IIMB Management Review (2011) 23, 15–29

available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/iimb

IIMB Management Review

The digital divide in rural South Asia: Survey evidence from Bangladesh, Nepal and Sri Lanka☆

Yan Zhou [a], Nirvikar Singh [b,*], P.D. Kaushik [c]

[a] California State University, Sacramento, USA
[b] Economics Department, E2 Building, University of California, Santa Cruz, CA 95064, USA
[c] Rajiv Gandhi Institute of Contemporary Studies, New Delhi, India

KEYWORDS
Digital divide;
South Asia;
Rural Internet;
Multinomial logit

Abstract This paper examines bridging the digital divide through organisational innovations that provide low cost Internet access in developing countries, within the existing conditions of income levels. We use survey data from three South Asian countries, Bangladesh, Nepal and Sri Lanka, to examine factors influencing patterns of computer and Internet use. We find that education plays a key role, in terms of its acquisition as a reason for computer and Internet use, and as an enabling variable (especially in the case of English language knowledge).

Introduction

The concept of a 'global digital divide' — unequal access to digital information and communication technologies — is well established. Many cross-country studies of determinants of differences in computer and Internet penetration have been undertaken, attempting to understand what factors shape this aspect of global inequality. For example, in a very recent, comprehensive study, Chinn and Fairlie (2006) examine a data set of 161 countries over the period 1999–2001, and find that a large portion of the global digital divide (measured by levels of computer and Internet penetration) is explained above all by income per capita, with telephone density and regulatory quality following in importance as explanatory factors. This ranking of causal factors, in addition to the use of a more current and broader data set distinguishes the Chinn-Fairlie study from previous analyses, but the main conclusions from all these studies are relatively unsurprising, and the policy implications quite blunt (i.e., get richer, have more telephones, and regulate telecommunications better).

An alternative policy approach to tackling the digital divide is to examine organisational innovations that seek to provide low cost Internet access in developing countries. Thus, rather than waiting for macroeconomic shifts in policy variables, the attempt in these cases is to overcome the digital divide within existing conditions of income per capita, telecommunications infrastructure and regulatory environment. In such cases, it is crucial to understand the factors

☆ We thank the NET Institute (www.NETinst.org) and the Research Administration at California State University, Sacramento for financial support. We are also indebted to Kristen Williams and Jake Kendall for significant contributions to this research project. This paper replaces earlier work with the title "Network Economics and the Digital Divide in Rural South Asia."

* Corresponding author. Tel.: +1 831 459 4093; fax: +1 831 459 5077.
E-mail address: boxjenk@ucsc.edu (N. Singh).

0970-3896
doi:10.1016/j.iimb.2010.12.002

Production and hosting by Elsevier

that affect choices with respect to using computers and the Internet, at the level of individual households.[1] Such an analysis gives a more fine grained perspective on the factors that can influence the digital divide, beyond obvious ones such as income levels. The aim is to generate policy recommendations that are achievable within the existing macro environment and without massive infrastructure investments which may prove unsustainable ex-post.

This research uses survey data from 500 individuals across three different South Asian countries (locations in Bangladesh, Nepal and Sri Lanka) to analyse the household-level determinants of computer and Internet use, in situations where access has been provided by a developmental agency (government or non-government).[2] We have data on characteristics such as income, household size, education, and occupation, as well as infrastructure factors such as quality of electricity supply, and availability of telephones and televisions. We also have data on motivations for the use of computers and the Internet, including educational, commercial and governmental purposes. Thus we are able to go beyond analyses of penetration at the country level, to understand the microeconomics of computer and Internet use in rural South Asia.

The paper is organised as follows. In the second section we provide some further discussion of our work and its contribution to the literature. The third section describes the data, including variables available, and summary statistics, as well as the econometric techniques used. We use logit and multinomial logit estimations to try and understand the behavioural factors that may influence computer and Internet use, as well as patterns of use, in terms of broad categories of purposes. The fourth section presents the results of our econometric analysis. Most significantly, we find that at the micro level, in such situations of potential local access, higher incomes are not positively associated with computer and Internet use, but education and some degree of English fluency are important positive factors. The results on factors affecting usage patterns are less clear cut, and less uniform across the three sample regions. In general, we should note that the use of cross-section data from specific locations places limitations on causal interpretations of the results: nevertheless, the patterns identified here should be of interest. The fifth section is a summary conclusion, also outlining limitations of the results and suggestions for future research.

Motivation and literature

This paper addresses a gap in the literature on the global digital divide,[3] by providing a microeconometric analysis of the factors affecting computer and Internet use in the rural areas of developing countries, where the majority of the world's population still lives. The research also contributes to the debate on the role of IT in development, which has been hampered by the absence of formal econometric studies that provide quantitative estimates of the micro-economic impacts and determinants of IT use in the development context.[4] The last two decades have seen the emergence of information technology (IT) as a major force for change in developed countries. While the virtues of IT have sometimes been overblown, one can reasonably argue that IT has begun to have a significant impact on the lives of people in developed, industrialised countries. The potential benefits of IT for developing countries are less clear cut. IT can improve efficiency, make developing country firms more globally competitive, and bring many benefits to well-off consumers — whose consumption patterns are close to those of the developed world — in these countries. From this perspective, IT is of limited relevance to the poor in developing countries, lacking basic health, sanitation and education. On the other hand, there have been numerous attempts to harness the power of IT in developing countries, to try to improve the delivery of such basic services, as well as provide other services that might have been otherwise inaccessible to poor, isolated villagers. Many case studies, newspaper articles and web sites describe various achievements in the use of IT to improve the lives of the poor in poor countries. While we do not have data to directly measure impacts, we can document the extent and patterns of use.

We can also directly gain insights into the behaviour of rural computer and Internet users in developing countries, a group whose choices have not previously been analysed through formal econometric techniques. These results can have wider implications for understanding the future spread of e-commerce, and also the overcoming of the global digital divide. By examining the motivations for using computers and the Internet in these cases, we expect to improve our understanding of demand side barriers to use. For example, if rural Internet users mainly seek information about global market conditions for their crops, individual adoption does not require other local adopters. On the other hand, if the Internet is used for local communication, commercial transactions, and government services, it will be critical that a sufficient number of other local residents are also users. Recent theoretical research (e.g., Ryan & Tucker, 2006) shows that in an environment where agents are heterogeneous and have diverse needs driving demand for ICT services, welfare can be improved by strategically targeting the right subgroup to stimulate adoption. Our work complements this work by measuring the heterogeneity of consumers and their demand needs.

As noted in the introduction, the Chinn and Fairlie (2006) study is the most up-to-date and comprehensive with respect to global digital divide issues. In addition to the variables mentioned, i.e., income per capita, telephone density and regulatory quality, per capita electricity consumption matters up to a threshold level, while human

[1] Some factors affecting supply and the conditions necessary for successful delivery of ICT services by rural Indian entrepreneurs are explored in Kendall and Singh (2010).

[2] Reports on related fieldwork in India include Kaushik and Singh (2004), Singh (2004, 2008a, 2008b), which also provide more detailed references to the literature on IT and rural development. Other important field studies include Best and Kumar (2008) and Goyal (2010), but the literature is vast.

[3] See Chinn and Fairlie (2006) for comprehensive references to the literature.

[4] Microeconomic studies in the context of developed country firms include Brynjolfsson and Hitt (2003) and Bresnahan, Brynjolfsson, and Hitt (2002).

Table 1 Computer and media usage patterns — data overview.

Initiative	Sample Size	Computer Users (%)	Internet Users (%)	TV Owners (%)	Newspaper Readers (%)	Telephone Owners (%)
VCIP (Bangladesh)	200	73	48	26	89.5	33.5
Indreni (Nepal)	100	71	63	76	60	36
e-srilanka (Sri Lanka)	200	62.5	62.5	85.4	38	32.5

capital variables have the right sign but are statistically insignificant. Somewhat surprisingly, they find that urbanisation rates have a negative impact on Internet penetration, which seems to be counter-intuitive (but see below). Chinn and Fairlie survey and critique many previous cross-country studies on the digital divide, and the reader is referred to those.

One study, by Dewan, Ganley, and Kraemer (2004) (not referenced by Chinn and Fairlie), provides a further dimension of analysis. They use quantile regressions to examine how the impact of individual socioeconomic factors varies with the level of IT penetration.[5] Using this technique, they find that not only is the level of IT penetration increasing in GDP per capita, but the influence of this factor is stronger in countries with higher IT penetration. For mainframes and PCs, telephone lines per capita, years of schooling, and trade in goods are found to have had similar but stronger effects in developed countries than in developing countries. On the other hand, for Internet users, telephone costs, years of schooling and trade in goods have a stronger impact in countries at lower penetration levels, even controlling for wealth differences. This study therefore suggests that the factors influencing the digital divide are quite nuanced, and not fully captured by standard cross-country regressions. Dewan et al. also find a negative impact of urbanisation on IT penetration, and suggest that other means of communication substitute for IT in urban environments. Note that this result is obtained, as is that of Chinn and Fairlie, controlling for differences in infrastructure and incomes. However, the substitution argument may not be completely compelling.

Data and empirical methods

Data

The data was collected in field surveys supervised and conducted by one of the authors (P.D. Kaushik). All samples were collected randomly in computer kiosks in rural areas of Bangladesh, Nepal and Sri Lanka, where a governmental agency or NGO provided computer and Internet access to the surrounding population. All the kiosks selected were not dealing with a single service, i.e. enabled services only, but these kiosks were also retail outlets for consumer goods or computer education, or career courses centre, or hardware shop, etc. Field investigators comprised mainly volunteer students, both male and female. Since all the selected kiosks were located in/near the main market place, the respondents were randomly selected from the people in the market place. The sample was collected at different times, during two time periods, 8 am—12 noon and 4—8 pm in each of the places. No other strict selection criterion was used for the selection of respondents.

Residents of each survey region were asked a detailed series of questions pertaining to patterns of Internet and Communications Technology (ICT) usage, individual socio-economic characteristics, and economic activities engaged in. The computer and media usage patterns of respondents are described in Table 1, which presents sample sizes and some summary statistics. It can be seen from Table 1 that each sample location has a fairly high proportion of computer and Internet users, which reflects the accessibility of the kiosks. This reflects the presence of Internet kiosks in the sampled locations, and therefore these proportions are not reflective of the overall availability or usage proportions of IT in the three countries.[6]

The sample in each country has fairly high ownership of televisions and telephones, especially in Nepal and Sri Lanka, but the proportions are not out of line with national averages (e.g., Agüero and de Silva, 2008; Sivapragasam, 2008). Individuals in the sample also rely to a considerable extent on newspapers for information, though the proportion is lowest for the highest income country in the sample, Sri Lanka. The picture is one of relatively active media consumers who might have many different reasons for recourse to the Internet.

Table 2 provides summary data on the initiatives that supported Internet access in each location. This consists of a mix of government and non-governmental organisations. Examples of services provided include e-mail, basic computer training, word-processing and printing services, access to information on the Internet, as well as locally-oriented databases on agriculture, jobs and the like, and information about government and NGO programmes relevant for villagers. Specialised content was often available in the local language, having been created for that location, but standard applications and Internet content were typically in English. While the Bangladesh site was 100 miles from Dhaka, the nearest major city, the other two sites were in districts with the national capitals, despite being outside the cities, in more rural locations.

In addition to information about usage and patterns, we have collected data on various individual or household characteristics. The main variables are summarised in Table 3. More detailed descriptions of the data are in the Appendix.

[5] They also examine IT penetration more broadly than simply Internet penetration.

[6] If the choice of location of these kiosks was itself influenced by demographic or other characteristics of the areas, then there could be a sample selection effect, which we are not able to test for without additional data.

Table 2 Overview of sample initiatives supporting internet access.[a]

Initiative	Organisational Basis	Number of Centres	Location
VCIP	Civil Society — Grameen Communications	1	Tangail District
Indreni	Civil Society — Nepal Internet Users Group	10	Kathmandu District
e-srilanka	Government of Sri Lanka and Private Sector (ICTA)	6	Colombo District

[a] For examples of discussions of these initiatives, see Islam (2006), Upadhaya (1999) and Gamage and Halpin (2007).

Empirical methods

The empirical analysis proceeds by using logit and multinomial logit regressions to analyse the choice to use computers, the choice to use the Internet, and the choice between various categories of Internet activity/service. We analyse each location separately, in order to allow for different local effects and the possibility of different structural relationships in each area. This permits us to make comparisons across locations to isolate similarities and differences in the factors that affect computer and Internet use on the demand side.

We perform logit analysis for each of the binary decisions: whether to use a computer or not, and (of computer users) whether to use the Internet or not. For computer and Internet users, we also estimate multinomial logit specifications, taking into account four possible categories of use (see Table 3) to determine what factors drive individuals' Internet needs.

Unfortunately the dummy variables in various categories are not perfectly comparable across survey sites. This was in most cases due to lack of responses in certain categories and multicollinearity concerns (e.g., when no respondents indicated having income greater than a certain level, the high income dummy had to be redefined with a lower cutoff for that site). The variable definitions for all sites and regressions were constructed to be as comparable as possible given these constraints. The exact definitions are given in the Appendix.

Non-response weights were used in the regression processes in order to take into account the fact that the majority of the respondents were male. We also looked at other individual characteristics that are likely to be related to the propensity to respond, such as education and income. It turns out that the distributions of these variables in the sample are very close to that in the general population.

Table 3 Main variables — individual and household characteristics.

Dependent Variables	Independent Variables
Use computer or not	Sex
Purpose of using computer	Marital status
Educational	Age
Commercial	Education
Personal	Main occupation
Government-related	Income level
Use Internet or not	Sale or own consumption
Purpose of using Internet	Electricity supply quality
Educational	Household income
Commercial	Newspaper readership
Personal	TV ownership
Government-related	Telephone ownership

Results

Our main discussion of the results will focus on individual regressions for the three countries/locations, including contrasts across the three samples. However, at the end of this section, we briefly discuss results from pooling the three samples.

Computer usage

Tables 4A and 4B show results of logit regressions for the determinants of computer usage at the three survey sites for all the respondents and for male respondents only, respectively. The reason that we look at the male respondents in particular is because the majority of the respondents are male and we want to see how much the male population may differ from the general population. The survey methodology and questions were the same across sites. Education and income categories are ordered in the same manner across regressions and the omitted dummy in the cases of education and income is the lowest level in the category.

Though the results are not uniform across sites, some patterns do emerge. Higher levels of education are associated with higher computer use, though this coefficient is not always significant. Reading an English language newspaper has a significantly positive effect on the decision to use a computer for the male population. This is probably an indicator of the need for some English language fluency to obtain many of the benefits of computer usage.

The data may also lend support to the notion that consumers with high desire for other media and communication services perceive the Internet as a complementary good. Telephone ownership has a positive and significant impact on computer use in Bangladesh and Sri Lanka, though it is insignificant (statistically as well as in economic magnitude) in Nepal. Most likely, telephones and the Internet are both used by relatively more sophisticated individuals who have greater communication needs.

Not surprisingly, the quality of the electricity connection has a positive impact on the likelihood of computer usage and its impact is significant in Sri Lanka. In other fieldwork (Singh, 2004), the lack of reliable power was cited as a constraint on Internet use in rural kiosks, and battery back-ups added to expense while providing limited extensions of time of availability. In the case of ITC e-choupals, analysed by Goyal (2010), ITC, as a large corporation,

Table 4A Computer use — logit marginal effects.

RHS Variable (std. error)	Bangladesh dy/dx	Nepal dy/dx	Sri Lanka dy/dx
Gender	0.097 (0.116)	0.007 (0.138)	0.033 (0.136)
Age	0.008 (0.008)	0.007 (0.006)	−0.019 (0.013)
Education 1	0.093 (0.118)	0.219 (0.145)	0.263** (0.112)
Education 2	−0.003 (0.130)	0.346** (0.139)	0.383*** (0.094)
Income 1	−0.775*** (0.086)	−0.015 (0.160)	0.051 (0.124)
English Newspaper	0.125 (0.085)	0.292** (0.131)	0.115 (0.160)
Electricity Connection	0.244 (0.215)	0.132 (0.162)	0.413** (0.173)
Own Telephone	0.241*** (0.091)	0.075 (0.161)	0.493*** (0.094)
Own Television	0.342*** (0.081)	0.369** (0.170)	−0.207 (0.128)
Observations	200	100	199

Notes: Standard errors in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
Lowest category is omitted when applicable (i.e. no education, low income).

provided robust power back-up as well as satellite-based Internet connectivity to kiosk operators.

In other cases, there are more striking differences across the three locations surveyed. The results for income are also somewhat different. Income has a small positive marginal effect for Sri Lanka, no significant effect for Nepal, and a negative and significant coefficient for Bangladesh. It is possible that the particulars of the Bangladesh location, either in terms of income distribution, or targeting of the services by the provider, are what is leading to this result. This result is suggestive of the possibility that targeted interventions to provide IT access can be successful in combating the digital divide.

Interestingly, television ownership has a negative effect on the use of computers in Sri Lanka, in contrast to the positive and significant coefficients for the other two sites. Kendall and Singh (2010) find that games are among the most frequently listed Internet uses reported by kiosk owners in rural India. Many households in the Sri Lanka sample may see Internet-based entertainment as a substitute for TV ownership given a binding budget, or alternatively, time constraint. The contrast between Bangladesh and Sri Lanka with respect to this variable certainly points to the importance of local factors in understanding patterns of use for information technology. Finally, in none of the regressions did we find occupational variables to be significant determinants of likelihood of computer usage. Nor did we find gender to be a significant explanatory variable, although the samples themselves are skewed towards males.

Internet usage

Tables 5A and 5B present results of the Internet usage logit regressions for the whole sample and for male respondents only, respectively. The results are quite similar across the three sites.

The results are very similar to those for computer use, which partly reflects the fact that the choice is framed between using the Internet and not for the whole sample, rather than being restricted to computer users. Nevertheless, these results provide additional evidence on factors affecting usage, as well as a check on the robustness of the previous results. Unsurprisingly, being less educated seems to indicate lower recourse for accessing the Internet; the parameters on these variables are significant in all three regressions.

The conclusions drawn from the Internet usage regressions are similar to those of the computer usage regressions. We find that 'user sophistication' as measured by media and communication consumption as well as education seems to be complementary with Internet use with the exception of television ownership, possibly due to a budget

Table 4B Computer use for males — logit marginal effects.

RHS Variable (std. error)	Bangladesh dy/dx	Nepal dy/dx	Sri Lanka dy/dx
Age	−0.002 (0.004)	0.001 (0.005)	−0.010 (0.008)
Education 1	0.048 (0.064)	0.129 (0.117)	−0.005 (0.096)
Education 2	0.107 (0.066)	0.320*** (0.121)	0.064 (0.107)
Income 1	−0.433*** (0.094)	0.032 (0.097)	0.142* (0.084)
English Newspaper	0.169*** (0.048)	0.314*** (0.090)	0.224* (0.127)
Electricity Connection	0.052 (0.118)	0.175 (0.131)	0.275 (0.274)
Own Telephone	0.178*** (0.060)	−0.101 (0.131)	0.367*** (0.075)
Own Television	0.296*** (0.064)	0.139 (0.140)	−0.213*** (0.078)
Observations	200	100	199

Notes: Standard errors in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
Lowest category is omitted when applicable (i.e. no education, low income).

Table 5A Internet use — logit marginal effects.

RHS Variable (std. error)	Bangladesh dy/dx	Nepal dy/dx	Sri Lanka dy/dx
Gender	−0.408*** (0.121)	0.183 (0.160)	0.026 (0.134)
Age	0.009 (0.010)	−0.011 (0.009)	−0.019 (0.014)
Education 1	0.263** (0.130)	0.049 (0.265)	0.260** (0.110)
Education 2	0.163 (0.152)	0.491*** (0.187)	0.399*** (0.090)
Income 1	−0.869*** (0.053)	0.073 (0.215)	0.067 (0.120)
Occupation 1	0.063 (0.172)	−0.405** (0.166)	0.012 (0.125)
Electricity Connection	0.016 (0.218)	0.107 (0.183)	0.409** (0.171)
Own Television	0.194 (0.196)	0.412** (0.174)	−0.198 (0.134)
Own Telephone	0.250** (0.121)	0.250 (0.153)	0.498*** (0.093)
Observations	200	100	199

Notes: Standard errors in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
Lowest category is omitted when applicable (i.e. no education, low income).

or time constraint. Interestingly, income plays almost no role in Internet or computer usage in Nepal and is negative and significant in Bangladesh. This is may reflect the fact that Internet usage is being subsidised at the sample sites by government or NGO support: major costs are often fixed costs of infrastructure (which are subsidised), and marginal costs of use are relatively low, the latter being reflected in the pricing of services offered in such circumstances.

Purposes of computer use

The regressions in Tables 6A and 6B are performed on subsamples of computer users, and the multinomial logit specifications seek to identify how particular characteristics affect the relative likelihood of different choices. As before, Table 6B is for male population only. Thus, the coefficients for any explanatory variable sum to zero across the four choices, which are educational, commercial, personal and other uses. Personal use includes general browsing, communication, and so on, while 'other' includes government-related activities, such as filling out application forms.

The final specifications vary considerably across the three countries, but several interesting observations are possible. Educational use is the most frequently reported reason for both computer and Internet use, comprising from 32% of computer users in Bangladesh to 51% of users in Nepal. This use of the Internet is clearly an important one and correlates with evidence of pursuing education on other margins. High income in Bangladesh seems to be associated with less educational use of the Internet, possibly reflecting a working population who are no longer pursuing education. In fact, income is almost always significantly negatively associated across all the four purposes of computer use in Bangladesh, reflecting the aggregate pattern observed in Tables 4A and 4B.

English newspaper readership has a significantly positive effect on educational use in Nepal and Sri Lanka and a positive though insignificant effect in Bangladesh among males. Television ownership has a significantly negative effect on educational use in Bangladesh but a significantly positive effect in Nepal and Sri Lanka. Telephone ownership has a significantly positive effect on educational use only in Sri Lanka.

The age variable is positively and significantly related to using computers for commercial purposes in both Bangladesh and Nepal, possibly reflecting higher rates of business ownership at the later stages of life. English

Table 5B Internet use for males — logit marginal effects.

RHS Variable (std. error)	Bangladesh dy/dx	Nepal dy/dx	Sri Lanka dy/dx
Age	0.003 (0.009)	−0.006 (0.006)	−0.011 (0.008)
Education 1	0.251* (0.134)	0.221 (0.169)	−0.005 (0.096)
Education 2	0.266* (0.155)	0.391** (0.149)	0.082 (0.108)
Income 1	−0.645*** (0.078)	0.178 (0.125)	0.161* (0.086)
Occupation 1	0.095 (0.146)	−0.413*** (0.137)	0.068 (0.087)
Electricity Connection	−0.018 (0.197)	0.260 (0.160)	0.315 (0.277)
Own Television	−0.017 (0.174)	0.190 (0.158)	−0.204** (0.085)
Own Telephone	0.224** (0.112)	0.038 (0.147)	0.412*** (0.073)
Observations	200	100	199

Notes: Standard errors in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
Lowest category is omitted when applicable (i.e. no education, low income).

Table 6A Purposes of computer use — multinomial logit marginal effects (dy/dx).

RHS Variable	Bangladesh				Nepal				Sri Lanka			
	Education	Commerce	Personal	Other	Education	Commerce	Personal	Other	Education	Commerce	Personal	Other
Age	−0.029**	0.030*	−0.001	−0.000	−0.028**	0.031**	−0.003	0.000	0.005	−0.008	−0.002	0.005
	(0.014)	(0.015)	(0.005)	(0.000)	(0.014)	(0.013)	(0.005)	(0.000)	(0.015)	(0.013)	(0.007)	(0.008)
Education 1	0.543**	−0.639***	0.097	0.000	−0.447*	0.451*	−0.004	−0.000	0.256	−0.066	0.008	−0.198**
	(0.213)	(0.184)	(0.085)	(0.000)	(0.231)	(0.229)	(0.007)	(0.000)	(0.157)	(0.159)	(0.079)	(0.087)
Education 2	0.670***	−0.670***	−0.000	−0.000	−0.072	0.085	−0.013	0.000*	0.421***	−0.246	−0.017	−0.158*
	(0.163)	(0.173)	(0.063)	(0.000)	(0.243)	(0.240)	(0.017)	(0.000)	(0.137)	(0.154)	(0.067)	(0.083)
Income 1	−0.263***	−0.659***	−0.062*	0.984***	−0.258	0.261	−0.004	−0.000	−0.163	0.036	0.021	0.105
	(0.098)	(0.099)	(0.032)	(0.057)	(0.195)	(0.196)	(0.011)	(0.000)	(0.150)	(0.137)	(0.055)	(0.070)
English Newspaper	−0.002	−0.353**	0.355**	−0.000	0.180 (0.167)	−0.171	−0.009	−0.000	0.526***	−0.356***	−0.025	−0.145**
	(0.193)	(0.169)	(0.139)	(0.000)		(0.167)	(0.016)	(0.000)	(0.107)	(0.094)	(0.061)	(0.059)
Own Television	−0.590***	0.709***	−0.119**	−0.000	0.611***	−0.614***	0.003	0.000*	0.471***	−0.636***	0.024	0.141***
	(0.113)	(0.112)	(0.054)	(0.000)	(0.146)	(0.147)	(0.006)	(0.000)	(0.094)	(0.120)	(0.075)	(0.048)
Own Telephone	−0.196	0.283	−0.087	−0.000	−0.066	0.045	0.021	0.000	−0.116	0.071	0.058	−0.014
	(0.210)	(0.221)	(0.063)	(0.000)	(0.214)	(0.217)	(0.043)	(0.000)	(0.169)	(0.181)	(0.065)	(0.085)
Observations		146				71				124		

Notes: Standard errors in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Lowest category is omitted when applicable (i.e. no education, low income).

Table 6B Purposes of computer use for males — multinomial logit marginal effects (dy/dx).

RHS Variable	Bangladesh				Nepal				Sri Lanka			
	Education	Commerce	Personal	Other	Education	Commerce	Personal	Other	Education	Commerce	Personal	Other
Age	−0.011	0.032***	−0.022	−0.000	0.004	0.016**	−0.020	0.000	0.012	0.001	−0.011	−0.002
	(0.013)	(0.012)	(0.015)	(0.000)	(0.017)	(0.007)	(0.016)	(0.000)	(0.012)	(0.011)	(0.007)	(0.010)
Education 1	0.075	−0.075	0.000	0.000	−0.068	0.187	−0.119	−0.000	0.121	−0.021	−0.028	−0.073
	(0.167)	(0.144)	(0.135)	(0.000)	(0.200)	(0.198)	(0.102)	(0.000)	(0.165)	(0.137)	(0.073)	(0.110)
Education 2	0.240	−0.100	−0.140	0.000	0.363**	−0.212	−0.151	0.000	0.124	−0.031	−0.044	−0.049
	(0.158)	(0.158)	(0.134)	(0.000)	(0.161)	(0.183)	(0.141)	(0.000)	(0.164)	(0.142)	(0.081)	(0.095)
Income 1	−0.410***	−0.472***	−0.081	0.964***	−0.018	0.060	−0.042	−0.000	0.026	−0.004	−0.014	−0.009
	(0.083)	(0.090)	(0.060)	(0.075)	(0.141)	(0.102)	(0.082)	(0.000)	(0.120)	(0.105)	(0.076)	(0.100)
English Newspaper	0.134	0.027	−0.161	−0.000	0.324**	−0.295**	−0.028	0.000	0.469***	−0.255***	−0.040	−0.173**
	(0.147)	(0.133)	(0.135)	(0.000)	(0.141)	(0.147)	(0.052)	(0.000)	(0.111)	(0.085)	(0.064)	(0.079)
Own Television	−0.331**	0.567***	−0.236*	−0.000	0.483*	−0.519**	0.036	0.000	0.383***	−0.587***	0.052	0.152
	(0.154)	(0.213)	(0.126)	(0.000)	(0.253)	(0.250)	(0.049)	(0.000)	(0.126)	(0.134)	(0.067)	(0.094)
Own Telephone	0.016	−0.075	0.059	0.000	0.177	−0.244	0.067	0.000	0.420***	−0.272**	−0.191**	0.042
	(0.114)	(0.111)	(0.106)	(0.000)	(0.213)	(0.180)	(0.115)	(0.000)	(0.124)	(0.128)	(0.078)	(0.082)
Observations		149				75				134		

Notes: Standard errors in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Lowest category is omitted when applicable (i.e. no education, low income).

Table 7A Purposes of Internet Use — Multinomial Logit Marginal Effects (dy/dx).

RHS Variable	Bangladesh				Nepal				Sri Lanka			
	Education	Commerce	Personal	Government	Education	Commerce	Personal	Government	Education	Commerce	Personal	Government
Age	0.015	−0.023**	0.006	0.001	−0.004	0.006	−0.002	0.000	−0.034**	0.002	0.008	0.023**
	(0.012)	(0.011)	(0.005)	(0.003)	(0.012)	(0.012)	(0.003)	(0.000)	(0.015)	(0.009)	(0.006)	(0.011)
Education 2	0.176	−0.159*	−0.097*	0.080	0.060	−0.270	−0.015	0.225**	−0.019	−0.129	−0.021	0.168
	(0.124)	(0.090)	(0.057)	(0.067)	(0.253)	(0.246)	(0.031)	(0.091)	(0.136)	(0.082)	(0.056)	(0.132)
Income 1	−0.585***	0.731***	−0.158***	0.012	−0.248	0.269*	−0.021	−0.000	0.095	−0.209**	0.017	0.097
	(0.159)	(0.172)	(0.056)	(0.072)	(0.163)	(0.151)	(0.044)	(0.000)	(0.149)	(0.104)	(0.058)	(0.110)
English Newspaper	0.154	−0.120	−0.066	0.031	0.112	−0.109	−0.002	−0.000	0.378***	0.013	−0.041	−0.350***
	(0.147)	(0.086)	(0.055)	(0.066)	(0.165)	(0.165)	(0.015)	(0.000)	(0.124)	(0.099)	(0.055)	(0.087)
Own Television	0.274**	−0.189**	−0.066	−0.018	0.968***	−0.977***	0.009	0.000	−0.251	−0.053	0.083*	0.221***
	(0.138)	(0.078)	(0.054)	(0.047)	(0.026)	(0.019)	(0.015)	(0.000)	(0.153)	(0.115)	(0.043)	(0.080)
Own Telephone	0.004	−0.178*	0.154	0.020	0.239	−0.240	0.001	0.000	0.285**	−0.185**	0.002	−0.102
	(0.164)	(0.105)	(0.105)	(0.051)	(0.197)	(0.197)	(0.014)	(0.000)	(0.137)	(0.086)	(0.051)	(0.114)
Observations		96				63				124		

Notes: Standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Lowest category is omitted when applicable (i.e. no education, low income).

Table 7B Purposes of Internet Use for Males — Multinomial Logit Marginal Effects (dy/dx).

RHS Variable	Bangladesh				Nepal				Sri Lanka			
	Education	Commerce	Personal	Government	Education	Commerce	Personal	Government	Education	Commerce	Personal	Government
Age	0.006	−0.003	0.000	−0.003	−0.002	0.003	−0.001	0.000	−0.012	0.000 (0.011)	0.004	0.007
	(0.013)	(0.012)	(0.000)	(0.006)	(0.003)	(0.004)	(0.001)	(0.000)	(0.011)		(0.007)	(0.009)
Education 2	−0.006	−0.206*	−0.001	0.213**	0.174	−0.337	−0.002	0.166	0.052	−0.056 (0.083)	−0.074	0.079
	(0.129)	(0.118)	(0.001)	(0.095)	(0.150)	(0.257)	(0.008)	(0.116)	(0.111)		(0.070)	(0.088)
Income 1	−0.162	0.522**	−0.254***	−0.107*	−0.051	0.060	−0.010	−0.000	−0.023	−0.087 (0.089)	0.024	0.086
	(0.240)	(0.249)	(0.064)	(0.054)	(0.073)	(0.082)	(0.018)	(0.000)	(0.109)		(0.075)	(0.085)
English Newspaper	0.178	−0.151	0.001	−0.028	0.145	−0.146	0.001	0.000	0.283**	0.040 (0.118)	−0.073	−0.251***
	(0.168)	(0.165)	(0.001)	(0.061)	(0.152)	(0.157)	(0.010)	(0.000)	(0.128)		(0.074)	(0.066)
Own Television	−0.095	−0.428***	0.000	0.523*	0.833***	−0.896***	0.063	0.000	0.101	−0.318** (0.146)	0.125*	0.091
	(0.280)	(0.148)	(0.001)	(0.282)	(0.080)	(0.062)	(0.056)	(0.000)	(0.142)		(0.068)	(0.089)
Own Telephone	0.010	−0.132	−0.000	0.122	0.129	−0.142	0.014	0.000	0.038	−0.068 (0.083)	0.037 (0.084)	−0.007
	(0.137)	(0.138)	(0.001)	(0.090)	(0.129)	(0.140)	(0.024)	(0.000)	(0.114)			(0.085)
Observations		99				68				134		

Notes: Standard errors in parentheses; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Lowest category is omitted when applicable (i.e. no education, low income).

newspaper readership as well as television ownership are both negatively associated with using computers for commercial activity, though not always significant. In the case of Nepal and Sri Lanka, however, English newspaper readership is significantly and negatively associated with commercial computer use.

In Bangladesh income is negatively associated with commercial use of computers. The results for Sri Lanka and Nepal may pick up an income effect from ownership of television, though why income would be negatively associated with using the computer for commercial purposes is not clear. One possibility is that higher income individuals are employed and it is lower income farmers or small business people who use computers more for commercial purposes such as document preparation or information gathering.

The variation in the signs and significance across the different locations may seem puzzling at first sight. However, one can also take the view that heterogeneity across countries and across local implementations can have significant effects on patterns of computer usage. Results such as ours can then be taken as providing a cautionary perspective on over-generalising at the international level, even for countries in a specific region.

Purposes of Internet use

Tables 7A and 7B present the results of multinomial logit estimations which regress the various purposes for which the Internet was accessed against individual and household characteristics. Again, Table 7A presents the results for the whole sample and Table 7B presents those for the male respondents only. In the Tables A.1—3 we have reported summary statistics including the relative frequency of Internet vs. computer use. Clearly most computer users also use computers to connect to the Internet with the percentage of computer users who also used the Internet at 66% for Bangladesh, 88% for Nepal, and reaching 100% of the sample in Sri Lanka.

Potentially due to the smaller sample sizes for Internet users, as well as the greater problems of convergence in a multinomial logit estimation, fewer variables register as significant in these regressions. Now, commercial Internet use seems to be negatively associated with television ownership and telephone ownership in all regressions, although these relationships are not all significant at 5%. This is consistent with the pattern in the purpose of computer use regressions. However, commercial Internet use seems to be positively associated with income in Bangladesh though commercial computer use seems to be negatively associated with income in Bangladesh. Why this pattern should reverse is not clear and may not be robust to the addition of more data observations. One possible explanation is that, while individuals in these samples typically use computers for both Internet- and non-Internet-based purposes, those with higher incomes are more likely to need the Internet for communication and more sophisticated information gathering.

Overall, there is not perhaps enough detailed information on usage patterns, or on causal factors behind those patterns, to say anything definitive about the possibility of network effects. However, it does seem that in the three samples considered in this analysis, Internet users are tapping into existing networks, and the nature of the interactions is not such as would be inhibited by low levels of local adoption. In addition, there is evidence that non-Internet-based computer uses are also important, and these do not rely on network effects. As network-based information gathering shifts to alternative devices such as mobile phones, it is useful to note that non-Internet-based computer uses do matter, even for rural developing country populations.

Pooled data results

As a check on our results, we also ran regressions analogous to those in Tables 4 through 7, but all three samples pooled. We included dummies for two locations: thus, variable coefficients were constrained to be equal across the samples, but the constant terms were allowed to differ. In general we found results that were broadly similar to the individual country results.[7] In particular, where a marginal effect was statistically significant for one or two country locations, while the other effects for the same variable were of the same sign or statistically insignificant, the pooled results displayed statistical significance. These cases could be taken as reinforcing the results presented above. In cases where different locations have statistically significant coefficients with different signs for a variable, the pooled regression tended to average out the individual sample results. Overall, therefore, we did not find anything in the pooled results to warrant modifying our conclusions.

Conclusions

In this paper, we have used data on approximately 500 individuals across three South Asian countries to examine factors that influence computer and Internet use in rural areas. By taking surveys in areas where computer and Internet services have been provided by NGOs and/or governmental agencies, we have been able to examine fairly rich usage data. An advantage of this kind of micro-econometric exercise is that cross-country differences are irrelevant, allowing one to focus on more precise behavioural effects. In the analysis undertaken here, access problems have been overcome to some extent, or are fairly homogeneous across individuals in any single location. However, there is still considerable variation in factors such as income and education, and we are also able to examine age and gender effects. Indeed one of our conclusions from this research is that one must take local heterogeneity into consideration when trying to determine what will drive demand for computers and Internet services.

The data also support the notion that computer and Internet users are generally more educated and 'media sophisticated' as measured by television usage and English newspaper reading. There are additional indications that entertainment plays a significant role in driving Internet demand, paralleling results elsewhere in the literature.[8]

[7] All these pooled results are available from the authors.
[8] See Kendall and Singh (2010).

One important finding is that education seems to be an important positive determinant at the micro level, often more strongly than appears to be the case from cross-country studies. Even more so, there is evidence that some degree of English language fluency is important for IT usage: this is supportive of the idea that lack of local language content in developing countries may be an important contributing factor to the digital divide on the demand side, even when supply constraints are mitigated by subsidies. The importance of local language content is not a new point, but deserves additional empirical support.

Lastly, respondents at all sites reported a desire for increased education as the most common reason for use of the Internet and computers in general, indicating the special role that the Internet can play in human capital acquisition in these areas. Given the well known externalities that exist in markets for education services, these results support the role of subsidies to Internet and computer access to promote increased education attainment and access to specialised educational opportunities that cannot be provided locally.

We close, however, with a caveat to our results. The data represent information collected at specific times and places, and is also subject to selection effects. As such, the patterns of usage revealed by the analysis may not generalise to other contexts, which can include different social, institutional and technological environments. To the extent that we have identified heterogeneity of patterns of usage and possible determining factors, our analysis is consistent with this message of caution. In particular, cross-country regressions need to be supplemented by the kind of rigorous microeconometric analysis that we have illustrated in this paper. While we do not have specific policy recommendations with respect to organisational innovations for improving rural IT access, our analysis does point to the need for better understanding of detailed demand patterns wherever such innovations are attempted.

Appendix

Variable summary statistics and definitions by survey site.

Table A.1 Bangladesh.

Variable Name	Variable	Freq./Ave	Codes	Description
LHS Variables				
Computer Use	use_comp	73%	Yes: 1	Did they use a computer?
		27%	No: 0	
Purpose of Computer Use	purp_use	32.19%	Education/student: 1	What is the purpose of using the computer?
		25.34%	Commercial: 2	
		12.33%	Personal/official: 3	
		30.14%	Others: 4	
	purp_use 3&4 combined	42.47%		
Internet Use	use_inet	48%	Yes: 1	Do they use Internet?
		52%	No: 0	
Purpose of Internet Use	purp_inet	38.54%	Education/student: 1	What is their purpose for using Internet?
		29.17%	Commercial: 2	
		20.83%	Personal/official: 3	
		11.46%	Government: 4	
	purp_inet 3&4 combined	32.29%		
RHS Variables				
Age	age	Ave: 28.29		Age of the respondent & other members of the family
		Range: 19—55		
	educ	0	Illiterate: 0	Education level of the respondent & other members of the family
		14.50%	Semi-Literate: 1	
		6%	Primary: 2	
		0.50%	Middle school: 3	
		9.50%	Secondary school: 4	
		31.50%	Higher secondary: 5	
		18.50%	Graduate: 6	
		19.50%	Post graduate: 7	
			Others: 8	
Education 1	educ3_second_highsec	41%		combined secondary and higher secondary

Table A.1 (*continued*)

Variable Name	Variable	Freq./Ave	Codes	Description
Education 2	educ4_grad_postgrad	38%		combined graduate and post graduate
	en_conn	94.50%	Yes: 1	Does the user have
		5.50%	No: 0	electricity connection?
		4.50%	Good: 1	Combined electricity
		35%	Avg: 2	status 1,2,&3 vs. 4
		55%	Poor: 3	
		5.50%	Unconnected: 4	
	in_come	59.50%	$<$ 10,000: 1	Household income per
		36.50%	10,000—25,000: 2	annum
		4%	25,000—50,000: 3	
		0	$>$ 50,000: 4	
				users with income of $<$10,000
Income 1	inc_234	40.50%		users in the income levels 2,3,&4 combined
	npap_lang	73.50%	Hindi/Local: 1	Language of the
		0	English: 2	newspaper
		16.00%	Both: 1,2	
		10.50%	None: 0	
	npap_both	16.00%		household receives both Hindi/local and English language
English Newspaper	eng_both_npap_lang	16.00%		combined households that receive English and both languages
	occ_main		None: 0	Main occupation of the
		19.50%	Farming: 1	respondent
		1%	Animal Rearing: 2	
		31%	Trade/Business: 3	
		42.50%	Employed: 4	
		0.50%	Student: 5	
		5.50%	Other: 6	
Occupation 1	occ2_farm_anrear	20.50%		combined occupations 1&2
Own Cable Connection	own_cc	21%	Yes: 1	Do they own cable
		79%	No: 0	connection?
Own Computer	own_comp	5.50%	Yes: 1	Do they own a computer?
		94.50%	No: 0	
Own Telephone	own_tel	33.50%	Yes: 1	Do they own a
		66.50%	No: 0	telephone?
Own Television	own_tv	26%	Yes: 1	Do they own TV?
		74%	No: 0	
Gender	sex	95.50%	Male: 1	Sex of the respondent &
		4.50%	Female: 0	other members of the family

Table A.2 Nepal.

Variable Name	Variable	Freq./Ave	Codes	Description
LHS Variables				
Computer Use	use_comp	71%	Yes: 1	Did they use a computer?
		29%	No: 0	
Purpose of Computer Use	purp_use	50.70%	Education/student: 1	What is the purpose of using the computer?
		23.94%	Commercial: 2	
		15.49%	Personal/official: 3	
		9.86%	Others: 4	
	purp_use 3&4	25.35%		
Internet Use	use_inet	63%	Yes: 1	Do they use Internet?
		37%	No: 0	
Purpose of Internet Use	purp_inet	61.90%	Education/student: 1	What is their purpose for using Internet?
		17.46%	Commercial: 2	
		9.52%	Personal/official: 3	
		11.11%	Government: 4	
	purp_inet 3&4	20.63		
RHS Variables				
Age	age	Average: 33.69 Range: 20—58		Age of the respondent & other members of the family
	cr_reason	25%	Sale: 1	Crop reason
		39%	Own consumption: 2	What is the purpose for the agriculture product?
		19%	Both: 1,2	
		17%	None: 0	
	sale_cr_reason	25%		crop reason- to sell
	educ	6%	Illiterate: 0	Education level of the respondent & other members of the family
		2%	Semi-Literate: 1	
		5%	Primary: 2	
		7%	Middle school: 3	
		19%	Secondary school: 4	
		20%	Higher secondary: 5	
		25%	Graduate: 6	
		16%	Post graduate: 7	
			Others: 8	
Education 1	educ3_second_highsec	39%		combined secondary and higher secondary
Education 2	educ4_grad_postgrad	41%		combined graduate and post graduate
Electrictiy Connection	en_conn	79%	Yes:1	Does the user have electricity connection?
		21%	No: 0	
		26%	Good: 1	Combined electricity status 1,2,&3 vs. 4
		28%	Avg: 2	
		25%	Poor: 3	
		21%	Unconnected: 4	
	in_come	52%	$<$10,000: 1	Household income per annum
		39%	10,000—25,000: 2	
		9%	25,000—50,000: 3	
		0	$>$50,000: 4	
Income 1	inc_234	48%		users in the income levels 2,3,&4 combined
	npap_lang	34%	Hindi/Local: 1	
		2%	English: 2	
		24%	Both: 1,2	
		40%	None: 0	
	npap_both	3.33%		household receives both Hindi/ local and English language

Table A.2 (*continued*)

Variable Name	Variable	Freq./Ave	Codes	Description
English Newspaper	eng_both_npap_lang	26%		combined households that receive English and both languages
	occ_main	8%	None: 0	Main occupation of the respondent
		21%	Farming: 1	
		1%	Animal Rearing: 2	
		22%	Trade/Business: 3	
		43%	Employed: 4	
		0	Student: 5	
		5%	Other: 6	
Occupation 1	occ2_farm_anrear	22%		combined occupations 1&2
Own Cable Connection	own_cc	39%	Yes: 1	Do they own cable connection?
		61%	No: 0	
Own Computer	own_comp	9%	Yes: 1	Do they own a computer?
		91%	No: 0	
Own Telephone	own_tel	36%	Yes: 1	Do they own a telephone?
		64%	No: 0	
Own Television	own_tv	76%	Yes: 1	Do they own TV?
		24%	No: 0	
Gender	sex	91%	Male: 1	Sex of the respondent &
		9%	Female: 0	other members of the family

Table A.3 Sri Lanka.

Variable Name	Variable	Freq./Ave	Codes	Description
LHS Variables				
Computer Use	use_comp	62.50%	Yes: 1	Did they use a computer?
		37.50%	No: 0	
Purpose of Comp Use	purp_use	43.20%	Education/student: 1	What is the purpose
		30.40%	Commercial: 2	of using the computer?
		10.40%	Personal/official: 3	
		16%	Others: 4	
Internet Use	use_inet	62.50%	Yes: 1	Do they use Internet?
		37.50%	No: 0	
Purpose of inet Use	purp_inet	44%	Education/student: 1	What is their purpose
		18.40%	Commercial: 2	for using Internet?
		12.80%	Personal/official: 3	
		24.80%	Government: 4	
RHS Variables				
Age	age	Average: 26.51		Age of the respondent &
		Range: 19—40		other members of the family
	educ	0.50%	Illiterate: 0	Education level of the
		10.50%	Semi-Literate: 1	respondent & other members
		8%	Primary: 2	of the family
		12%	Middle school: 3	
		21.50%	Secondary school: 4	
		17.50%	Higher secondary: 5	
		18%	Graduate: 6	
		11%	Post graduate: 7	
		1%	Others: 8	

(*continued on next page*)

Table A.3 (*continued*)

Variable Name	Variable	Freq./Ave	Codes	Description
Education 1	educ3_second_highsec	39%		combined secondary and higher secondary
Education 2	educ4_grad_postgrad	29%		combined graduate and post graduate
Electrictiy Connection	en_conn	96%	Yes: 1	Does the user have
		4%	No: 0	electricity connection?
		14.50%	Good: 1	Combined electricity
		'35.5%	Avg: 2	status 1,2,&3 vs. 4
		46%	Poor: 3	
		4%	Unconnected: 4	
	in_come	37.50%	<10,000: 1	Household income
		37.50%	10,000—25,000: 2	per annum
		24.50%	25,000—50,000: 3	
		0.50%	>50,000: 4	
Income 1	inc_234	62.50%		users in the income levels 2,3,&4 combined
	npap_lang	24.50%	Hindi/Local: 1	Language of the newspaper
		1.50%	English: 2	
		12.00%	Both: 1,2	
		62.00%	None: 0	
English Newspaper	eng_both_npap_lang	13.50%		combined households that receive English and both languages
	occ_main	1.50%	None: 0	Main occupation of
		29%	Farming: 1	the respondent
		1%	Animal Rearing: 2	
		17.50%	Trade/Business: 3	
		45.50%	Employed: 4	
		0	Student: 5	
		5.50%	Other: 6	
Occupation 1	occ2_farm_anrear	30%		combined occupations 1&2
Own Cable Connection	own_cc	44%	Yes: 1	Do they own cable connection?
		56%	No: 0	
Own Computer	own_comp	3.50%	Yes: 1	Do they own a computer?
		96.50%	No: 0	
Own Telephone	own_tel	32.50%	Yes: 1	Do they own a telephone?
		67.50%	No: 0	
Own Television	own_tv	85.43%	Yes: 1	Do they own TV?
		14.57%	No: 0	
Gender	sex	90.50%	Male: 1	Sex of the respondent &
		9.50%	Female: 0	other members of the family

References

Agüero, A., & de Silva, H. (2008). *Bottom of the pyramid expenditure patterns on mobile phone services in selected emerging Asian countries*. Teleuse@BOP study. LIRNE*asia*.

Best, M. L., & Kumar, R. (2008). Sustainability failures of rural telecenters: challenges from the sustainable access in rural India (SARI) project. *Information Technologies and International Development, 4*(4), 31—45.

Bresnahan, T., Brynjolfsson, E., & Hitt, L. (2002). Information technology, workplace organization and the demand for skilled labor: firm-level evidence. *Quarterly Journal of Economics, February*, 339—376.

Brynjolfsson, E., & Hitt, L. (2003). Computing productivity: firm-level evidence. *Review of Economics and Statistics, November*, 793—808.

Chinn, MD., & Fairlie, R. W. (2006). The determinants of the global digital divide: a cross-country analysis of computer and Internet penetration. *Oxford Economic Papers*, 16—44.

Dewan, S., Ganley, D., & Kraemer, KL. (2004). *Across the digital divide: A cross-country analysis of the determinants of IT penetration, working paper*. Irvine, November: Personal Computing Industry Center, Graduate School of Management, University of California.

Gamage, P., & Halpin, E. F. (2007). E-Sri Lanka: bridging the digital divide. *The Electronic Library, 25*(6), 693—710.

Goyal, A. (2010). Information, direct access to farmers, and rural market performance in central India. *American Economic Journal: Applied Economics, 2*(3), 22—45.

Islam, M. S. (2006). Status of rural library and information services in Bangladesh: directions for development. *The Social Sciences, 1*(1), 15—21.

Kaushik, P. D., & Singh, N. (2004). Information technology and broad-based development: preliminary lessons from North India. *World Development, 32*(4), 591—607.

Kendall, J., & Singh, N. (2010). *Performance of Internet kiosks in rural India: gender, caste and location*. UC Santa Cruz Working Paper.

Ryan, S., & Tucker, C. (2006). *Heterogeneity and dynamics of technology adoption*. NET Institute Working Paper #06-26.

Singh, N. (2004). Information technology and rural development in India. In B. Debroy, & A. Ullah Khan (Eds.), *Integrating the rural poor into markets* (pp. 221—246). New Delhi: Academic Foundation.

Singh, N. (2008a). Transaction costs, information technology and development. *Indian Growth and Development Review, 1*(2), 212—236.

Singh, N. (2008b). Crossing a chasm: technologies, institutions and policies for developing a regional IT industry. In A. Saith, M. Vijayabaskar, & V. Gayathri (Eds.), *ICTs and Indian social change: diffusion, poverty and governance* (pp. 192—218). , New Delhi: Sage Publications.

Sivapragasam, N. (2008). *The future of the public phone: Findings from a six-country Asian study of telecom use at the BOP*. Teleuse@BOP study. LIRNE*asia*.

Upadhaya, G. R. (1999). *Indreni — the Nepali Intranet: A platform for electronic publishing and information sharing in Nepal*. Kathmandu, Nepal: Nepal Internet Users Group.