CONNECTED FOR DEVELOPMENT? THEORY AND EVIDENCE ABOUT THE IMPACT OF INTERNET TECHNOLOGIES ON POVERTY ALLEVIATION

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ABSTRACT

Governments are investing heavily on Internet connectivity projects, based on the assumption that increased access to Internet services will accelerate economic growth and improve the wellbeing of the poor. This paper reviews the existing evidence about the impact of Internet diffusion on various development dimensions, and articulates the empirical evidence into a theoretical framework that seeks to conceptualize the microlinkages between Internet adoption and poverty alleviation. The findings suggest the need for more careful consideration of differentiated effects in the design and implementations of connectivity initiatives.

Keywords: INTERNET ACCESS; POVERTY; IMPACT EVALUATION; LITERATURE REVIEW.

1. INTRODUCTION

For many years, the “computer paradox” puzzled scholars and policymakers. Originally stated by Nobel-laureate economist Robert Solow in the late 1980s, the paradox referred to the lack of empirical evidence about the impact of investments in Information Technology (IT) on firm productivity, and ultimately on aggregate GDP growth (Brynjolfsson, 1993). Today, a similar gap between expectations and evidence has emerged in relation to the contribution of Internet technologies to development in general, and more specifically to poverty alleviation. Governments and donors are investing heavily on various connectivity projects, based on the assumption that increased access to Internet services will accelerate growth and improve the wellbeing of the poor. A 2011 report by the United Nations calls on governments to invest in broadband infrastructure and promote Internet adoption in order to achieve the Millennium Development Goals (MDGs) by the target date of 2015, or else “lose the opportunity to reap the economic and social benefits that broadband brings” (UN Broadband Commission, 2011, p. 1).

Yet the few rigorous studies conducted to date suggest a more complex dynamics between connectivity and poverty. The more skeptical argue that there is limited evidence about the positive development impact of Internet technologies, suggesting that “the impact of broadband rollout on achieving the MDGs would be marginal” (Kenny, 2011, p. 1). Others argue that most of the gains associated with Internet diffusion are being appropriated by those already well-off, thus exacerbating inequalities and making broadband initiatives a questionable development investment. As Forman et al. (2012) summarize it: “we find that while the Internet is widespread, the payoffs are not” (p. 1).

Lack of conclusive evidence has not deterred governments from committing significant resources to Internet connectivity initiatives. According to a report by the International Telecommunications Union (ITU, 2013), 134 countries had a national broadband plan in place by early 2013. While some are little more than broad policy strategy documents, others involve significant public investments in infrastructure, applications and training. A good example is Colombia's Vive Digital, an ambitious initiative encompassing the building of a national fiber backbone, Internet service subsidies to low-income households, online government services and various ICT training programs. The estimated investments total USD $2.25 billion, or 0.62% of Colombia's current GDP.

This paper contributes to the debate about the development impact of Internet technologies in two fundamental ways. First, it reviews the existing evidence about the effect of Internet diffusion on a number of social and economic dimensions of poverty. The review favors academic studies in peer-reviewed publications that use rigorous impact evaluation techniques, although in some cases high-visibility reports by multilateral agencies and other development actors are also considered. The goal is to scrutinize the existing literature, summarizing findings (what we know) and identifying key opportunities for future research (what we don't know). While the emphasis is on evidence from developing contexts, key studies conducted in advanced economies are also discussed.

Second, the paper articulates the empirical evidence into a theoretical framework that attempts to conceptualize the microlinkages between Internet diffusion and poverty alleviation. This is an important step forward in our understanding of the Internet's role in development. As discussed below, the existing literature provides limited theorization about impact mechanisms. This conceptual gap makes it difficult to disentangle the multiple possibilities that the technology affords. For example, assuming that Internet

adopters are on average better off than the rest, is this because they are able to find better jobs, to acquire new skills, to draw on a larger social network for financial support, or perhaps to demand better services from the government? The theoretical framework presented in this paper draws on a large body of literature in order to address these fundamental questions.

The paper is organized as follows. The next section presents an overview of the available macro-level literature about the impact of Internet technologies on aggregate output and employment, and about its distributional effects. Next we lay out a theoretical foundation that seeks to establish the microlinkages between Internet adoption and poverty alleviation, and present evidence for the different impact mechanisms in each of the four subsections. The conclusion resumes the broader discussion about the role of Internet technologies in development initiatives, and how the existing evidence can serve to better orient their design and implementation.

2. WHAT WE KNOW (AND DON'T) ABOUT THE ECONOMIC IMPACT OF THE INTERNET

There is agreement in the development literature that economic growth is the strongest driver of long-term poverty reduction (Barro, 2000; Lopez, 2004; Kraay, 2006). Investments in telecommunications have long been credited with catalyzing productivity and output growth (Madden & Savage, 1998; Roller & Waverman, 2001; Datta & Agarwal, 2004). Building on these findings, several scholars have examined the linkages between Internet investments and aggregate indicators of economic activity. In others words, these studies have attempted to establish whether the Internet has a positive *growth effect*.

On the other hand, a more recent development literature suggests that economic growth is not enough for poverty alleviation, particularly in the presence of high levels of inequality as is the case in most developing countries (Wade, 2004; Krishna, 2005). While the growth effect is stronger, changes in income distribution also have an important effect on poverty reduction (Ravallion, 2004; Cruces & Gasparini, 2013). Based on these findings, a second body of literature has examined the *distributional effect* of Internet technologies.

This section reviews the macro-level evidence about the *growth* and *distributional effects* of Internet technologies. The review suggests that Internet diffusion does promote aggregate growth, although the magnitude of the impact for developing countries is significantly more modest than estimated in earlier studies due to threshold effects and of increasing returns to adoption. In contrast, the evidence about *distributional effects* is mixed. While some studies suggest that Internet technologies exacerbate inequality through skill-bias effects in labor markets, others indicate that it favors economic integration of isolated areas. Each of these bodies of literature is discussed in more detail below.

(a) The growth effect of Internet technologies

The early enthusiasm about the positive development impact of Internet technologies is largely based on a set of high-profile studies released between 2006 and 2009. In one of these studies, Gillett et al. (2006) examine the impact of broadband availability on economic activity in the U.S. at the zip-code level. Based on panel data for 1998-2002 and a standard OLS model with controls by zip code, the study finds that the availability of broadband services (regardless of actual adoption) adds as much as 1.4% to the employment growth rate. In a similar study, Crandall et al. (2007) analyze the economic impact of broadband adoption (rather than simply availability) in the U.S. at the state

level for the 2003-2005 period. The findings suggest that an increase of 1% in a state's broadband penetration yields an increase of up to 0.3% in the level of employment per year, although no effects are found on GDP growth. However, Mayo and Wallsten (2011) are unable to replicate these results using data for the 2006-2008 period. In fact, in some model specifications broadband adoption seems to negatively affect employment and GDP growth. These authors conclude that previous positive results are not robust and highly sensible to the period of analysis.

Similar panel studies have been conducted with cross-country data. In a much-publicized World Bank report, Qiang and Rossotto (2009) examine the economic impact of several new ICTs with data from 120 countries for the 1980-2006 period. Two findings stand out in this study. First, the positive impact of Internet technologies on GDP growth is found to be significantly larger (as a much as three times larger) than the impact of other communication technologies such as fixed and mobile telephony. Second, the economic impact of the Internet is found to be larger for middle- and low-income countries. Specifically, the authors estimate that a 10-point increase in broadband penetration yields a 1.38-point increase in GDP growth for emerging countries (in comparison to a 1.21-point increase for advanced economies). The report unequivocally concludes that "broadband's benefits are major and robust for both developed and developing countries" (p. 45).

This first set of studies has well-known limitations, including difficulties in properly identifying causality and attribution problems due to the level of data aggregation (since for example people may work in one zip code but live in another). A key concern is the lack of robust techniques to account for reverse causality in panel data regressions. Simply put, given that the decisions to subscribe to Internet services by individuals or firms (or to invest in certain areas by service operators) are not random, it is likely that impact estimators are capturing both the effect of Internet penetration (or availability)

on economic growth as well as the effect of economic growth on Internet penetration (or availability). Another problem is the limited set of controls for omitted variables (such as better governance) that could simultaneously be causing both increased Internet diffusion and economic growth. As a result, the true effect of Internet technologies on economic activity tends to be overestimated in these studies.

The study by Koutrompis (2009) is among the first to address these problems and provide more reliable estimates, although it is limited to a sample of 22 OECD countries for the 2002-2007 period. The author captures the two-way relationship between economic growth and Internet investments by modeling the supply, the demand, and the output of Internet in three separate models, which are estimated simultaneously with the main regression that captures the impact of Internet on GDP growth. The findings indicate, first, that the impact on economic growth is robust but more modest than previously suggested; and second, that the impact is not linear but rather grows as penetration increases. The study also identifies a critical mass effect, whereby the positive externalities of Internet diffusion kick in only after a certain threshold level of adoption. Similar findings are reported by Katz and Koutroumpis (2012), who suggest that the limited contribution of Internet technologies to economic growth in Senegal is due to low adoption levels.[1] Overall, these results challenge the findings by Qiang and Rosotto (2009) about larger effects in less-developed economies.

Czernich et al. (2011) utilize a different strategy to control for reverse causality in cross-country panel regressions. Using a panel of OECD countries for the 1996-2007 period,

[1] The result is consistent with studies for other technologies. For example, Gruber and Koutrompis (2011) show that the impact of mobile telecommunications on economic growth is smaller for countries with low levels of mobile telephony penetration.

the authors start from the assumption that the provision of broadband depends on previous investments in traditional voice telephony and cable TV networks. Therefore, the authors specify a technology diffusion model in which variations in the ceiling of broadband penetration are determined by the availability of pre-existing telecommunications networks, which is used as instrumental variable. The results suggest a strong contribution of broadband to economic growth, projected to be between 0.9 and 1.5 percentage points in additional per capita GDP growth for every 10-point increase in broadband penetration. Yet there results are only statistically significant above the 10% penetration threshold, thus confirming the critical mass effect identified by Koutroumpis (2009).

The studies reviewed above are summarized in Table 1. In general the results corroborate the positive contribution of Internet technologies to aggregate economic growth (what we call the *growth effect*), although the impact in developing contexts is significantly more modest than previously estimated. Moreover, there is agreement about the nonlinearity of the impacts and the presence of threshold effects. In addition, the strongest evidence is based on studies for advanced economies. Whether increased Internet access can significantly boost growth (and therefore promote poverty reduction) in countries with a small share of technology-intensive industries and limited technology-absorption capacity by individuals and firms remains largely uncertain.

- Table 1 about here -

(b) The distributional effect of Internet technologies

While the debate about the factors that explain changes in income distribution is ongoing, the available evidence points to changes in the composition of labor demand as a key factor (see López-Calva & Lustig, 2010). Following this hypothesis, in order to

examine the distributional effects of Internet technologies several studies have examined its effect on labor demand. These studies build on a long research tradition about the impact of new technologies - from the steam engine to microchips - on labor markets. Overall, this literature suggests that the relationship is complex and context-dependent. Some technologies might help standardize production processes and replace skilled labor, as weaving and spinning machines did in the early days of the industrial revolution (Goldin & Katz, 1998). However, other technologies increase demand for educated workers, thus placing a premium on skilled labor. This skill-bias hypothesis was first presented by Autor et al. (1998) in an influential paper which argues that much of the rise in wage inequality in the U.S. since the 1970s can be explained by the adoption of computers and related technologies.

The empirical evidence suggests that Internet diffusion positively affects labor markets regardless of effective adoption – in other words, that Internet technologies have positive labor externalities. Yet the evidence also indicates that benefits tend to be disproportionately appropriated by the most skilled workers, who are also more likely to be already employed, thus explaining the lack of consistent effects on aggregate employment found in earlier studies. This is also consistent with recent findings by Autor and Dorn (2013), who suggest that the impact of generic information technology investments on wage and employment in advanced economies is U-shaped, with growth at the top and bottom but losses in the middle of the skill distribution.

For example, Atasoy (2013) analyzes the effects of the diffusion of broadband on labor market outcomes in the U.S. between 1999 and 2007 using county-level data. The author finds that broadband availability is associated with a 1.8-point increase in the county employment rate, and attributes most of this effect to increases in the scale of existing firms. These effects are found to be larger in counties with a larger fraction of college-educated workers, thus confirming that workers with more abilities benefit more

from investments in broadband. Yet the study also suggests that broadband availability may be compensating for geographical isolation, as the positive employment effect is found to be significantly larger in rural counties.[2]

The findings by Forman et al. (2012) also suggest a strong complementarity between Internet technologies and skilled labor. The authors study employment and wage growth in U.S. counties between 1995 and 2000, and examine whether the observed differences are associated with the intensity of Internet investments by local firms. The results reveal a strong skill bias in the employment effect of Internet technologies: whereas the positive effects of Internet investments on wage and employment are statistically significant but marginal in magnitude, these effects are found to be very large in a handful (6%) of counties. These locations share several characteristics: large populations, an educated workforce and a large share of IT-intensive industries. Based on these results the authors conclude that Internet investments tend to exacerbate existing wage inequalities between regions. In contrast to Atasoy (2013), the authors question the ability of broadband to compensate for geographical isolation.

Very few rigorous studies have examined the impact of Internet technologies on employment and wages in developing countries. One exception is De los Ríos (2010), who examines the impact of Internet adoption on household incomes in Peru between 2007 and 2009. The results indicate that individuals who became Internet users between 2007 and 2009 experienced faster income growth than those that remained non users. Further, the reported gains are larger for users in rural areas, confirming the findings by Atasoy (2013). However, the results indicate that Internet adoption has no effect on the probability of finding employment. Another exception is Katz and Callorda (2013) who take advantage of a large initiative to expand broadband coverage by the

[2] Similar findings are reported by Kolko (2012).

public telecom operator in Ecuador (CNT) to investigate the impact on individual labor incomes. The findings indicate that broadband availability at the county level is associated with an increase of 7.5% in individual labor income over a two-year period, regardless of whether the individual had in fact adopted the service, thus confirming the strong positive externalities of Internet investments. However, overall employment effects were again found to be null. Similar findings are reported by May et al. (2011), who use microdata from household surveys in four countries in East Africa (Kenya, Rwanda, Tanzania and Uganda) to examine the impact of increased access to new ICTs on multidimensional poverty over the 2007-2010 period. The findings indicate that gaining access to ICTs is associated with a 2.5% improvement in a household's poverty status. Interestingly, the magnitude of the effect increases when the sample is restricted to the poorest households, thus confirming the U-shape distributional pattern identified by Autor and Dorn (2013).

The studies reviewed above are summarized in Table 2. Overall the evidence suggests that Internet diffusion positively affects wages, though the impacts on aggregate employment are mixed. Further, most studies confirm the skill bias hypothesis whereby benefits are disproportionately appropriated by the more educated workers. Whether connectivity can compensate for geographical isolation and promote economic diversification in rural areas is yet unclear. In particular, answering this question requires a more in-depth understanding about the channels through which Internet technologies affect economic activity and development in general, to which we turn in the next section.

- Table 2 about here -

3. OPENING THE INTERNET BLACK BOX

The studies reviewed so far generally provide limited theorization about the channels through which Internet technologies affect the various social and economic dimensions of poverty. Parsing out these microlinkages is critical for advancing our understanding about the potential contribution of Internet investments to poverty alleviation, as well as for evaluating the cost effectiveness of policy initiatives aimed at universalizing access. In this section we organize the existing evidence from various fields into a coherent theoretical framework that presents several hypotheses about these impact mechanisms.

We suggest four key mechanisms through which Internet technologies may accelerate the pace of economic growth or reduce income disparities (or both), thus contributing to poverty alleviation. They are: a) increases in firm productivity; b) improvements in market coordination, particularly labor markets; c) the strengthening of social and human capital; and d) the promotion of inclusive political institutions. Each is discussed in more detail in the following subsections.

(a) Raising firm productivity

At its most basic, the Internet is a general-purpose technology (GPT) that allows individuals and firms to share information in a vastly more efficient manner. Following standard models of economic growth, more efficient sharing of information and ideas will allow firms to find better ways to combine physical and human capital, thus increasing output per worker (Romer, 1990; Aghion & Howitt, 1992). These benefits will accumulate over time due to learning effects, further raising productivity as the new technology progressively disseminates throughout the economy (Howitt, 2004).

Capturing these productivity gains in empirical studies has nonetheless proved elusive, not only because reliable productivity data at the firm level is notoriously demanding to collect, but also because the Internet is a relatively recent technology. Despite these challenges, some rigorous evidence has begun to emerge. For example, Colombo et al. (2012) analyze the impact of Internet adoption on SME productivity in Italy between 1998 and 2004. The authors differentiate between the adoption of basic applications (such as email and remote banking) and advanced applications (such as VPNs, video conferencing, and supply-chain management). The results indicate that whereas the use of basic applications has no productivity impact, the adoption of selected advanced applications results in significant productivity gains, in particular when adoption is combined with organizational changes. In a developing context, Galiani and Jaitman (2010) report on the impact of an initiative in Argentina to promote the adoption of Internet-enabled software that allows small and medium-scale cattle farmers to track animals throughout the supply chain. The findings indicate that farmers who adopted the system became more efficient and received better prices relative to a control group.

The empirical evidence is however significantly more limited than the theoretical potential. This misalignment is in part due to the relatively short lifespan of the Internet and its characteristics as a GPT. In fact, previous research about the productivity impact of other GPTs such as the steam engine, electric power and computers have found results consistent with what is being observed for Internet technologies. Among these key results are: 1) that the short-run impact of the adoption of a GPT on firm productivity may be negligible or even negative because of adjustments costs related to learning and the relocation of labor and other activities (Helpman & Trajtenberg, 1996; Aghion & Howitt, 1998); 2) that the productivity impact of GPTs is strongly dependent on complementary investments in human capital and the reorganization of activities within the firm (Brynjolfsson & Hitt, 2000); and 3) that the full potential of GPTs is realized only when complementary innovations become available (Rosenberg,

1982; Breshnahan & Trajtenberg, 1995). It is therefore likely that the full productivity impact of Internet technologies will take several decades to materialize, particularly in developing countries where threshold effects may further delay productivity returns on these technology investments.

(b) Improving market coordination

A basic economic principle states that, under perfectly competitive markets, production factors such as labor and capital will be optimally allocated to the most productive firms, rewarding them and as a result promoting aggregate growth. However it is also well established that many factors prevent markets from being perfectly competitive as often assumed. A well-known example is when agents have incomplete or asymmetric information (Stigler, 1961; Salop & Stiglitz, 1977). The more information about the quality or quantity of goods in a market is incomplete or unevenly distributed, the greater the opportunities for rent-seeking behavior, which results in deviations from Pareto efficiency (Stahl, 1989). It follows that any mechanism that reduces information-seeking costs and facilitates information dissemination will contribute to accelerate long-term growth by improving the allocation of resources across the economy.

There is solid evidence that earlier communication technologies have improved market coordination in developing contexts. Most of these studies have focused on the impact of communication infrastructure rollout on supply chains in agricultural markets. This is highly relevant for development purposes given that the functioning of agricultural markets plays a central role in determining the incomes of the poorest. For example, Jensen (2007) showed that the availability of mobile phone services in South India resulted in a reduction in price dispersion across fish markets, and in an increase in both consumer and producer welfare. Similar findings are reported by Aker (2010), who estimates that the introduction of mobile phones in Niger is associated with a 20%

reduction in grain price differences across markets (although no increases were found in prices paid to producers). Camacho and Conover (2011) similarly found that Colombian farmers who received regular price and weather information through text messages had a significant reduction in crop loss relative to a control group. Muto and Yamano (2009) report that the adoption of mobile telephony by Ugandan farmers improved resource allocation by promoting participation in remote markets.

Building on these studies, there is growing evidence that Internet adoption also reduces information asymmetries and enhances market performance in agricultural markets. In a study of soybean farmers in India, Goyal (2010) found evidence that, after a large processor and buyer of soybeans installed Internet kiosks in a group of villages, farmers were able to bypass intermediaries and receive better crop prices. The author also finds a significant reduction in the dispersion of soybean prices across markets. Similarly Beuermann (2011) finds that the availability of payphones and telecenters in rural Peru helped raise agricultural income by about 16%, which the author attributes to reductions in information asymmetries between farmers and traders.

The impact of Internet technologies on coordination in labor markets is a special case of the above discussion, but one particularly relevant to the welfare of the poor. Several studies have examined whether new communication technologies improve labor markets performance, reducing friction (for example the time it takes to find a new job) and improving matching between demand and supply. In general, the empirical findings corroborate the theory about positive information effects on labor markets coordination. For example, Aker et al. (2011) show that an adult education program in rural Niger in which students learned how to use mobile phones increased the likelihood of rural-urban migration. Kuhn and Mansour (2011) find that, among young jobseekers, those using the Internet for job searches were able to find employment 25% faster than those

not using the Internet for this purpose. Mang (2012) finds that job changers who found their new job online are better matched than their counterparts who found their new job through newspapers, friends, job agencies, or other channels. The effects are particularly strong for jobseekers in rural areas, suggesting that Internet adoption is partly compensating for geographical isolation and broadening the spatial scope of labor markets.

In summary, the evidence suggests that the diffusion of Internet technologies is linked to better market performance in a variety of contexts, thus improving resource allocation across the economy. While most existing studies in developing contexts examine the impact of mobile telephony in agricultural value chains, there is growing evidence that the findings also hold true for Internet technologies as well as for other markets. The case is particularly strong for labor markets, which in developing countries are characterized by various types of information-related frictions that result in suboptimal employment and poor matching.

(c) Promoting social and human capital

Internet diffusion is also hypothesized to contribute to poverty alleviation by promoting the accumulation of two types of intangible assets: social capital and ICT skills. It is well know that the poor often rely on family, friends or neighbors to access various services, from risk insurance to day care for preschoolers (Dercon, 2004). This has spanned an extensive literature on the role of social capital in development. The rapid adoption of new information technologies in emerging regions has renewed this debate, with particular attention to how changes in the structure and dynamics of social networks may in turn affect other social and economic outcomes.

For example, several studies have examined the link between Internet use, social capital, and employment. The role of personal networks in labor markets has been extensively corroborated: they constitute key channels for information about jobs and wages to disseminate across members of a social group (Lin, 2001; Granovetter, 2005). Given that Internet use affects the size, the structure, the intensity, and the type of interactions that take place in personal networks, associated changes can be expected in the matching between workers and employers, and possibly in the resulting wage distribution (Di Maggio et al., 2001). While few rigorous studies have been conducted to test these hypotheses, preliminary findings point into two directions. First, that Internet users tend to maintain a larger network of weak ties, and that these ties are often activated at crucial times such as when looking for a job or changing occupations (Boase et al., 2006). Second, that Internet use also intensifies remote ties with close family members and friends, which in turn promotes labor migration (Aker et al., 2011).

Another set of studies suggest that Internet adoption increases employability by promoting the acquisition of ICT skills. The assumption is that ICT skills are increasingly becoming a key component of human capital, even in traditional low-skill occupations such as those in the service sector. In a field experiment in which 11,000 fake CVs where submitted to real job openings in sales and administration in two Latin American cities (Buenos Aires and Bogotá), Blanco and Lopez Boo (2010) found that having basic ICT skills significantly increased the likelihood of being called for a job interview. Several other survey-based studies confirm the association between ICT skills and earnings (Di Maggio & Bonikowski, 2008; Mossberger et al., 2007).

Given the role of schools in human capital formation, many governments and donors have invested heavily on ICT-in-school programs in recent years. These programs, which combine the provision of equipment, connectivity and teacher training in various

ways, are premised on two key assumptions: a) that schools have an important role to play in promoting ICT literacy, and b) that the introduction of computers and the Internet in schools can positively affect student performance, promoting learning as well as other desirable outcomes such as motivation and retention (Warschauer & Matuchniak, 2010).

In general terms the empirical evidence supports the first assumption but provides mixed results about the second. The use of computers and the Internet in schools has been found to significantly increase students' ICT skills. For example, Fairlie (2012) reports that low-income college students randomly selected to participate in a program that provided free computers had significantly higher ICT skills than the control group. Interestingly the author reports that effects were stronger for the lowest income students, thus mitigating previous inequalities in exposure to ICTs. Likewise, Malamud and Pop-Eleches (2011) report strong results on ICT skills for a voucher program in Rumania designed to promote computer ownership among low-income households, whereas Cristia el al. (2012) report significant computer skill gains among beneficiaries of Peru's OLPC (*One Laptop per Child*) program.

By contrast the impact of computers and the Internet on other educational outcomes is much less clear. Most studies find no significant effects of computer use on student achievement in traditional subjects such as language and math (Angrist & Lavy, 2002; Barrera-Osorio & Linden, 2009; Cristia et al., 2012). Interestingly, some even report negative effects, which are attributed to lack of teacher training and displacement of time from other educational activities (e.g., Sprietsma, 2012). The literature about the impact of Internet subsidies for schools is less extensive, but the results are equally mixed. Goolsbee and Guryan (2006) analyze the impact of the e-Rate program, a large initiative started in 1998 to promote Internet connectivity among public schools in California. The authors find that while the initiative successfully reduced connectivity

gaps between schools, it had no observable effect on student learning. Further, Belo et al. (2010) find that the introduction of broadband in schools in Portugal negatively affected student learning, which the authors attribute to ineffective use (schools which blocked access to non-educational websites performed relatively better).

In sum, there is solid evidence to suggest that Internet adoption can increase employment opportunities for the poor by promoting the acquisition of basic ICT skills. In addition, Internet use has been found to reconfigure social interactions in ways that favor increased numbers of weak ties, which have been shown to be critical in obtaining non-redundant information about jobs and other issues of high relevance to the poor. Finally, Internet use is linked to an intensification of ties with close friends and family, thus promoting what Woolcock and Narayan (2000) have termed bonding social capital. This type of capital is associated with increased levels of social trust, which as shown in several studies is particularly important for economic transactions in weak institutional contexts (Fafchamps & Minten, 1999; Overa, 2006). Further, increases in bonding social capital also have important implications for collective action in the political realm, to which we turn in the next section.

(d) Promoting inclusive institutions

Poverty and political exclusion are known to create a self-reinforcing trap. On the one hand, poverty prevents the accumulation of human capital and increases political instability, both of which negatively affect the quality of institutions that regulate market transactions and organize political life. On the other, inclusive political institutions, which promote citizen participation and constrain the actions of political elites, are a

key determinant of economic wellbeing.[3] There are many studies suggesting that ICTs in general and the Internet in particular can promote democratization, social engagement, and other positive outcomes associated with better institutions (e.g., Castells, 2009). Yet much of this literature is based on anecdotal evidence or case studies of large-scale political changes (such as in the so-called Arab spring), in which the potential contribution of the Internet is difficult to disentangle from multiple other factors.

Despite these challenges there is a small but growing literature which point to several microlinkages between Internet diffusion and better governance. This literature shows that Internet diffusion may result in more inclusive political institutions through two key mechanisms: first, by increasing government transparency, and thus limiting opportunities for corruption and improving the allocation of public resources; second, by promoting political engagement and mobilization, which threatens political elites and leads to more responsive government. Each of these mechanisms is further examined below.

(i) Increased government transparency

Both theoretical and empirical studies indicate that a more informed population promotes better governance (Besley & Burgess, 2002; Strömberg, 2004). It follows that any mechanism that facilitates widespread information access and dissemination is likely to strengthen this effect. For example, Ferraz and Finan (2008) show that the disclosure of information about government corruption in Brazilian municipalities led voters to punish corrupt incumbents. Similarly, Andersen et al. (2011) report that the

[3] Acemoglu and Robinson (2012) are a recent example within a vast literature that dates back, at least, to North and Thomas (1973).

diffusion of the Internet across U.S states is associated with a significant decrease in corruption incidents in local governments. The authors suggest that Internet diffusion not only increases the risk of detection for corrupt politicians but also has a disintermediation effect, enabling citizens to bypass local officials and other information gatekeepers.

There is also evidence that increased information transparency about the delivery of public services can effect positive changes in the quality of such services. Reinikka and Svensson (2005) report that the disclosure of information about the allocation of school funds in local media reduced corruption and increased the availability of funds for schools in Uganda. In a similar study, Bjorkman and Svensson (2009) document how providing local communities in Uganda with basic information about the quality of health services received (in comparison to other communities and with the standards set by the federal government) reduced capture and led to increases in both the quality and quantity of health services provided. By empowering citizens with information about the performance of politicians and the delivery of public services, Internet diffusion is hypothesized to reduce corruption and better align the allocation of public resources with voters' preferences.

(ii) Promoting political engagement and mobilization

As discussed, there is evidence that Internet diffusion promotes government accountability. Yet government accountability is itself a public good and therefore subject to well-known collective action and free-riding problems. Learning about corruption and inefficiencies in the delivery of public services is not only costly but ultimately of little use unless individuals are willing to organize and engage in political action. In a study of corruption in public works in Indonesia, Olken (2005) found that providing information to citizens was much less effective than traditional top-down

monitoring of contracts. Not only is collective action difficult to organize, but local elites are often able to trump any proposed changes.

The question then becomes whether Internet diffusion can foster civic engagement and help individuals overcome collective action challenges to political mobilization. Theoretically, the reduction in information search and coordination costs that improves the performance of markets (discussed above) should also promote political engagement by similarly reducing the cost of acquiring political information and opening new channels for political participation. Yet Internet adoption could also reduce civic engagement by displacing time from political activities and favoring entertainment or other non-instrumental uses (e.g., Putnam, 2000).

Despite much theoretical debate, very few rigorous studies have been conducted to test these competing hypotheses. In general, the available evidence suggests that Internet adoption has a small but statistically significant effect on civic engagement. Longitudinal studies based on large-scale surveys indicate that Internet use has positive effects on voter turnout, campaign contributions, and the intensity of contact with elected officials (Mossberger et al., 2007, Stern et al., 2011). However, a meta-study by Boulianne (2009) finds that, while most studies suggest an association between Internet adoption and civic engagement, the magnitude of the effects is dramatically reduced when controlling for pre-existing political interest. In summary, while the anecdotal evidence abounds, more rigorous studies are needed to confirm the links between Internet diffusion and civic engagement. In particular, more studies are needed in the context of the young and fragile democracies that characterize the political environment of the world's poorest.

4. CONCLUSION

The development community continues to debate the role of Internet technologies in addressing the multiple social and economic dimensions of poverty. The enthusiasm with which many governments and development donors have embraced the Internet has too often discouraged empirical evaluations about its true contribution for poverty alleviation and the cost effectiveness of the multiple connectivity initiatives under way. In addition, the limitations in existing datasets have presented serious methodological challenges for development scholars. As a result, large public investments in Internet infrastructure and training have been oriented by reports from industry or advocacy groups, which generally lack the scrutiny that characterizes scholarly work.

The systematic review of the evidence undertaken in this paper suggests that the development payoffs of Internet technologies are highly uncertain due to two interrelated effects. First, because effective appropriation requires various skills as well as complementary investments in human capital and organizational changes, which tends to favor well-educated workers and firms with more innovative capacity and access to financing. Second, because the positive effects of Internet dissemination on market coordination and political institutions grow exponentially with adoption levels. As a result, while the evidence indicates that advanced economies are reaping numerous benefits from Internet investments, the returns for less advanced economies, and in particular for the fight against poverty in these regions, remain ambiguous. This is not to say that poor countries should not invest.

Conceptually, the paper has presented several hypotheses about the impact channels that link Internet diffusion and poverty reduction. In some cases (e.g., improving market coordination, promoting ICT-related human capital) the evidence is unambiguous and supports a moderate optimism about the contribution of Internet technologies to

development goals. In others (e.g., productivity and employment gains), it is more ambiguous and requires careful consideration of its distributional effects. Yet in others (e.g., better governance) the available evidence is very limited and leaves key questions unanswered. This mapping of the available knowledge stock is expected to promote further academic inquiry to fill the numerous gaps identified throughout the paper.

This stocktaking exercise is not intended to discourage policymakers and practitioners from continuing to find ways to leverage new communication technologies such as the Internet for development purposes. Rather, it seeks to better align expectations with empirical results, as well as to encourage more careful consideration of differentiated effects in the design and implementations of initiatives. Much like investments in transportation and electricity, Internet connectivity investments are poised to play a significant role in poverty alleviation initiatives in the future. But still much remains to be understood about their complementary with other investments (in basic education, in SME productivity, in institutional strengthening) in order to assess their long-term development impact.

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Table 1: The *Growth Effect* of Internet Technologies

Authors	Data	Methodology	Key findings
Gillett et al. (2006).	Panel of U.S. zip codes and counties for 1998–2002.	Instrumental variable regression and matched-sample.	Availability of broadband adds between 1-1.4% to growth rate of employment and 0.5-1.2% to growth rate of business establishments.
Crandall et al. (2007).	Panel of U.S. states for 2003-2005.	OLS regression.	A 1% increase in broadband penetration yields an increase of between 0.2-0.3% in employment rate. No effects on GDP growth.
Qiang & Rossotto (2009)	Panel data of 120 countries for 1980-2006.	OLS regression.	For high-income economies: a 10 p.p. increase in broadband penetration yields a 1.21 p.p. of additional GDP growth. For developing countries: a 10 p.p. increase in broadband penetration yields a 1.38 p.p. of additional GDP growth.
Koutroumpis (2009)	Panel of 22 OECD countries for 2002–2007.	Simultaneous equations model with instrumental variable.	A 10% increase in broadband penetration rate increases economic growth by an average of 0.25%.
Czernich et al. (2011).	Panel of 25 OECD	Instrumental variable	A 10 p.p. increase in broadband penetration raises annual GDP per-

	countries for 1996-2007.	regression.	capita growth by 0.9-1.5 p.p.
Mayo and Wallsten (2011).	Panel of U.S. states for 2006 -2008.	OLS regression.	Small negative effect of broadband penetration on GDP growth and employment.

Source: The authors.

Table 2: The *Distributional Effect* of Internet Technologies

Authors	Data	Methodology	Key findings
De los Ríos (2010).	Household surveys in Peru 2007-2009.	OLS regression.	Internet adoption is associated with labor income gains of between 13% and 19%.
May et al. (2011).	Household surveys in East Africa 2007-2010.	OLS regression with matched sample.	Access to ICTs is associated with a 2.5% improvement in a household's poverty status. Larger effects for poorer households.
Forman et al. (2012).	Panel of U.S. counties for 1995-2000.	Instrumental-variable regression with falsification test.	Internet investments are associated with wage and employment growth only in 6% of counties.
Atasoy (2013).	Panel of U.S. counties for 1999-2007.	County fixed-effects model with falsification test.	Broadband availability is associated with 1.8 p.p. increase in employment rate, with larger effects in rural counties.
Katz and Callorda (2013).	Panel of counties in Ecuador 2009-2011.	Quasi-experiment.	Broadband availability yields a 7.5% increase in individual labor income over a two-year period, regardless of adoption.

Source: The authors.