared	0.112	
Number of observations	282	81

*Notes: The figures in parentheses are (corrected for selection) standard errors. Coefficients on district dummies are not shown to conserve space. *** indicates significance at the 1% significance level; ** indicates significance at the 5% significance level; * indicates significance at the 10% significance level.*
1. The estimates are multiplied by 1,000.
2. Data were cleaned to remove implausible outliers (exceeding the mean by more than 5 standard deviations).

ing literate, the household expenditure per equivalent person,[18] the land owned, and the value of nonland fixed assets have positive and significant effects on the probability of being a telephone user (Table 3).

In the second stage, I perform regression analysis of the determinants of using telephone for saving time to obtain health information for 81 households that actually used telephones. The independent variables used in the second-stage probit regression were the shares of health and telephone expenditures of total expenditures. As expected, the share of health expenditures—a proxy for the relative importance that the provision of public health services has for different households—is significantly and positively correlated with using the telephone for saving time to obtain health information. This supports the proposition that ICTs can contribute significantly to delivering timely information on health services to households for which this type of information is most important. The next step would be to investigate the determinants of actual demand for telecommunications infrastructure. The survey conducted in Laos contains the necessary information for that purpose.

Evidence from Laos

In recent years the Laotian telecommunications sector has experienced rapid development. Teledensity

18. To account for economies of size, expenditure is calculated per equivalent person using a single-parameter equivalence of 0.5. I also reestimate the model using the household expenditures per head. The estimated coefficient on this variable remains significant and carries the predicted positive sign.

Table 4a. Telecommunications, by Percent

	Telephone in 2001		
	% No access	% Access	Total %
Telephone in 2000			
No access	36.37	52.27	88.64
Access	0.00	11.36	11.36
Total	36.37	63.63	100.0

Table 4b. Hospital, by Percent

	Telephone in 2001		
	% No access	% Access	Total %
Telephone in 2000			
No access	76.00	12.00	88.00
Access	0.00	12.00	12.00
Total	76.00	24.00	100.0

increased from 0.21 lines per 100 population in 1992 to 0.75 lines in 2000.[19] Although these developments were mainly located in the urban provinces, some projects supported development of rural telecommunications.[20] It is interesting to investigate the impact that the intensified introduction of residential telephony may have had on shaping the demand for public infrastructure by the poor living in rural areas.

Measuring dynamic effects of ICT impact requires panel data, that is, data before and after ICT adoption. Yet such data are scarce in developing countries. Fortunately, the survey conducted in Laos contains this kind of data for 60 households.[21] The data reveal a significant increase in the number of calls made for health- or emergency-related information: the share of these calls in the total number of calls increased from 7.7% before to 15% after the additional 60 households obtained access to telephones.

An additional advantage of the survey conducted in Laos is that it included a question on the infrastructure most needed by the households. Telecommunications and a hospital were among the possible choices to answer this question.[22] The respondents' answers on most-needed infrastructure can be used as a proxy for their demand for public goods and services. Moreover, it is possible to determine how this demand has changed after the telephone adoption.

In 2000, only 9 out of 200 interviewed households said telecommunications was the most-needed infrastructure, while 43 said it was a hospital they needed the most. When these 200 households were re-interviewed in 2001—after the number of telephone users increased from 16 to 76—only 25 households named a hospital as the most-needed infrastructure, while the number of those needing telecommunications the most increased to 44 households.

To gauge the importance of these movements in relation to the telephone adoption, I analyze these changes by household structure (Tables 4a and 4b). The panel is divided into households with and without access to a telephone, with the rows being the status of origin in 2000 and the columns being the status of destination in 2001.

The matrices show substantial mobility for the households in the panel. I find that the telecommunications infrastructure had greatest significance for those that obtained access to a telephone in 2001. Fifty-two percent of the households that viewed telecommunications as the most important infrastructure were actually the new telephone users. Surprisingly, telecommunications were also important for the households that remained without telephone access. A possible explanation is that these

19. Despite these developments, teledensity in Laos is still below the average for low-income countries (1.64 lines per 100 population).

20. Since 1992, the German government has supported the expansion of the Laotian telecommunications infrastructure through financial assistance aimed at connecting rural areas in the country by providing adequate telecommunications networks.

21. The survey was first conducted in 2000 and included 606 households. In 2001, 200 households were interviewed again. While in 2000 only 16 out of these 200 households had telephone access, in 2001 the number of households with telephone access increased to 76.

22. The other possible responses included school, safe water, irrigation, agricultural research, agricultural extension service, electricity, access to roads, and public transportation.

Table 5. Multinomial Analysis of Demand for Infrastructure—Marginal Effects

	Telecommunications	Hospital	Other infrastructure
Transition from phone nonuser to phone user	0.1167**	−0.0938	−0.0229
	(0.0575)	(0.0607)	(0.0753)
Share of health expenditure in the total	−0.7106**	0.1061	0.6045*
	(0.3040)	(0.2075)	(0.3282)
Household expenditure per equivalent person[1]	0.0004**	−0.0003	−0.0001
	(0.0002)	(0.0002)	(0.0003)
Land occupied by house	0.0024***	−0.0014**	−0.0009
	(0.0009)	(0.0007)	(0.0010)
Hospital exists in the community	0.1364**	−0.0294	−0.1070
	(0.0566)	(0.0517)	(0.0699)
Constant	−0.4501***	0.0466	0.4035***
McFadden R-squared		0.1151	
Number of observations		96	

*Notes: The figures in parentheses are standard errors. *** indicates significance at the 1% significance level; ** indicates significance at the 5% significance level; * indicates significance at the 10% significance level. 1. The estimates are multiplied by 1,000. Data were cleaned to remove implausible outliers (exceeding the mean by more than 5 standard deviations).*

households had a higher reference norm or that they recognized the benefits to the households that gained telephone access.[23]

In contrast to the need for telecommunications infrastructure, the need for a hospital was greatest among the households that remained without a telephone. A striking 76% of these households named a hospital as the most important infrastructure. The marked asymmetry between these households and the households with telephone access can be attributed to the fact that the households without telephone access were on average poorer and spent a higher share of their income for health-related purposes (Figure 1a and Table A.1).

To try to understand what explains the demand for infrastructure, a multinomial logit analysis was conducted (Table 5). Consistent with Table 4, the results show the importance of the transition from not having to having a telephone in explaining the demand for telecommunications infrastructure. Household expenditures and wealth (proxied by the land occupied by the house) also have a positive and significant effect on the demand for telephony services. Interestingly, household wealth seems to be positively correlated with the demand for telecommunications infrastructure and negatively correlated with the demand for medical facilities. This implies that as households become richer, they tend to view the access to better information as relatively more important for improving their welfare.

The share of health expenditures of total expenditures has a negative effect on the demand for telecommunications infrastructure. Again, this result can be attributed to the fact that the families in the lower quintiles of the distribution spend relatively more for medical purposes and relatively less for communication (Figures 1a and 1b). As their welfare improves, these households will spend a smaller share of their incomes for medical purposes and will demand more adequate telecommunications infrastructure. Additionally, the multinomial analysis below utilizes the presence of a hospital in the community as an indicator of publicly-provided health services. This indicator positively affects the demand for telephony services.

The results of the microlevel analysis presented in this section clearly show the importance of the share of health expenditures in total expenditures—a

23. For more on reference norms see, for example, Easterlin's (1974) pioneering work on the changing nature of norms and aspirations, and Hirschman's (1973) tunnel effect hypothesis.

measure of the relative importance of public healthcare services for different households—in explaining the households' use of telephones to obtain health-related information and in explaining the demand for telecommunications infrastructure. In addition, the transition from not having to having a telephone seems to be important in explaining changes in households' preferences for public infrastructure.

Concluding Remarks

At the beginning of this paper, I posited that complementarities exist between ICTs and public health promotion. The results of the cross-country analysis show that an increase in the stock of telecommunications infrastructure is positively correlated with an improved health status of the population. To integrate more realism into the macrolevel analysis, the paper utilizes household surveys conducted in two emerging market economies: Bangladesh and Laos. Analysis at the household level shows that a basic telephone service offers opportunities to deliver timely information on health services to households with relatively greater demand for this type of information. Telephone access is also associated with an increased demand for telecommunications infrastructure and medical facilities.

While the results of the microlevel analysis need not generalize to other contexts, they seem to suggest that continued investment in provision of rural telecommunications infrastructure is warranted for at least two reasons. First, while there are potential benefits from the introduction of advanced ICTs, such as the Internet and e-mail access (Press et al. 2003), a publicly accessible and reliable basic telephone service is an essential prerequisite. Second, if rural development and health improvement continue to be objectives of development strategies, then the development of telecom services in rural areas appears to be an important factor supporting these objectives, as the study demonstrates.

Despite the vast opportunities, the transfer of ICTs to developing countries remains problematic, with the risk that a large part of the population will be left out of the process. This has led to calls for focused deliberate intervention to complement the role of the market as an engine of technological advancement and economic development (UNDP 2001). However, there are several concerns about the relevance and impact of ICT-based intervention. These include lack of quantitative analyses of the impact and the cost efficiency of ICTs in many areas, including the provision of public goods and services. As a result, best practices in these areas are largely anecdotal. There is thus a need for more rigorous studies to ensure that ICT-based interventions are justified. More specialized and detailed surveys are required to identify the economic and social effects of ICT investment, especially in remote rural areas where access to better information could be of importance. ■

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Appendix

Countries Included in the Life Expectancy Regressions

*indicates the country is also included in the 2SLS regression

Argentina	Ghana*	Mongolia	Paraguay*
Bangladesh*	Guyana*	Malawi	Peru*
Brazil*	Honduras*	Mauritania	Philippines*
Burundi*	Hungary*	Mauritius	Rwanda*
Chile*	India*	Morocco*	Sri Lanka*
Colombia*	Indonesia*	Nepal*	Swaziland*
Costa Rica*	Jamaica*	Nicaragua*	Thailand*
Dominican Republic*	Jordan*	Niger*	Trinidad and Tobago*
Ecuador*	Lesotho*	Pakistan*	Uganda*
Egypt*	Madagascar*	Panama*	Zimbabwe*

Countries Included in the Child Mortality Regressions

*indicates the country is also included in the 2SLS regression

Argentina	Guyana*	Mauritania*	Philippines*
Bangladesh*	Honduras*	Mauritius	Sri Lanka*
Burundi*	Hungary*	Morocco*	Swaziland*
Chile*	India*	Nepal*	Thailand*
Colombia*	Indonesia*	Nicaragua*	Trinidad and Tobago*
Costa Rica*	Jamaica*	Niger*	Uganda*
Dominican Republic*	Jordan*	Pakistan*	Zimbabwe*
Ecuador*	Lesotho	Panama*	
Egypt*	Madagascar*	Paraguay*	
Ghana*	Malawi	Peru*	

Table A.1. Distribution of the Medical and Telecommunication Expenditure by Quintiles of Total Expenditure per Head (monthly): Laos, in Kips

	All households				Households that use phone			
Quintile of total expend. per head	**Total expend. per head in Kips**	**% share of medical expend.**	**% share of telecom expend.**	**% of households**	**Total expend. per head in Kips**	**% share of medical expend.**	**% share of telecom expend.**	**% of households**
I	70,568	7.89	0.61	68.73	101,534	7.05	2.77	61.67
II	174,585	6.16	1.31	24.91	223,340	5.79	2.43	29.44
III	302,628	10.53	2.11	4.00	396,134	4.91	0.61	6.11
IV	419,179	2.48	0.51	1.45	596,278	0.91	7.53	1.67
V	572,195	1.08	4.57	0.91	767,250	6.53	3.00	1.11
Total	122,008	7.40	0.88	100.00	171,045	6.44	2.62	100.00

Notes: The total number of households for which data on total expenditure are available is 550 (after excluding 5 observations for which the value of total expenditure exceeded the mean by more than 5 standard deviations). The number of households that use phone for which data on total expenditure are available is 180 (after excluding 1 observation for which the value of total expenditure exceeded the mean by 5 standard deviations).
Source: "Access to Telecommunications Service in Rural Areas of Lao PDR," Questionnaire 2000, Household Information. *Survey conducted by Center for Development Research, University of Bonn.*

Table A.2. Distribution of the Medical and Telecommunication Expenditure by Quintiles of Total Expenditure per Head (yearly): Bangladesh, in Taka

	All households				Households that use phone			
Quintile of total expend. per head	**Total expend. per head in Taka**	**% share of medical expend.**	**% share of telecom expend.**	**% of households**	**Total expend. per head in Taka**	**% share of medical expend.**	**% share of telecom expend.**	**% of households**
I	9,216	5.17	0.87	75.71	14,907	6.23	4.68	74.41
II	25,900	5.60	3.73	18.93	39,604	1.52	1.84	16.28
III	42,550	8.66	1.68	2.14	76,997	0.57	0.63	5.81
IV	61,838	1.34	3.28	1.79	119,000	0.70	0.00	1.16
V	84,300	1.55	0.15	1.43	137,501	4.38	5.27	2.33
Total	15,101	5.21	1.46	100.00	26,599	5.03	3.94	100.00

Notes: The total number of households for which data on total expenditure are available is 280 (after excluding 4 observations for which the value of total expenditure exceeded the mean by more than 5 standard deviations). The number of households that use phone for which data on total expenditure are available is 86.

Source: "Information, Communication and Poverty Reduction," *Questionnaire #1, 2001. Survey conducted by Center for Development Research, University of Bonn.*