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The Internet as a General-Purpose Technology

Firm-Level Evidence from around the World

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Abstract

This paper uses firm-level data to assess whether telecommunication services are general-purpose technologies (technologies that benefit a large segment of the economy and have long-lasting effect). It finds that only Internet services are so: firm growth and productivity are much higher when Internet access is greater and when firms use the Internet more intensively; and Internet access benefits firms in high- and low-tech industries, firms of all sizes, and exporter and non-exporter firms. Small firms appear to benefit more from the Internet than large firms do. In contrast, fixed-line and cellular services are not robustly linked to firm performance.

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The Internet as a General-Purpose Technology:

Firm-Level Evidence from around the World

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Key words*:* Telecommunications; internet; broadband; general-purpose technology.

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Introduction

Countries that invest in telecommunications services benefit in several ways. Firms in industries that produce telecom equipment and services benefit directly. And firms in other industries can benefit indirectly if telecom services—especially broadband Internet services—are general-purpose technologies (Basu and Fernald, 2008), which benefit a large segment of the whole economy and have long-lasting benefits.

Telecom services can be considered general-purpose technologies for several reasons. First, well-developed telecom services allow firms to spend less on communications and to obtain inputs more efficiently (Hardy, 1980; Roller and Waverman, 2001). Second, strong telecom services help firms expand into new regions and countries, allowing them to achieve economies of scale. Finally, good telecommunications can cut the costs of collecting information—encouraging firms to create and share knowledge and to organize more efficiently.

Many studies have found that countries with well-developed telecom services grow faster (Hardy, 1980; Roller and Waverman, 2001; Lee and others, 2011). But most of those studies have focused on fixed-line and cellular services. Because Internet and broadband services have expanded only in recent years, fewer studies have looked at the links between Internet services and economic growth (Qiang, 2009). That is unsurprising: general-purpose technologies take time to affect economic performance (Basu and Fernald, 2008).

In this paper we use comprehensive firm-level data from around the world to analyze the effect of access to telecom services—with particular attention to the Internet—on firm productivity and growth. We find evidence that the Internet acts as a general-purpose technology: firm growth and productivity are much higher when Internet access is greater and when firms use the Internet more intensively; and Internet access benefits firms in both high- and low-tech industries, firms of all sizes, and exporter and non-exporter firms. Small firms appear to benefit more from the Internet than large firms do. In contrast, fixed-line and cellular services are not robustly linked to firm performance.

This paper contributes to the literature on telecommunications and economic performance in two ways. First, it takes into account how different telecom services—cellular, fixed-line, and the Internet—affect firm performance differently. We find that firms grow faster and are more productive in countries with better Internet access and in regions of countries where firms use the web more intensively. Correlations between firm performance and Internet access are robust to different model specifications. In contrast, we find no evidence that firms perform better in countries with greater access to fixed-line and cellular services.

Second, rather than focusing on economic growth, we look at how access to telecom services affects firm performance. If telecom services are general-purpose technologies, firm performance should be better in countries with better telecom acces and in *all* industries—not just telecom-producing industries. Indeed, performance is better for all the firms that we consider: in both high- and low-tech industries; in small, medium-sized, and large firms; and exporters and non-exporters alike. Small firms, however, benefit more than other firms do.

Data and empirical methodology

We use worldwide firm-level data from the World Bank's Enterprise Surveys (WBES). The surveys have been completed in over 100 developing countries since 2006. Although the surveys include retail and service firms, we exclude them because detailed information on firm performance is only collected for manufacturing firms.[2]

To investigate the relationship between firm performance and telecommunications, we estimate the following regressions:

[2] The Enterprise Survey website (www.enterprisesurveys.org) describes the data.

$$y_{ijct} = \alpha + \beta_{TC}TEL_{ct} + \beta_{TI}TEL_{ijct} + \beta_F F_{ijct} + \beta_{BC}BE_{ct} + \beta_{BI}BE_{ijct} + \gamma_t + \mu_j + u_{ijct}$$

Subscripts *i, j, c*, and *t* represent firm, industry, country, and time. The dependent variables (y_{ijct}) are log labor productivity and sales growth. All regressions include time (γ_t) and sector dummies (μ_j). Some regressions include country-year dummies (i.e., unique dummies for each survey). To avoid overstating precision, we cluster the standard errors at the country level.

The most important independent variables are the country- and firm-level variables representing access to telecom services, TEL_c and TEL_{ijc}. The three country-level variables are fixed line density, mobile phone density, and Internet density (subscriptions per 100 people). These variables are omitted when we include country-year dummies. The final telecom variable is the percent of similar firms in the same city with a business website. We include this rather than a variable representing whether the firm has its own website because website use might be endogenous to firm performance. In contrast, it is difficult for one firm to change the local business environment, especially given that most WBES firms are small or medium-sized. To further reduce endogeneity concerns, we omit the firm's own response when calculating the average.[3] We refer to variables like this as local averages.

The regressions include firm, country, and local variables to control for other differences in firm characteristics and the business environment. The firm-level variables, F_{ijc}, include age and ownership. We also include initial sales in the regression for sales growth to allow large firms to grow differently from small firms. Additional country-level variables, BE_c, control for development (per capita GDP), geography (population and whether the country is landlocked), infrastructure quality (cost of exporting a standard container) and labor regulation (an index of the difficulty of firing workers).[4] Additional local averages, BE_{ijc}, control for access to formal finance and trade credit (% of firms with overdrafts and trade credit), competition (average markup and

[3] Many studies use a similar approach (Xu, 2011).

[4] Variables come from the World Bank's *World Development Indicators* and *Doing Business* project and the CEPII trade database.

country-industry-year tariff rates), and governance (% of firms that pay bribes).[5] These controls are employed to reduce the danger of the omitted variable bias: if the access to telecom services is correlated with the above determinants of firm performance (i.e., the level of development, geography, transportation costs, labor regulation, access to finance, competition, and corruption), the estimates of the telecom effects could be biased.

Empirical Results

Firms grow faster and are more productive in countries where Internet access is better (see Table 1). A one standard-deviation increase in the percent of firms with websites (35%) increases firm growth by 5.8 percentage points (or 20 percent of one SD of firm growth) and log labor productivity by 28 percent (or 16 percent of one SD of log labor productivity). Similarly, a one standard deviation increase in fixed line Internet subscriptions (5.2%) increases firm growth by 2.7 percentage points (or 9 percent of one SD of firm growth) and log labor productivity by 35 percent (or 20 percent of one SD of log labor productivity). These effects are thus economically significant.

Firms with better access to fixed line and cellular services do not perform better: the coefficients on fixed line and cellular subscriptions are mostly statistically insignificant. The one significant coefficient—on fixed line subscriptions in the productivity regression—is negative. This result, however, is not robust: it becomes statistically insignificant in several regressions for smaller subgroups of firms.

We perform several checks to see if the main results for the Internet variables are robust. We summarize these results in Table 2 and an online appendix. The robustness checks include:

1. *Including country dummies*. Now country-level variables, including the country-level telecom variables, are dropped due to collinearity.
2. *Including additional controls* (industry-country tariffs and local averages for markup and corruption). Such controls are potentially important if openness, competition and

[5] Tariffs are from the UN TRAINS database. All other variables are from the WBES.

corruption affect firm performance and are correlated with access to telecom services. Including them reduces sample size by between 6,500 and 11,000 observations and 9 and 11 countries.

3. *Dropping fixed-line and cellular subscriptions*.
4. *Including one Internet variable at a time* to avoid multicollinearity.

In all cases, the coefficients on the Internet variables remain positive, and significant with similar magnitudes after these changes.

We also re-run the regressions after dividing the sample into different groups: high-tech and low-tech industries; small, medium, and large firms; and exporters and non-exporters. The coefficients (in Table 2) remain significant in all cases. In most cases, the differences between groups are statistically insignificant. An exception is substantially and significantly smaller coefficients on the Internet variables for large firms than for small and medium-sized firms (SMEs). An interpretation is that cheap new communication technologies allow SMEs to expand their markets and improve technology to a greater extent.

Conclusions

Evidence from worldwide firm-level data shows that Internet services in general—and web use by local businesses in particular—are remarkably robustly linked to labor productivity and firm growth. The results also suggest that the Internet is a general-purpose technology—it benefits firms of all varieties no matter the level of technology, size, and export oridentation. Moreover, it benefits SMEs more than large firms.

Because the Internet has high returns and is a general-purpose technology, developing countries might be able to catch up with rich countries by investing in broadband technologies. Only 4.4 percent of Internet subscribers in developing countries are broadband subscribers compared with 24.6 percent in developed countries (Kelly and Rossotto, 2012). The fact that the Internet benefits SMEs more suggests that it may be particularly useful in achieving mulitple policy goals such as efficiency (since SMEs create more jobs) and equity (since SMEs employ

more poor people). Investing in the Internet and broadband technologies in developing countries might, therefore, be worthwhile.

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Table 1: Effect of telecommunications on firm performance

Column	(1)	(2)
Dependent Variable	Sales growth	Labor productivity (nat. log)
Observations	24,439	23,856
Number of Countries	130	130
Sector Dummies	Y	Y
Time Dummies	Y	Y
Telecom Variables		
Average web use	0.166***	0.007***
	(8.09)	(7.21)
Fixed line Internet subscriptions per 100 people	0.521**	0.058***
	(2.31)	(5.14)
Fixed line subscriptions per 100 people	0.016	-0.017**
	(0.09)	(-2.26)
Cellular subscriptions per 100 people	-0.028	-0.001
	(-0.83)	(-0.78)
Firm Characteristics		
Initial Sales (nat. log)	-4.922***	
	(-12.09)	
Age of firm (nat. log)	-1.143**	0.127***
	(-2.18)	(5.01)
% of firm that is foreign-owned	0.082***	0.006***
	(7.10)	(11.04)
% of firm that is state-owned	0.074*	0.001
	(1.94)	(0.80)
Local Averages		
% of firms with overdraft	7.154***	0.368***
	(4.16)	(4.17)
% of firms using trade credit	2.629	0.311**
	(1.12)	(2.35)
Country Controls		
GDP per capita (nat. log, PPP 2009 US$)	-2.169	0.337***
	(-0.87)	(3.05)
Population (nat. log)	-0.342	-0.087***
	(-0.72)	(-3.19)
Country is landlocked	1.360	-0.107
	(0.41)	(-0.76)
Cost of laying off worker	0.017	-0.000
	(0.47)	(-0.10)
Cost of exporting 20ft container	-0.002	0.000
	(-1.62)	(1.32)
Constant	63.972***	6.303***
	(3.76)	(6.51)
R-Squared	0.138	0.283

***, **, * Statistically Significant at 1%, 5% and 10% significance levels
Note: T-statistics in parentheses. Standard errors are clustered at country level.

Table 2: Coefficients on Internet Variables, by firm characteristics

	Sales Growth		Log Labor Productivity	
	Average Web Use	Fixed line Internet Subscriptions	Average Web Use	Fixed line Internet Subscriptions
Base regression	0.166***	0.521**	0.007***	0.058***
Country FE included	0.152***		0.006***	
Additional variables included	0.147***	0.458**	0.007***	0.058***
Telecom variables dropped	0.165***	0.509**	0.006***	0.037***
Average web use dropped		0.679***		0.068***
Internet subscriptions dropped	0.172***		0.008***	
High- vs. Low tech firms				
Low-tech firms	0.173***	0.533**	0.007***	0.059***
High-tech firms	0.144***	0.584**	0.005***	0.063***
Test of Equality (p-value)	0.15	0.80	0.07*	0.72
By firm size				
Small firms (<20 workers)	0.076***	0.844***	0.007***	0.066***
Mid-sized firms (20-99 workers)	0.070***	0.663***	0.006***	0.054***
Large firms (>=100 workers)	0.029*	0.565***	0.004***	0.034***
Tests of Equality (p-values)				
Small vs. large	0.05**	0.17	0.10*	0.06*
Medium vs. large	0.03**	0.55	0.06*	0.15
Small vs. medium	0.78	0.32	0.58	0.25
Exporters vs. Non-exporters				
Non-exporters	0.161***	0.566**	0.006***	0.061***
Exporters	0.128***	0.374*	0.004***	0.040***
Test of Equality (p-value)	0.09*	0.48	0.11	0.15

***, **, * Statistically Significant at 1%, 5% and 10% significance levels.
Note. Regressions are identical to regressions in Table 1except as noted.
T-statistics clustered at the country level. In the fixed effects regressions with no country-level variables, results are similar whether standard errors are clustered at local- or country-level.