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Chapter 4

The Role of ICT in Doing Business

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A vibrant private sector—where firms invest, create jobs, and improve their productivity—promotes growth and increases opportunities for poor people (World Bank 2004). There is a growing consensus in the development community that in order to improve the investment climate in their countries, governments should place a high level of priority on improving access to information and communication technology (ICT) as well as its quality.

A good communication and information infrastructure is an essential part of overall infrastructure; it can improve the connectivity between firms, suppliers, and clients as well as provide business opportunities, especially for companies that are physically distant from urban centers. Barr (2000) suggests that entrepreneurs with wider, more diverse contacts have more productive enterprises and are more likely to have access to supplier credit. A network of entrepreneurs—either by exchanging information through an industry-specific online bulletin or by establishing relationships with distant clients—can feed back into the traditional face-to-face network and accelerate endogenous firm growth.

Besides increasing firms' networks, ICT also reduces the historical advantages of long-established firms. This allows firms from developing countries greater opportunities to participate in international trade and become connected to foreign markets. Clarke and Wallsten (2004), in a study of 27 high-income countries and 66 developing countries, found that a 1 percentage point increase in the number of Internet users boosts total exports by 4.3 percentage points, and increases exports from low-income countries to high-income countries by 3.8 percentage points.[1] Freund and Weinhold (2004), in a study that included 56 developed and developing countries, also found a significant link between access to the Internet and trade growth for the period 1997–9. Specifically, they found that developing countries with the fewest established trade links benefit the most from using the Internet.

Furthermore, the internalization of ICT applications affects business operations directly. The ability to transfer information seamlessly through shared electronic files and networked computers improves the efficiency of business processes such as documentation, data processing, and other back-office functions (for example, organizing incoming orders and preparing invoices). Increasingly sophisticated ICT applications—such as customer resource management (CRM) and electronic data interchange (EDI)—allow firms to store, share, and use their acquired knowledge.[2] All this can reduce inefficiencies in the use of capital and labor and can lower operational and transaction costs among economic agents, thus improving the productivity and profitability of firms.

A growing number of firm- and industry-level studies have recently been carried out on the links between ICT and growth. One advantage of microeconomic studies is that they provide specific information on why and how firms adopt ICT applications and which aspects of the ICT adoption process are especially useful. Examination of

firm-level data also helps to reveal the effects experienced by different types of firms. The results can then be used to formulate targeted public policies and reforms. For example, in a country with high potential for agricultural exports, expanding a basic service such as e-mail may be the most beneficial policy because it would allow producers to communicate electronically with their agribusiness constituents. In another country, the garment industry may require more sophisticated corporate data services to provide the edge it needs to compete in overseas markets. For these reasons, we will also use firm-level data.

This chapter is organized as follows. In the next two sections we describe the firm surveys in more detail. We present the pattern of firm behavior related to ICT use along with the effect of ICT use on enterprise performance based on our empirical analysis. The following two sections identify the key obstacles to ICT adoption. We conclude by suggesting a number of policy issues that should be addressed to remove the obstacles identified.

Firm Behavior Related to ICT Use

The data used in this study come from Investment Climate Surveys (ICS) conducted by the Private Sector Development Network and Development Economics Research Group at the World Bank, in collaboration with local partners in the countries involved.[3] These surveys were conducted through face-to-face interviews between 1999 and 2003, covering 20,000 firms from 26 sectors in 56 low- and middle-income countries (see table 4.1) in East Asia and Pacific, Europe and Central Asia, Latin America and the Caribbean, the Middle East and North Africa, South Asia, and Sub-Saharan Africa.[4] The surveys include core questions, which are identical across countries. They also include country- and region-specific questions that are intended to provide greater information on specific investment climate issues that highlight country or regional characteristics.

ICS has the following three indicators for ICT use:

1. percentage of a firm's workforce regularly using computers in their jobs
2. whether a firm uses e-mail to interact with its clients and suppliers
3. whether a firm uses a Web site to interact with its clients and suppliers.

These indicators show which firms are currently using ICT in the 56 developing countries surveyed (see annex 4B for country-level summary statistics of these three and other ICT-related indicators).

Rates of E-Mail and Web Site Use

Firms in both manufacturing and service sectors use e-mail at a similar rate, but the use of Web sites and computers is much higher for service firms than for manufacturing ones. Although over 55 percent of firms in both sectors

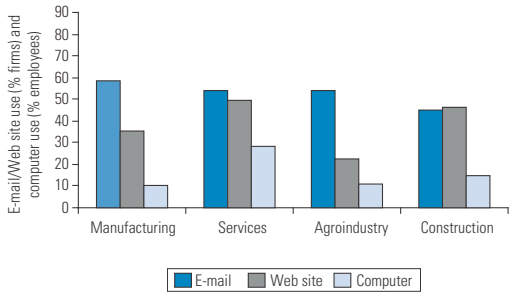
Table 4.1 Countries in the ICS Sample

Region	Country
East Asia and Pacific	Cambodia (503), China 2002 (1,548), China 2003 (2,401), Indonesia (713), Philippines (716)
Europe and Central Asia	Albania (170), Armenia (171), Azerbaijan (170), Belarus (250), Bosnia and Herzegovina (182), Bulgaria (250), Croatia (187), Czech Republic (268), Estonia (170), Georgia (174), Hungary (250), Kazakhstan (250), Kosovo (329), Kyrgyz Republic 2002 (173), Kyrgyz Republic 2003 (102), Latvia (176), Lithuania (200), Macedonia, FYR 2002 (170), Moldova 2002 (174), Moldova 2003 (103), Poland 2002 (500), Poland 2003 (108), Romania (255), Russian Federation (506), Serbia 2001 (402), Serbia 2003 (408) and Montenegro (100), Slovak Republic (170), Slovenia (188), Tajikistan 2002 (176), Tajikistan 2003 (107), Turkey (514), Ukraine (463), Uzbekistan 2002 (260), Uzbekistan 2003 (100), the former Yugoslavia (250)
Latin America and the Caribbean	Bolivia (671), Brazil (1,642), Ecuador (453), Guatemala (455), Honduras (450), Nicaragua (232), Peru (583)
Middle East and North Africa	Algeria (557), Morocco (859)
South Asia	Bangladesh (1,001), India 2000 (895), India 2002 (1,827), Pakistan (965)
Sub-Saharan Africa	Eritrea (78), Ethiopia (427), Kenya (284), Mozambique (1,940), Nigeria (232), Tanzania (276), Uganda (300), Zambia (207)

Note: Numbers in parentheses are the number of firms surveyed in each country.

Source: Authors' compilation.

Figure 4.1 E-Mail, Web Site, and Computer Use by Sector



Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

reported using e-mail to interact with their clients and suppliers, 50 percent of service firms and only 35 percent of manufacturing firms use Web sites for the same purpose (see figure 4.1).

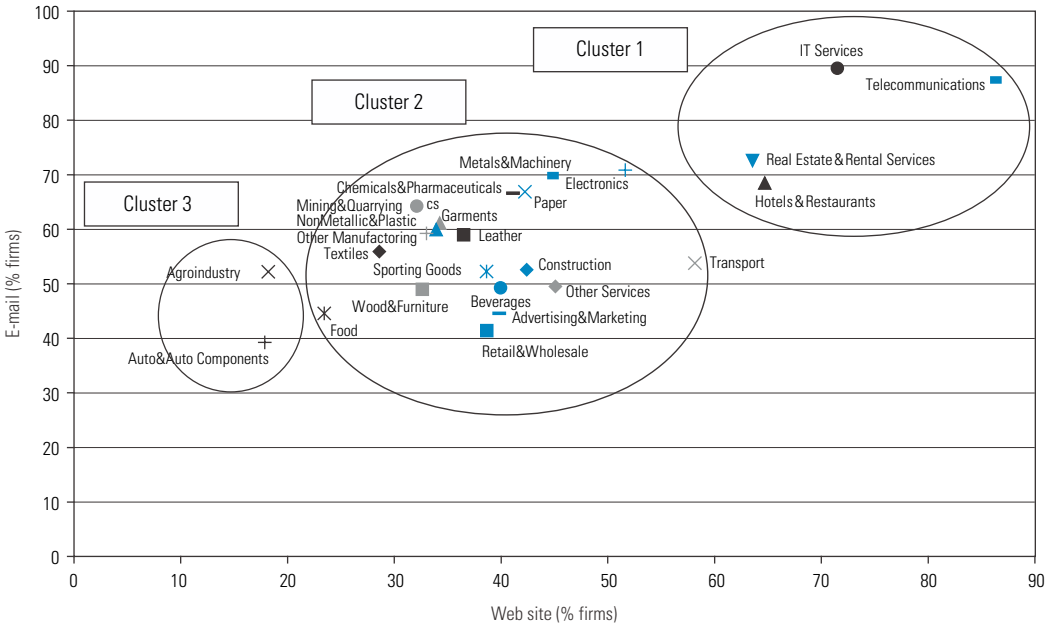
Exports of the manufacturing sector are twice the level of service sector exports, and the sector is likely to be more mature than service, finance, and retail sectors in most developing economies. In its markets, networks of clients and suppliers are already established, thus e-mail alone would suffice for many manufacturing firms to keep in contact with existing clients. Service firms, on the other hand, need to differentiate their products more than traditional manufacturers do, so they may want to use Web sites to disseminate information and cast a wider net to recruit new clients.

Computer use differs from e-mail use in that it does not necessarily infer communication. It suggests rather that the firm has invested in automation or processes business information electronically. A much higher rate of employees (40 percent more) use computers in service firms than in manufacturing firms. Service firms have a higher proportion of desk workers and may require many of them to work on individual computers, whereas manufacturing firm employees can share computers, or a single computer can run a series of processes.

Top ICT Users from Service Sector

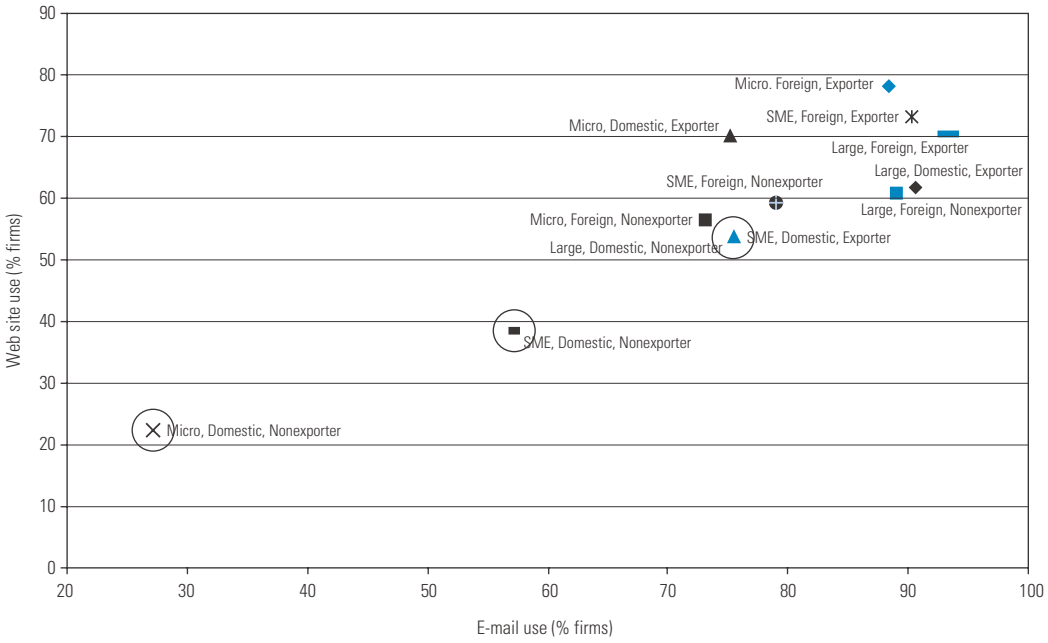
Firms in the IT and telecommunications industries appear to be the heaviest users of both Web sites and e-mail (Cluster 1 in figure 4.2). This is expected because these firms themselves are providing these services. In addition, close to 70 percent of firms use ICT applications to interact with clients and suppliers in both the real estate and the hotel and restaurant sectors. Although data on e-mail and Web site use are not available for the accounting and finance sector, this subsector has the highest percentage (67 percent) of employees using computers at work.

Figure 4.2 Web Site and E-Mail Use by Subsector



Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Figure 4.3 E-Mail and Web Site Use by Size, Export Orientation, and Ownership



Note: SME - small and medium enterprise.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

The second cluster in figure 4.2 is composed mostly of manufacturing firms. These firms' usage rates range from 30 to 50 percent for Web sites and from 50 to 70 percent for e-mail. The traditional sectors that have driven many developing economies forward, such as the agroindustry and automotive industry sectors, seem to be lagging in ICT use and fall into the third cluster. In most developing economies, an expanding service sector with information as an integral part could propel a shift toward ICT adoption.

Exporters and Foreign Firms More Likely to Use ICT

The upper-right cluster in figure 4.3 shows that exporters and foreign-owned firms rely significantly on e-mail and Web sites. Also, firms that are either exporters *or* have foreign ownership are relatively heavy ICT users regardless of the size of the firm.[5] In contrast, the size of a firm becomes a critical factor when the firm is both a nonexporter and domestically owned. Among the *micro nonexporting domestic firms*, only 27 percent use e-mail and 22 percent use Web sites to interact with clients and suppliers. If computer use affects firm productivity and IT expands networking within sectors and industries, the micro nonexporting domestic firms may not be benefiting from these externalities.

ICT Use Correlated with Income Level

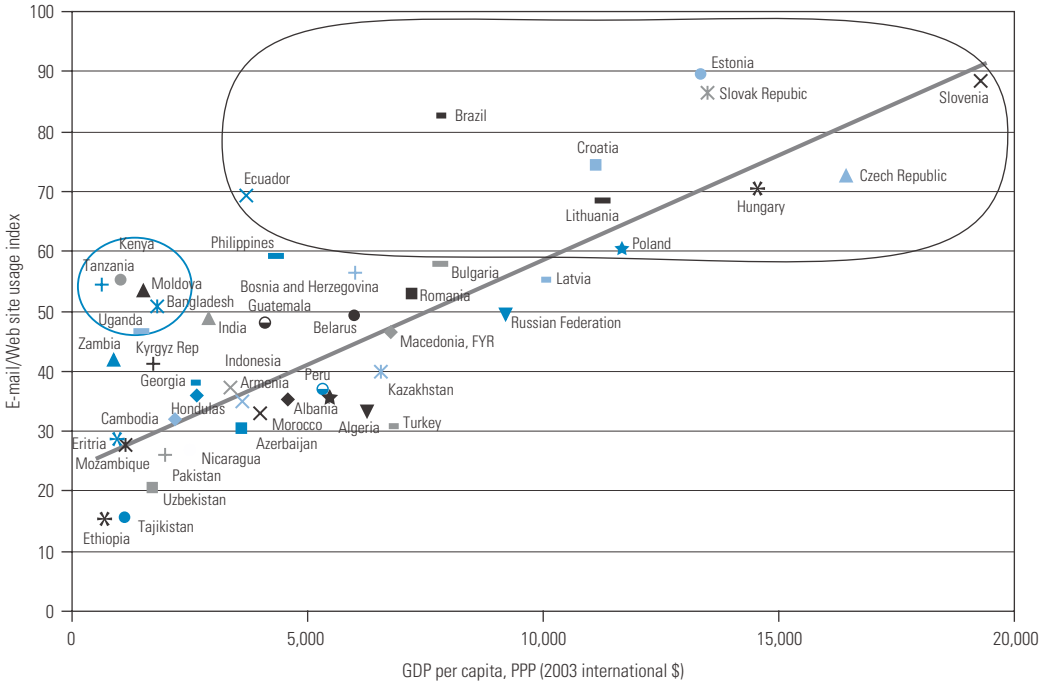
ICT use is highly correlated with income level**.** Countries with high ICT usage (that is, countries where between 60 and 90 percent of firms use e-mail or Web sites) have an average per capita GDP of $12,500. The top 10 e-mail and Web site users for client interactions are mostly in transition countries in Central and Eastern Europe. Brazil and Ecuador are the exceptions, both geographically and in their much lower income levels ($7,767 and $3,684, respectively).

Several low-income countries, such as Bangladesh, Kenya, Moldova, and Tanzania, have an average rate of e-mail and Web site use of between 50 and 60 percent, suggesting that ICT use is not a luxury (figure 4.4).

Does ICT Use Improve Enterprise Performance?

Increasing access to ICT is not a goal in itself. The real question is whether ICT use improves the performance of an enterprise. In this section, ICS data are used to test whether this is the case by looking at several measures of enterprise performance, including sales and employment growth, labor productivity, total factor productivity, and investment

Figure 4.4 E-Mail and Web Site Use by Country



Source: Authors' calculations based on data from the World Bank Investment Climate Surveys 2000–2003.

(see table 4.2). These performance measures are described in greater detail in annex 4A.

To reduce the possibility of finding a spurious correlation between enterprise performance and technology use, the impact of technology use on enterprise performance is estimated in a regression framework. This controls for other factors that might affect both enterprise performance and technology use.[6] These factors include firm size, export status, foreign ownership, age of the firm, country characteristics, and sector characteristics.[7] The empirical results are summarized in table 4.3. The detailed empirical findings are presented in annex 4C, tables 4C.1 to 4C.3.

Enterprise growth. Two measures of enterprise growth—sales and employment growth—are included in the analysis. After controlling for other enterprise characteristics (ownership, export status, size, and age) and for unobserved country and sector characteristics, we find that enterprises that used ICT more intensively tended to grow faster. Enterprises that used e-mail to communicate with their clients and suppliers grew 3.4 percentage points faster per year in terms of sales and 1.2 percentage points faster in terms of employment than those that did not. This is relatively high, given that the average annual growth rates for these variables were 3 percent and 5 percent, respectively.

Table 4.2 Enterprise Performance Measures

Variable	Measure
Sales growth	Average real annual sales growth for past three years
Employment growth	Average annual growth in employment for past three years
Profitability	Profits divided by sales
Investment rate	Total new investment over book value of current assets
Re-investment rate	Percentage of net profits re-invested in the enterprise
Labor productivity	Value added per worker in U.S. dollars
Total factor productivity	Technical efficiency

Source: Authors' analysis.

Table 4.3 Effect of ICT Use on Enterprise Performance in Developing Countries

Performance Indicator	Enterprises that do not use ICT	Enterprises that use ICT	Improvement
Enterprise growth			
Sales growth (percent)	0.4	3.8	3.4
Employment growth (percent)	4.5	5.6	1.2
Profitability (percent)	4.2	9.3	5.1
Investment[a]			
Investment rate (percent)	n.a	n.a	2.5
Re-investment rate (percent)	n.a	n.a	6.0
Productivity			
Labor productivity (value added per worker, dollars)	$5,288	$8,712	$3,423
Total factor productivity (percent)	78.2	79.2	1.0

Note: n.a. Not applicable.

a. Because the investment rates and re-investment rates are limited dependent variables (that is, they are truncated below at zero), the marginal improvements are not equal to the coefficients. For this reason, the authors do not calculate the average rates. The unconditional means for the two variables are 6 percent and 44 percent, respectively.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Profitability. Enterprises that used ICT more intensively were also more profitable. Profits as a percentage of sales were about 5 percentage points higher on average for enterprises that used the Internet to communicate with clients and suppliers than profits for those that did not, or more than 60 percent higher than that of the average enterprise in the sample, the profits of which were equal to about 7 percent of sales.

Investment. The empirical analysis includes two measures of investment: investment as a share of assets and the re-investment rate (investment as a share of profits). In general, enterprises that used ICT more intensively tended to invest more than other enterprises, although the impact of ICT on investment appeared to be less than its impact on growth and profitability. Enterprises that used e-mail to communicate with clients and suppliers re-invested about 6 percent more of their profits than other enterprises. This was only 15 percent higher than the average reinvestment rate of about 44 percent of profits. However, since enterprises that used ICT also tended to be more profitable, the impact of the higher investment rate is magnified.

Productivity. Finally, both labor and total factor productivity are higher for enterprises that use ICT more intensively. The coefficients for the three ICT variables are positive and statistically significant in both regressions. On average, technical efficiency is about 1 percentage point higher for enterprises that communicate with their clients and suppliers using e-mail (that is, they produce about 1 percent more output with the same inputs). Value-added for these enterprises is about $3,400 higher per employee (the average level is about $7,000 for enterprises in the sample). The larger relative impact on labor productivity is probably because enterprises that use information technology more intensively are more capital intensive overall.

In summary, enterprises that use ICT more intensively are more productive, grow faster, invest more, and are more profitable. These results are robust across different measures of ICT use and across different measures of enterprise performance.

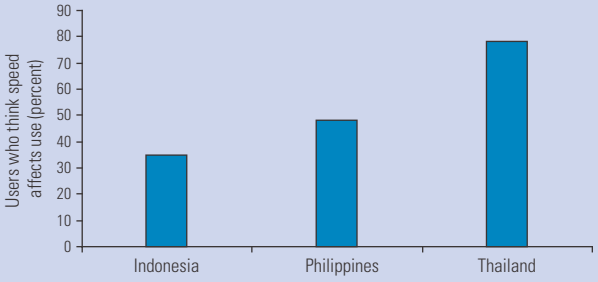
Impact of Telecommunications Infrastructure on ICT Adoption

If, as shown above, ICT applications offer "digital opportunities" to firms in developing countries, the natural assumption is that all firms would invest in these technologies and adopt them for doing business. This, however, has not happened. There continue to be significant differences in ICT adoption rates depending on income levels, firm size, ownership structure (foreign or domestic), and export orientation.

Box 4.1 Impact of Telecommunications Infrastructure on ICT Use

The lack of available telephone lines and Internet service providers (ISPs) has been cited as a major barrier to ICT use among small and medium enterprises (SMEs) in Indonesia, the Philippines, Sri Lanka, and Thailand. Availability was seen as being particularly problematic outside major cities. Speed of connectivity was also a major concern (see figure). In Indonesia, for instance, 66 percent of Internet users found service slow or very slow, with some businesses avoiding online research or downloading documents because of the slow speed and frequent disconnections. In Thailand, speed of connection was considered the primary criterion for choosing an ISP.

Impact of Slow Connectivity on Internet Use



Source: Asia Foundation 2002.

Among the obstacles to adopting ICT that can explain this phenomenon, insufficient availability, affordability, and poor quality of the existing telecommunications services are likely to be initial concerns for enterprises in many developing countries. One major constraint is bandwidth for data traffic. Slow and unreliable access limits ICT use (see box 4.1).[8]

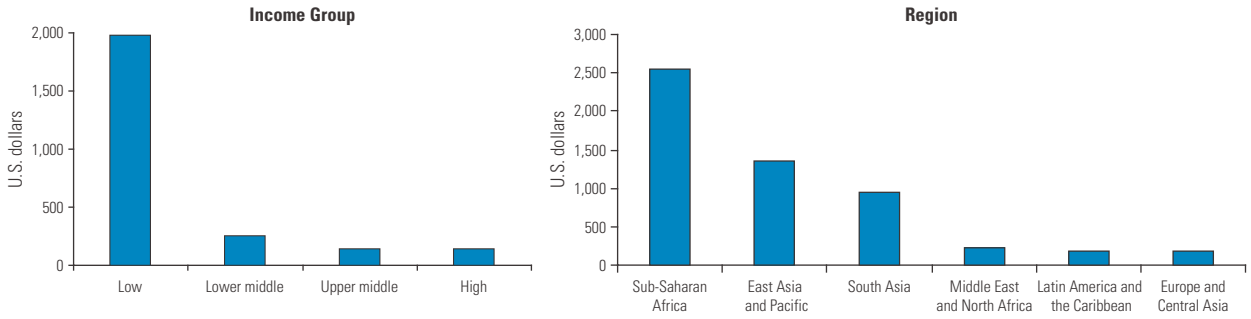
Telecommunications services are also much more expensive in developing countries than in developed countries, even without taking income level into account. Prices for broadband (defined by the ITU as a dedicated connection to the Internet of 256 kbs or faster) varied significantly between income groups and regions (see figure 4.5). In 2004, the monthly charge for a 256 kbs speed connection for high- and middle-income countries was on average $180. For low-income countries (with a GNI per capita of $825 or less), the charge was $1,976.

ICS Data on Telecommunications

The ICS surveys contain two types of questions on telecommunications:

1. Objective questions on sector performance. Examples of questions include how many days telephone service was interrupted during the previous year, how much telecommunications service interruptions cost the firm (as a percentage of sales), how long it takes to get a

Figure 4.5 Monthly Broadband Charges by Income Group and Region, 2003



Note: Broadband means a connection speed of more than 256 kbs. Categories calculated by authors using 2003 World Bank income and region classifications.

Source: Authors' analysis based on data from ITU 2003.

fixed-line connection, and whether a bribe needs to be paid to get a fixed-line connection.

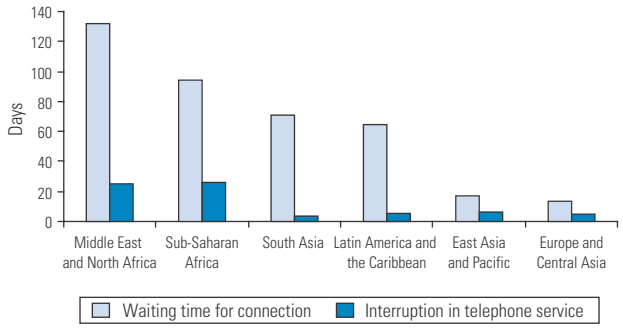
2. Subjective questions on enterprises' perceptions about telecommunications service. These questions most notably include asking managers how significant an obstacle poor telecommunications service is for the operations and growth of their business.[9]

There are large differences in wait days for telephone connections across countries and regions. For example, businesses in the Middle East and North Africa region wait, on average, 132 days for a telephone line connection. This is almost eight times the wait in either the East Asia and Pacific region or the Europe and Central Asia region. Businesses in the Middle East and North Africa and in Sub-Saharan Africa are more than five times as likely to experience telephone service interruptions than firms in Latin America and the Caribbean or in South Asia (see figure 4.6).

Firms in many developing countries also face regulatory and bureaucratic delays. Depending on the nature of the business and its dependence on ICT, an individual firm may need to offer a bribe to speed up transactions or to acquire a particular telecommunications service. Out of the 22 countries where the question was asked, respondents reported paying bribes in 20 of them (the only countries where bribes were not reported were Poland and Uzbekistan). Firms in over a dozen countries indicated the amounts of bribes (see figure 4.7). In Honduras, firms paid an average bribe close to 1,400 percent of the telephone connection charge in order to get the connection.

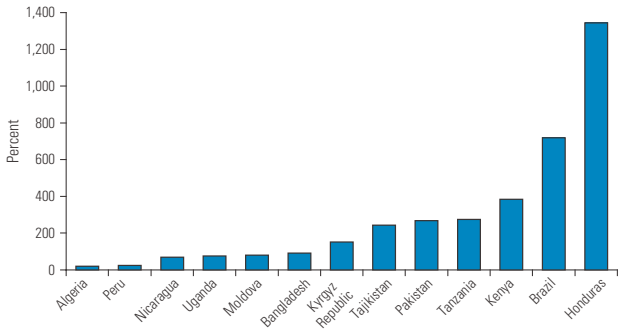
Our analysis also shows that a bribe was paid by 10 percent of the firms (out of the total of 3,837 that responded) to get a fixed-line connection. Only 6 percent of firms in IT services (16 firms) and none of the firms in telecommunications paid bribes. Furthermore, both telecommunications and IT firms indicated relatively few wait days: 4.5 and 15.3, respectively, compared with 36 days on average. Firms in the telecommunications and IT services industries are likely to have easier access to regulators and telecommunications authorities.

Figure 4.6 Quality of Telephone Service by Region



Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Figure 4.7 Bribe Value as a Percentage of Telephone Connection Charge



Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Impact on ICT Adoption

To investigate more fully the impact of telecommunications services on the probability that the firm uses ICT, multivariate Probit analysis was used to estimate how much the quality of telecommunications infrastructure affects e-mail, Web, and computer use (see annex 4C for the details of this analysis).

The number of days it takes to get a fixed-line telephone is used as a proxy for the quality of telecommunications service. This measure was chosen because it is available for more countries than other measures. The negative and statistically significant coefficients for this variable (see table 4C.4 in annex 4C) suggest that, when the quality of telecommunications service is poor, firms are less likely to use e-mail or the Web to communicate with clients, and are less likely to use computers.

The effect of the quality of telecommunications service, however, appears relatively small. For example, raising the service quality from the level observed at the 20th percentile of quality to the level observed at the 80th percentile would increase the average probability that a firm in the sample would use e-mail to communicate with clients and suppliers by 3.5 percentage points (a 5.4 percent increase). Similarly, higher-quality service would increase the probability that a firm would use the Web to communicate

Table 4.4 Effect on IT Use of Moving from Poor to Good Telecommunications Service

Quality of telecommunications service	Increase in probability of using e-mail to communicate with clients (percentage points)	Increase in probability of using Web to communicate with clients (percentage points)	Increase in number of workers using computers (percentage points)
Days waiting for a connection	3.5	1.8	2.2

Note: Probabilities are calculated for all enterprises in the sample and then averaged over all enterprises to find the average probability.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

with clients and suppliers by 1.8 percentage points (a 5 percent increase). It would also increase the number of workers using computers by 2.2 percentage points (a 12.6 percent increase) (see table 4.4).

Although the results for e-mail and Web use are robust for the different measures of the quality of telecommunications service, the results for the percentage of workers using computers are not robust.[10] This is not surprising because computer use alone does not rely directly on telecommunications service.

Other Factors Affecting ICT Use

Because the ICA surveys were conducted to provide a general analysis of investment climate, the coverage of ICT questions was limited. The questions mainly required "yes" or "no" responses on ICT use, but they did not provide further insights about

1. how often a firm uses ICT,
2. for what purpose a firm uses ICT (such as information search, monitoring the market/prices, banking and financial services, and so on),
3. e-commerce (for example, purchase and sales via EDI or Internet), or
4. barriers to the use of ICT.

In order to identify the obstacles that hinder the adoption and use of ICT by firms in developing countries, we reviewed five other firm-level surveys that included specific questions about reasons for not adopting ICT.

- **London School of Economics (LSE) and Institute of Development Studies (IDS) E-Commerce Survey (2003).** More than 180 e-marketplace sites were surveyed to examine their role in supporting firms seeking to participate in international trade. Seventy-four managers from exporting firms in the garments and horticulture sectors in Bangladesh, Kenya, and South Africa, along with 37 other key informants in these countries and Europe were interviewed about their experiences with the uptake of business-to-business (B2B) e-commerce applications (Humphrey et al. 2003).
- **Mekong Project Development Facility (MPDF) Survey of Current IT Usage at SMEs in Vietnam (2003).** Manufacturing and trading firms located in Hanoi and Ho Chi Minh City were interviewed to assess how ICT is applied in small and medium enterprises (SMEs) in Vietnam, and to identify the pressing issues of ICT adoption in those firms (MPDF 2003).
- **CRITO Global E-Commerce Survey (2002).** This survey included 2,139 firms in 10 economies (Brazil, China, Denmark, France, Germany, Japan, Mexico, Singapore, Taiwan [China], and the United States). Questions in the survey covered the use of e-commerce technologies, drivers for Internet use and barriers to conducting business on the Internet, benefits from e-commerce use, prevalence of online sales, and online service offering (CRITO 2002).
- **South Africa E-Commerce Survey (2002).** The empirical evidence is drawn from 120 firm-level interviews and 31 personal interviews with industry experts in the South African manufacturing sector regarding firm perception and experiences in e-mail and Internet use for conducting business operations (Moodley 2002).
- **World Information Technology and Services Alliance (WITSA) International Survey of E-Commerce (2000).** Twenty-eight of the WITSA members from both developed and developing countries were interviewed about their views on the best way to encourage the growth of e-commerce (WITSA 2000).

According to these surveys, there is a range of reasons that firms in developing countries hesitate to use ICT (table 4.5).

Table 4.5 Barriers to ICT Adoption in Selected Countries

Barrier	Brazil	China	Singapore	Global
Need for face-to-face interaction	..	..	38	34
Concern about privacy of data or security issues	49	45	48	44
Customers do not use the technology	48	33	..	31
Finding staff with e-commerce expertise	34	..	..	..
Costs of implementing an e-commerce site	34	..	45	34
Making needed organizational changes	..	..	38	..
Level of ability to use the Internet as part of business strategy	..	31	..	..
Business laws do not support e-commerce	..	41	..	..
Inadequate legal protection for Internet purchase	41	55	44	34

Note: The numbers refer to the percentage of firms citing obstacles (top five for each country). .. Not available.

Source: CRITO 2002, quoted in Wong and Ho 2004.

These reasons vary considerably among sectors and countries.[11] They also change over time and depend on a country's progress along the ICT adoption ladder.

Besides the limitations of the existing telecommunications infrastructure in developing countries (as already revealed through the ICS analysis), the principal constraints in adopting and using ICT applications can be summarized as follows:

1. lack of applicability and little incentive to change business models when returns are not clear;
2. lack of trust in e-business processes and legal protection including privacy of data, online transactions, authentication, and security; and
3. shortage of ICT-skilled labor.

Lack of Applicability and Little Incentive to Change Business Models When Returns Are Not Clear

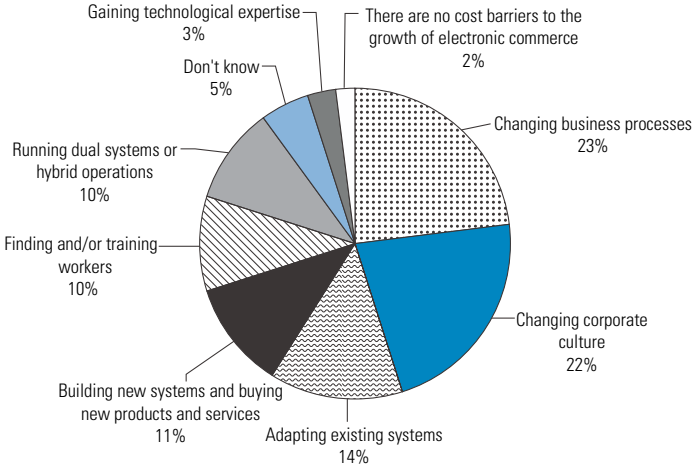
Both the LSE/IDS survey and the WITSA survey found that many firms in developing countries are not fully aware of the opportunities and benefits that can be derived from an ICT-enabled business environment. Clearly, for firms to adopt ICT strategies and applications, the potential returns must outweigh investment and maintenance costs. Beyond a certain level of connectivity (PC, Internet access, and online information or marketing), many firms will stay with traditional business processes if they believe ICT is unsuitable for their business, or if expected returns are small.

But the decision of whether to adopt ICT often depends on the perceived benefits to the firm's existing business operations and clientele networks. This is contrary to the notion that the Internet will enable access to larger markets and therefore create the opportunities for firms' business to grow. For example, if a firm's existing clients and suppliers are not using the Internet and do not have the necessary ICT capabilities, the firm may not see any direct benefit of using ICT in its business operations. Moodley (2002), in his survey of South African firms, found that even those firms that do use e-mail and Web sites do so with existing clients and suppliers, and do not seem to be expanding their markets.

Although direct benefits are sometimes not clear, there is increasing evidence that e-business is a complex and costly undertaking that calls for substantial investments and institutional changes (figure 4.8). Adopting ICT could affect all aspects of a company's operations and business processes, especially its distribution, supply chain, customer service, marketing, and finance. This involves costs that range from building new systems and buying new products (such as computers) and services to running dual systems or hybrid operations (incorporating old business processes) and gaining technical expertise (such as hiring skilled workers to build a Web site).[12] Moreover, the ICS surveys also show that the ability to absorb ICT costs differs according to firm characteristics (box 4.2). There are, however, no systematic methodologies to help firms assess the costs of adopting ICT and pursuing online activities.[13]

Even when a firm is convinced that it is necessary to integrate ICT in its business operations, a typical developing-country firm may still face the following obstacles:

Figure 4.8 The Most Significant Costs That Obstruct E-Business
(percentage of survey respondents)



Source: WITSA 2000.

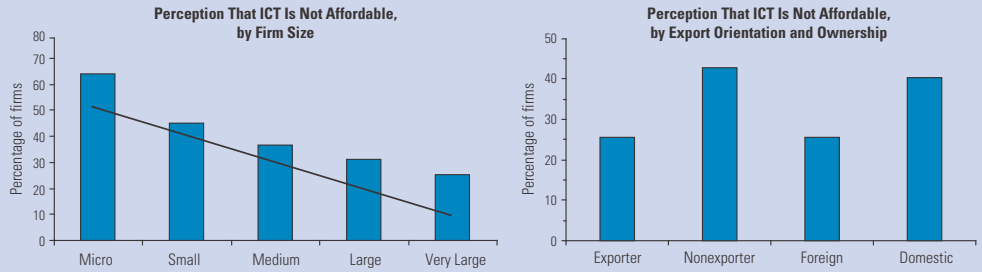
1. lack of understanding how ICT can help to conduct business differently (see box 4.3);
2. lack of accepted, coherent, and industry-specific e-business models in practice;
3. inertia and internal reluctance to change existing corporate culture and operating structures; and
4. logistical challenges of integrating into a real-time environment (for example, inadequate transport infrastructure to deliver the firm's products).

Lack of Trust in E-Processes and Legal Protection

All five firm-level surveys found that the lack of trust in e-mail or Internet-based activities is one of the major

Box 4.2 Perception of ICT Affordability

The ICS data analysis shows that the ability to absorb ICT costs differs according to firm size. Smaller firms find it more difficult (see figure). Although 63 percent of micro firms said ICT services were not affordable, only 25 percent of very large firms felt the same way. The figure also shows that foreign, export-oriented firms tend to have more positive perceptions about ICT affordability. One explanation for this might be that foreign-owned firms are more likely to receive technical support and resources from their parent companies, and are also richer on average than domestic firms, so their affordability is higher. Export companies may understand the benefits of ICT use more easily because of the nature of their business. Another explanation might be that service affordability is more of a concern and the benefits harder to imagine for domestic, nonexporting firms.



Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Box 4.3 Internet: No More than a Bulletin Board?

Business dropped dramatically at a small hotel in Sengiggi, Indonesia, after a riot, with occupancy rates falling to less than 10 percent. To boost business, in 1999 the hotel invested in developing a Web site, hoping to attract more customers. However, the managers lacked basic understanding of how to use the Web site and the Internet. After the hotel paid a one-time fee to the Web designer, it never updated or improved the site, nor did it check to see whether the site had been registered on any one of the major search engines. The hotel had five computers, but only one was connected to the Internet. That computer was located in the director's office and only the manager was allowed to check e-mails, and that only once a month. Not surprisingly, the company was dissatisfied with its "e-business" experiment. Such cases are not uncommon in developing countries where firms expect ICT to transform their business without analyzing *how* ICT helps them to conduct business differently. Furthermore, a Web site is a live communication and transaction medium requiring constant monitoring for it to add business value.

Source: Asia Foundation 2002.

constraints for uptake of ICT. From a firm's perspective, trust in e-processes implies confidence that

- online information and communication are accountable for the quality, reliability, and legality of products and services;
- personal information and finances are secure;
- electronic purchases, fund transfers, and business deals are considered equal to paper-based transactions in terms of validity.

Both the WITSA and the LSE/IDS surveys highlighted the firms' fear that the technology platform is not robust enough to protect online transactions, information privacy, and data integrity. Uncertainty about the identity of communicating parties could further complicate these concerns (see box 4.4 for an illustration of how a trading company deals with electronic business inquiries). Internet security software such as firewalls, encryption technology, antivirus packages, authentication routines, and security administration systems have been developed to mitigate these concerns.

On top of the technical dimension of adopting ICT in business practices, shifting from traditional interactions to electronic transactions has led to a number of legal and regulatory concerns. The lack of a satisfactory redress mechanism when things go wrong online may strongly discourage online transactions. Moreover, in the case of cross-border transactions, often there is no harmonized legal framework with rules that pertain to the determination of jurisdiction and applicable law, nor are there mechanisms that ensure the cross-border enforcement of legal rulings. Businesses can risk being sued in multiple jurisdictions under a number of inconsistent laws.

Particularly in developing countries, access to reliable advice on appropriate security measures is often at a premium. In these countries, the cost of keeping abreast of rapid developments in the complex technological and legal issues involved in online transactions may be too high for many firms.

Shortage of ICT-Skilled Labor

Another barrier is the availability of ICT competencies within the firm. The WITSA survey listed workforce concerns in order of importance (see figure 4.9).

Skilled labor plays an important role because it affects the absorption rate of ICT applications within a country. Some nations depend on a small set of skilled local or foreign ICT workers, which limits the development of e-business. For example, the Bhutanese government, in order to encourage ICT use by businesses, recently began to incorporate ICT programs at the university level to supplement its existing ICT-skilled labor force, which was composed mostly of Indian migrant workers (Bhutan, UNDP, and World Bank 2002).

However, this does not necessarily mean that all countries require a highly ICT-skilled workforce to integrate the newest technologies available. The labor force should,

Box 4.4 A Fruit and Vegetable Trader's Experience in the E-Marketplace

A small fruit and vegetable trading company in Nairobi registered with open e-marketplaces and was interacting with potential buyers who, through e-mails, inquired about macadamia nuts from Switzerland, carrots from Romania, and oranges from the Ukraine. The owner of the firm outlined his procedures for dealing with an e-mail inquiry:

- Ignore any inquiry from a firm with a hotmail or Yahoo e-mail address.
- Check to see if the company making the inquiry has a Web site, and possibly consult Web-based "Yellow Page" business directories.
- Consider the product requested. It is better to deal with robust products (for example, fruit rather than vegetables) because the logistical requirements are simpler.
- Check on the Internet to see who the competitors are in the market being supplied, in particular to see whether and when there are supply gaps in the market.
- Follow up the inquiry with a quote based on the cost of local sourcing, packaging, freight costs, and the exporter's markup. Contact with the customer is predominantly by e-mail.

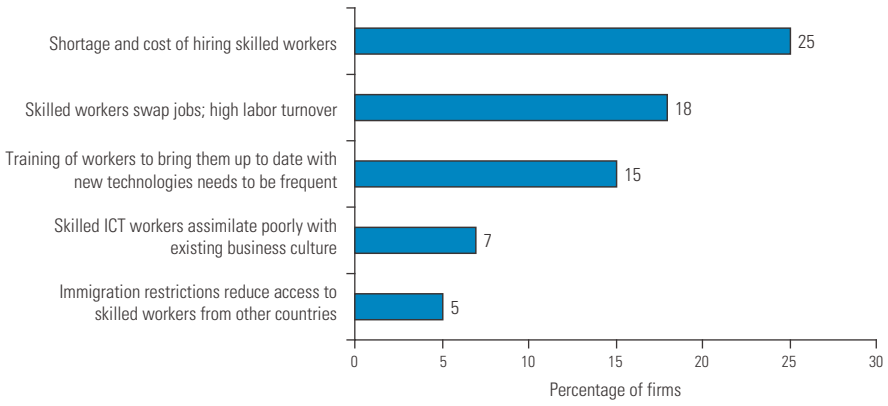
Although the trading firm was thorough in its online dealings, after some unfortunate experiences of nonpayment, the exporter was demanding a 50 percent down payment and the remainder on proof of shipment.

Source: Humphrey et al. 2003.

ideally, adjust to ICT technology and applications that are used in the country and within industries. For example, a study of Philippine workers made it evident that Internet-based businesses do not necessarily require highly skilled labor (De Vera 2002). Rather, there is a need for semi-skilled ICT labor in certain industries, such as tourism, electrical communications equipment, and telecommunication services (for example, in call centers).

Apart from the lack of ICT-skilled and semi-skilled labor, a significant number of the firms also lack managerial understanding and skills for successfully integrating ICT applications. Many firms rely on internal ICT enthusiasts as their main source of ICT skill and knowledge. Business executives who run the firms may not know what the options are for ICT solutions; in many ways, they do not know what they need to know to make decisions about the

Figure 4.9 Main Constraints on ICT-Skilled Workforce



Source: WITSA 2000

allocation of resources and effort regarding ICT equipment and human resources.

Appropriate management of ICT adoption requires a firm to have personnel who can combine both business and technology disciplines to do the following:

- select from a broad range of ICT applications (from basic use of e-mail to the much broader concept of data exchange or supply chain management) that would save time and resources for business processes and strengthen the firm's core competence;
- provide guidelines on which types of ICT technologies and telecommunications services would be most appropriate for their firm (or industry);
- avoid incompatible systems and networks between firms, clients, and suppliers (or regions); and
- maintain and upgrade ICT applications to fit business needs and technology changes.

The professional advice of ICT consultants can help, but such consulting is both scarce and costly in most developing countries.

Public Policies

This analysis and other microeconomic studies have identified a number of barriers that hinder firms' adoption of ICT. The potential benefits of ICT applications in businesses are more likely to come to fruition if policy makers focus on removing these obstacles. Specifically, governments can

- create appropriate environments for ICT uptake. This includes liberalizing markets to expand and improve network infrastructure, providing a supportive legal and regulatory environment for e-business, and taking steps to enhance technological diffusion.
- target programs to overcome market failures. Often, such programs are needed in particular areas such as demand aggregation (for example, by developing e-government services and encouraging firms to use them) and skill formation (for example, by emphasizing ICT in curriculum).

Easing Bottlenecks in the Telecommunications Infrastructure

The availability of a wide range of high-quality communications services at competitive prices is important: this allows firms to choose technologies and services appropriate to their business needs. Experience in OECD countries shows that the availability of affordable access to a high-speed telecommunications infrastructure is closely linked with a firm's migration to e-business (OECD 2004). In developing countries, analog modems are still the dominant way to access the Internet, and speed of access remains an issue for business use. New broadband technologies, such as cable modem and digital subscriber line (DSL), offer faster connections. Governments will need to play a leading role in promoting the modernization and extension of the national information infrastructure.

A priority for policy is therefore to continue to emphasize liberalizing the telecommunications market and promoting effective competition (see box 4.5). This will stimulate new investment in additional bandwidth, increase demand for communication services through falling prices, and promote greater efficiency and innovation in the provision of infrastructure and services. Policy initiatives to promote technology neutrality among competing and developing technologies are also important for encouraging interoperability, innovation, and choice among services.

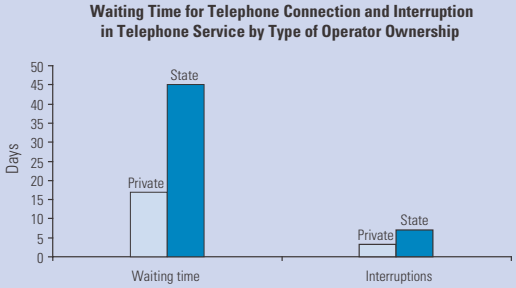
E-Trust

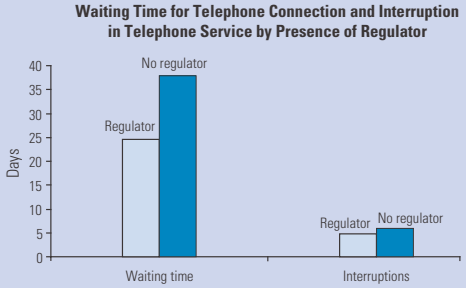
The government's support of a regulatory framework for trust, security, enforcing authentication mechanisms, and combating cyber-crime—combined with internationally accepted privacy and consumer protection protocols—is essential in encouraging business use of ICT applications. Of particular relevance for firms are low-cost online dispute resolution mechanisms both among firms and between firms and consumers.

Countries are developing e-security policies and programs, including public key infrastructure (PKI) and computer emergency response teams (CERT). These policies and programs are often a combination of top-down, government-led initiatives together with bottom-up, industry-led programs. PKI supports digital signatures and other public security services, and is necessary in laying the foundation for e-applications such as e-signature, e-notarization, and e-certification. The CERT program, a multi-agency information-sharing framework, aims at assessing and managing e-security risks, providing training and emergency alert and response services, and offering backup to ensure the continuity of network systems and applications.

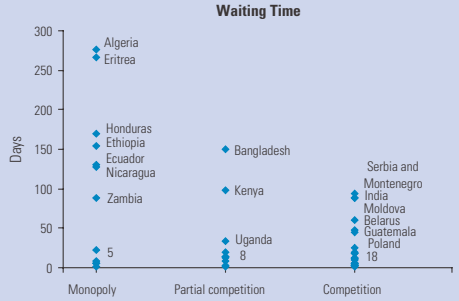
Box 4.5 Pro-competitive Regulatory Framework to Ease Telecommunications Bottlenecks

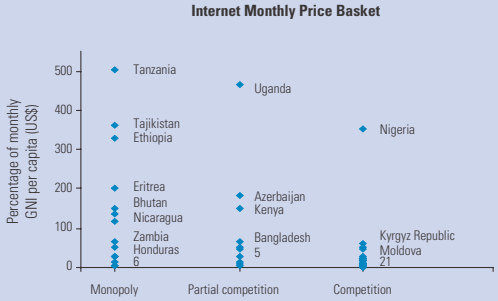
Based on the ICS analysis, firms in countries with private operators or a separate telecommunications regulatory authority experience fewer wait days for telephone connections and interruptions in telephone service (top pair of figures). Among the top 10 countries experiencing many wait days for telephone connections, only two have a competitive market (bottom pair of figures).





Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.





Source: Authors' analysis based on data from ITU 2003 (price and sector structure) and from World Bank (waiting time and GNI per capita).

The government's role in providing a pro-competitive regulatory framework is clearly critical to ease the bottlenecks hampering the development of a telecommunications infrastructure.

Demand Aggregation

Firms will adopt ICT when they are convinced of its applicability and potential returns. They need to make realistic assessments of e-business opportunities, benefits, and costs. Policy measures that encourage business associations or other groups to provide awareness-raising and consultation services can be beneficial. A measure that could mitigate some of the costs associated with ICT use, open source software has been proposed as an economically viable solution for establishing and upgrading ICT systems. Open source software can foster wider compatibility between different applications and operating systems, and it can lower the cost of ICT adoption, especially for SMEs.

In addition, the provision of information and services online by the government itself can demonstrate the effects of ICT on businesses by spreading awareness of the potential for online delivery and interaction, and offer incentives for the adoption of ICT. Governments, as model users, can also act as standard-setters for ICT adoption by firms. In order to ensure access to public services and obligatory requirements for business purposes, firms would adjust their choice of systems and software to maintain interoperability with these online government services. Public e-procurement provides

such an example. Government demand aggregation to provide services can also contribute to promoting trust and security in online transactions.

Building Human Resources

For ICT investment to be fully effective, one has to take advantage of "network externalities." This requires that a large enough number of firms make the investment and become connected to the network. Moreover, network externalities are fully exploited only when those using ICT communicate among themselves effectively, rapidly, and efficiently. This requires that users have certain levels of technical, analytical, and problem-solving skills.

Lack of ICT and business skills is a widespread impediment to effective uptake once adoption decisions have been made. Governments have major roles to play in providing basic ICT skills in compulsory schooling, and an important role in conjunction with educational institutions, businesses, and individuals in providing the framework to encourage ICT skill formation at higher levels as well.

Governments might also help firms to confront the difficulties of technological learning in a developing-country context. It can assist companies by putting in place a set of complementary institutions and associations that provide advice on technology choice, identify and disseminate information of best practices, and assess the available e-commerce technologies and approaches. This can be especially effective through the support of training and skills development.

Conclusion

Results from firm-level survey analysis suggest that ICT is widespread in businesses across sectors and income levels. Also, ICT is playing an important role in allowing businesses to grow faster and become more productive—this alone suggests that creating an appropriate environment to exploit ICT is important. Governments can liberalize the telecommunications market to allow affordable access to network infrastructure, provide a supportive legal and regulatory environment for e-business, and overcome market failures in areas such as demand aggregation and skill formation. But it is clear that the relevance of ICT varies across industries and income levels, implying the need for realism and a tailored response. Beyond a certain level of connectivity (computer use, Internet access, online information, or marketing), many firms in developing countries may choose to stay with traditional business processes either because the more sophisticated ICT applications are unsuitable for their business, or because expected returns from business reengineering are small. Any supporting role played by ICT is crucially dependent on business processes within firms and the broader economic environment beyond them.

Annex 4A: Measures of Firm Performance

This annex describes the construction of the performance variables used in this study:

- sales growth
- employment growth
- investment rate
- re-investment rate
- profitability
- labor productivity
- total factor productivity (TFP).

Descriptions of the formulas used to calculate the various productivity measures, other than TFP, are described in table 4A.1. The construction of the measure for TFP is explained in detail below.

Data

The data used in this study come from Investment Climate Surveys (ICS), which were filled out by trained enumerators during face-to-face interviews that lasted about three hours. Most questions were answered by the owner or managing director of the firm. Exceptions were the specialized questions on employment and company accounts; these were directed toward the relevant professionals (for example, human resource managers or accountants).

The surveys, conducted between 1999 and 2003, cover firms from 26 sectors in about 56 low- and middle-income countries in all regions. The surveys include both core questions and country- and region-specific questions. Although, in principle, the core survey should be identical across countries, some questions have been added or dropped over time and not all questions have been asked in all countries. For instance, balance sheet and income statement data were not collected for some countries, meaning that most productivity measures cannot be calculated for the firms in those countries. Table 4A.2 contains information on which

Table 4A.1 Productivity Measures

Variable	Measure
Sales growth	**Average real annual sales growth for past three years** If data were not available for all three years, then the average was calculated over available years. Nominal values are converted to real values using GDP deflator (that is, sector-specific deflators were not available).
Employment growth	**Average annual growth in employment for past three years** If data were not available for all three years, then average was calculated over available years. Workers include both temporary and permanent workers.
Profitability	**Profits divided by sales** Profits are sales less expenditures on intermediate inputs, energy, interest expenditures, and overhead costs.
Investment rate	**Total new investment over book value of current assets**
Re-investment rate	**Percent of net profits re-invested in establishment** Question was asked directly of managers during survey (it is not calculated). Data are missing for firms with negative net profits.
Labor productivity	**Value added per worker** Value added is sales less expenditures on intermediate inputs and energy (electricity, fuel, and other). Workers include both temporary and permanent workers. Converted to U.S. dollars using the average exchange rate for the year of the survey.
Total factor productivity	**Technical efficiency (see text for calculations)**

Source: Authors' analysis.

surveys contained enough information to calculate each of the productivity measures.

The surveys were conducted in a uniform way across countries. The sampling frames were stratified across location within each country, subsector, and enterprise size. When recent census data were available, the random samples were constructed using census data. If recent census data were not available, the lists were constructed using lists of enterprises from government agencies (for example, from the National Bureau of Statistics in Tanzania). As a result, the surveys ultimately cover the formal sector—firms that need to be registered are included. When firms could not be located or refused to participate in the survey, they were replaced with new firms with characteristics as similar (in terms of size, sector, and location) as possible.

Table 4A.2 Countries with Enough Data to Compute Productivity Measures

	Year	Employment growth	Sales growth	Profitability	Investment rate	Re-investment rate	Labor productivity	Total factor productivity
Albania	2002	X						
Algeria	2002	X	X					
Armenia	2002	X						
Azerbaijan	2002	X						
Bangladesh	2002	X	X	X	X		X	X
Belarus	2002	X						
Bosnia and Herzegovina	2002	X						
Bolivia	2000		X	X				
Brazil	2003	X	X		X	X		
Bulgaria	2002	X						
Cambodia	2003	X	X	X	X	X	X	X

(*Table continues on the following page.*)

Table 4A.2 *continued*

	Year	Employment growth	Sales growth	Profitability	Investment rate	Re-investment rate	Labor productivity	Total factor productivity
China	2002	X	X	X			X	X
China	2003	X	X	X		X	X	X
Croatia	2002	X						
Czech Republic	2002	X						
Ecuador	2003	X	X	X		X	X	X
Eritrea	2002	X	X		X		X	X
Estonia	2002	X			X			
Ethiopia	2001	X	X	X			X	X
Macedonia, FYR	2002	X						
Georgia	2002	X						
Guatemala	2003	X	X			X		
Honduras	2003	X	X			X		
Hungary	2002	X						
India	2000	X	X	X	X		X	X
India	2002	X	X	X	X		X	X
Indonesia	2003	X	X		X	X		
Kazakhstan	2002	X						
Kenya	2003	X	X	X		X	X	
Kosovo	2003	X	X			X		
Kyrgyz Republic	2002	X						
Kyrgyz Republic	2003	X	X	X		X	X	X
Latvia	2002	X						
Lithuania	2002	X						
Moldova	2002	X						
Moldova	2003	X	X	X		X	X	X
Montenegro	2003	X	X			X		
Morocco	2000	X	X	X			X	X
Mozambique	2002	X	X	X			X	
Nicaragua	2003	X	X			X		
Pakistan	2002		X	X	X		X	X
Peru	2002	X	X	X		X	X	X
Philippines	2003	X	X	X	X	X	X	X
Poland	2002	X						
Poland	2003	X	X	X		X	X	X
Romania	2002	X						
Russian Federation	2002	X						
Serbia	2001	X	X					
Serbia	2003	X	X			X		
Slovak Republic	2002	X						
Slovenia	2002	X						

Table 4A.2 *continued*

	Year	Employment growth	Sales growth	Profitability	Investment rate	Re-investment rate	Labor productivity	Total factor productivity
Tajikistan	2002	X						
Tajikistan	2003	X	X	X		X	X	X
Tanzania	2003	X	X	X	X	X	X	X
Turkey	2002	X						
Uganda	2003	X	X	X		X	X	
Ukraine	2002	X						
Uzbekistan	2002	X						
Uzbekistan	2003	X	X	X		X	X	X
Yugoslavia	2002	X						
Zambia	2002	X	X	X	X	X	X	X
Total		59	35	24	13	23	24	21

Source: Authors' analysis.

Estimating Total Factor Productivity

TFP is estimated using a stochastic frontier approach and assuming a Cobb-Douglas production function. This essentially estimates how far firms fall short of the amount that they could produce given the amount of capital and labor they would use if they were fully efficient (that is, as efficient as the most efficient enterprises in the sample). Formally, the equation estimated is

$$\ln S_{ik} = \sum_j D_{ijk}(\beta_j + \alpha_{jL} \ln L_{ik} + \alpha_{jK} \ln K_{ik} + \alpha_{jI} \ln I_{ik}) + \lambda_k - \mu_{ik} + \varepsilon_{ik} \quad (4A.1)$$

where S_i is sales for firm i in the year of the survey, L_i is the number of full-time employees (permanent and temporary), K_i is the net book value of fixed assets for firm i in the year of the survey, and I_i is the value of intermediate inputs. All monetary variables (for example, sales, intermediate inputs, and capital) were collected in local currency units, which were converted to U.S. dollars using average exchange rates. To control for the possibility that the annual exchange rates might not be long-run exchange rates, country dummies (I_k) are included in the base regression. Since the monetary variables are in natural logs, the country dummies effectively control for the possibility that the results might be affected by exchange rates.[14]

In addition to labor, capital, and intermediate inputs, equation 4A.1 also contains a series of 26 sector dummies, D_{ijk}, that are equal to 1 if firm i in country k is affiliated with sector j.[15] The sector dummies also interact with labor, capital, and intermediate inputs to allow different sectors to use different production technologies—that is, labor, capital, and intermediate input intensities are not assumed to be the same across sectors. Technically, this is done by multiplying the sector dummies by the variables representing capital, labor, and intermediate inputs.

The error term is assumed to have two components: ε_i, which represents random statistical noise (for example, noise from measurement error or individual firm-level shocks), and μ_i, which represents the firm's technical efficiency (that is, how far the firm is from the production possibilities frontier). The first term, ε_i, is a two-sided error term, which is assumed to have a normal distribution. The second term, μ_i, is assumed to be nonnegative (that is, greater than or equal to zero) and to follow an exponential distribution.[16] The two error terms are assumed to be independently and identically distributed. The technical efficiency of firm i is calculated using the following formula:

$$TE_i = E\{\text{Exp}(\mu_i | \varepsilon_i)\}. \quad (4A.2)$$

Annex 4B: ICT-Related Investment Climate Survey Data by Country

Table 4B.1 Telecommunications Results

Country	Survey year	Number of firms	Fixed line[a]	Telecom major or severe obstacle to business operations and growth (% firms)	Unavailable main line telephone service (days)	Unavailable main line telephone service (hours)	Unavailable main line telephone service (total % sales lost)	Workforce regularly using computers in their jobs (percent)	E-mail use for interacting with clients and suppliers (% firms)
Albania	2002	170	C	18.24	8.79	..	..	..	38.24
Algeria	2002	557	M	15.67	25.20	..	..	..	41.72
Armenia	2002	171	M	11.11	7.90	..	..	..	39.77
Azerbaijan	2002	170	P	3.64	3.21	..	..	..	32.35
Bangladesh	2002	1001	C	24.65	..	..	..	..	70.30
Belarus	2002	250	C	2.83	1.75	..	..	..	53.60
Bolivia	2001	671	M	..	..	..	..	..	..
Bosnia and Herzegovina	2002	182	M	3.41	4.43	..	..	..	58.24
Brazil	2003	1642	C	6.16	2.06	13.00	1.23	17.53	92.02
Bulgaria	2002	250	C	6.85	1.72	..	..	..	61.60
Cambodia	2003	503	P	3.21	4.55	4.85	2.62	21.03	40.76
China	2002	1548	P	23.53	..	..	..	33.33	..
China	2003	2400	P	..	..	..	..	35.97	..
Croatia	2002	187	C	1.08	1.18	..	..	..	76.47
Czech Republic	2002	268	C	2.26	0.83	..	..	..	75.37
Ecuador	2003	453	M	18.14	12.38	41.61	7.62	22.25	83.22
Eritrea	2002	78	M	14.29	12.16	..	..	..	47.44
Estonia	2002	170	C	5.36	1.94	..	..	..	89.41
Ethiopia	2002	427	M	29.40	..	..	..	..	24.65
Georgia	2002	174	P	6.32	13.87	..	..	..	39.08
Guatemala	2003	455	C	6.61	2.56	6.80	4.37	12.75	66.37
Honduras	2003	450	M	18.26	6.47	5.50	7.23	7.68	50.22
Hungary	2002	250	C	1.61	1.60	..	..	..	74.40
India	2000	895	C	..	..	..	..	..	44.39
India	2002	1827	C	5.33	..	..	..	17.03	62.07
Indonesia	2003	713	P	9.12	1.81	..	2.64	13.21	49.93
Kazakhstan	2002	250	C	2.87	5.63	..	..	..	43.20
Kenya	2003	284	P	44.12	35.83	37.06	..	13.78	78.42
Kosovo	2003	329		17.19	4.90	4.58	3.04	17.99	29.35
Kyrgyz Republic	2002	173	C	1.04	15.91	..	..	..	28.90
Kyrgyz Republic	2003	102	C	3.53	2.21	19.50	0.23	..	40.20
Latvia	2002	176	C	3.41	0.75	..	..	..	56.25
Lithuania	2002	200	C	4.00	1.38	..	..	..	69.00

Table 4B.1 *continued*

Country	Survey year	Number of firms	Fixed line[a]	Telecom major or severe obstacle to business operations and growth (% firms)	Unavailable main line telephone service (days)	Unavailable main line telephone service (hours)	Unavailable main line telephone service (total % sales lost)	Workforce regularly using computers in their jobs (percent)	E-mail use for interacting with clients and suppliers (% firms)
Macedonia, FYR	2002	170		3.70	3.29	..	..	..	45.88
Moldova	2002	174	C	4.85	1.73	11.80	..	..	37.93
Moldova	2003	103	C	2.30	4.14	..	0.16	..	53.40
Montenegro	2003	100	C	..	..	..	..	..	..
Morocco	2000	859	M	..	..	..	..	..	49.27
Mozambique	2002	194	M	20.65	13.59	..	..	6.87	36.31
Nicaragua	2003	452	M	12.39	6.96	5.79	9.51	7.93	37.39
Nigeria	2001	232	C	59.39	..	..	..	..	..
Pakistan	2003	965	C	9.24	2.66	..	..	10.65	33.58
Peru	2002	583	C	4.03	6.68	89.19	..	27.90	50.27
Philippines	2003	716	C	11.34	1.88	9.46	..	13.57	48.76
Poland	2002	500	C	3.70	1.43	..	..	..	66.40
Poland	2003	108	C	4.83	0.53	10.44	0.06	..	66.67
Romania	2002	255	C	7.11	1.98	..	..	..	57.25
Russian Federation	2002	506	D	4.29	7.79	..	..	..	53.56
Serbia	2001	402	C	13.93	7.90	..	..	27.67	45.27
Serbia	2003	408	C	..	..	..	..	..	..
Serbia and Montenegro	2003	508	C	..	2.21	7.14	0.54	25.52	53.94
Slovak Republic	2002	170	C	1.81	1.40	..	..	..	83.53
Slovenia	2002	188	M	1.06	1.12	..	..	..	87.23
Tajikistan	2002	176	M	6.33	43.36	9.22	0.41	..	10.80
Tajikistan	2003	107	M	4.09	4.99	..	..	..	7.62
Tanzania	2003	276	M	11.76	49.56	10.81	..	10.29	58.43
Turkey	2002	514	P	10.94	0.82	..	..	..	51.17
Uganda	2003	300	P	5.19	17.83	30.29	..	7.07	38.67
Ukraine	2002	463	D	5.36	3.41	..	..	..	57.02
Uzbekistan	2002	260	D	2.08	23.58	..	5.00	..	21.15
Uzbekistan	2003	100	D	5.65	1.80	..	..	..	14.00
Yugoslavia, the former	2002	250		10.33	13.35	..	..	..	70.00
Zambia	2002	207	M	32.85	40.05	13 48	..	10 03	83 50

Note: .. Not available. C = competition; D = duopoly; LCU = local currency unit; M = monopoly; P = partial competition.

a. Level of competition for fixed-line local services in 2004.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Table 4B.2 ICT Results

Country	Survey year	Number of firms	Fixed line[a]	Web site use for interacting with clients and suppliers (% firms)	ICT services are NOT affordable (% firms)	ICT services poor in quality (% firms)	Waiting time for main line telephone connection (days)	Gift/ payment expected for connection (% firms answering yes)	Gift/payment expected for connection (value in LCU)
Albania	2002	170	C	32.35	18.36	..	18.10	..	..
Algeria	2002	557	M	24.74	..	19.71	276.53	4.67	719.71
Armenia	2002	171	M	30.41	..	..	5.43	..	..
Azerbaijan	2002	170	P	28.24	..	..	2.17	..	..
Bangladesh	2002	1001	C	31.12	20.10	16.94	150.43	..	147,809.93
Belarus	2002	250	C	44.80	..	..	59.92	..	..
Bolivia	2001	671	M	..	..	..	..	10.91	..
Bosnia and Herzegovina	2002	182	M	54.95	..	..	1.93	..	..
Brazil	2003	1642	C	73.14	..	21.60	18.22	2.10	301.94
Bulgaria	2002	250	C	54.00	..	..	20.05	..	..
Cambodia	2003	503	P	23.06	71.97	17.24	4.15	..	50.63
China	2002	1548	P	..	..	85.73	12.11	5.51	..
China	2003	2400	P	..	..	14.94	6.05	..	1.07
Croatia	2002	187	C	72.19	..	..	5.00	..	..
Czech Republic	2002	268	C	69.78	..	..	1.86	..	..
Ecuador	2003	453	M	55.41	8.05	12.79	129.68	27.36	176.59
Eritrea	2002	78	M	10.26	17.78	42.50	266.46	..	..
Estonia	2002	170	C	89.41	..	..	2.36	..	..
Ethiopia	2002	427	M	6.34	48.56	44.96	154.90	..	..
Georgia	2002	174	P	36.78	..	..	8.85	..	..
Guatemala	2003	455	C	29.23	22.96	9.27	47.68	3.92	560.00
Honduras	2003	450	M	21.78	32.97	14.05	170.11	14.36	11,419.05
Hungary	2002	250	C	66.00	..	..	4.41	..	..
India	2000	895	C	..	..	..	..	..	..
India	2002	1827	C	35.90	..	..	86.68	..	..
Indonesia	2003	713	P	24.33	60.87	9.71	26.59	4.25	36,564.14
Kazakhstan	2002	250	C	36.80	..	..	5.98	..	..
Kenya	2003	284	P	32.00	..	..	98.82	55.49	8,824.36
Kosovo	2003	329		35.99	3.23	6.67	26.96	15.79	3.68
Kyrgyz Republic	2002	173	C	28.90	..	..	21.11	..	2,500.00
Kyrgyz Republic	2003	102	C	42.57	..	..	11.57	30.43	..
Latvia	2002	176	C	53.98	..	..	2.83	..	..
Lithuania	2002	200	C	67.50	..	..	2.23	..	..
Macedonia, FYR	2002	170		47.06	..	..	8.19	..	..
Moldova	2002	174	C	29.89	..	..	7.83	..	..
Moldova	2003	103	C	53.40	..	..	88.20	20.00	900.00
Montenegro	2003	100	C	..	..	..	..	..	..
Morocco	2000	859	M	16.56	..	..	..	..	..
Mozambique	2002	194	M	19.16	48.00	32.50	21.20	..	..
Nicaragua	2003	452	M	16.19	37.89	14.29	127.60	11.71	2,765.64

Table 4B.2 *continued*

Country	Survey year	Number of firms	Fixed line[a]	Web site use for interacting with clients and suppliers (% firms)	ICT services are NOT affordable (% firms)	ICT services poor in quality (% firms)	Waiting time for main line telephone connection (days)	Gift/ payment expected for connection (% firms answering yes)	Gift/payment expected for connection (value in LCU)
Nigeria	2001	232	C	..	..	..	..	..	..
Pakistan	2003	965	C	18.34	47.60	22.04	25.29	..	4,945.90
Peru	2002	583	C	..	..	4.38	9.93	..	141.90
Philippines	2003	716	C	24.42	29.31	21.12	13.21	2.40	13.20
Poland	2002	500	C	65.00	..	..	7.61	..	..
Poland	2003	108	C	69.44	..	..	44.57	..	..
Romania	2002	255	C	53.73	..	..	6.03	..	..
Russian Federation	2002	506	D	48.42			14.42		
Serbia	2001	402	C			22.84	63.51		
Serbia	2003	408	C	33.08					
Serbia and Montenegro	2003	508	C	45.67	7.49	24.55	88.08	19.05	59.64
Slovak Republic	2002	170	C	80.59	..	..	2.85	..	..
Slovenia	2002	188	M	89.36	..	..	7.76	..	..
Tajikistan	2002	176	M	6.25	..	..	17.41	..	180.00
Tajikistan	2003	107	M	2.88	..	..	5.96	33.33	..
Tanzania	2003	276	M	23.48	29.96	18.44	23.07	18.89	110,000.00
Turkey	2002	514	P	50.78	..	..	1.52	..	..
Uganda	2003	300	P	10.00	..	..	33.41	18.32	83,000.00
Ukraine	2002	463	D	54.21	..	..	13.82	..	..
Uzbekistan	2002	260	D	16.15	..	..	20.00	..	..
Uzbekistan	2003	100	D	14.00	..	..	8.93	..	..
Yugoslavia, the former	2002	250		66.80	..	..	29.69	..	..
Zambia	2002	207	M	27.18	16.56	28.48	88.55	..	0.63

Note: .. Not available. C = competition; D = duopoly; LCU = local currency unit; M = monopoly; P = partial competition.

a. Level of competition for fixed-line local services in 2004.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Annex 4C: Regression Results

Effect of ICT Use on Enterprise Performance

In the empirical analysis of the effects of ICT use on enterprise performance, the following model is used:

$$performance_{ijk} = \alpha + \beta \mathrm{ICT}_{ijk} + \gamma X_{ijk} + \lambda_k + \nu_j + \omega_t + \varepsilon_{ijk} \quad (4C.1)$$

where $performance_{ijk}$ is the performance of enterprise i in sector j in country k. The performance measures are listed in annex 4A. ICT_{ijk} is an indicator reflecting enterprises' use of ICT. It is based on the three ICT indicators discussed above: a dummy variable indicating that the enterprise communicates with clients and suppliers using e-mail; a dummy variable indicating that the enterprise communicates with clients and suppliers using the Web (other than through e-mail); and the percentage of employees who regularly use computers. These three indicators are used to test the robustness of results. They are typically available for different countries and they capture different aspects of ICT use.[17]

In addition to the ICT variables, the model also includes X_{ijk}, a vector of enterprise level characteristics. These include enterprise size, age, exports as a percentage of sales, and dummy variables representing whether the enterprise is state- or foreign-owned.

Finally, the model includes a series of dummy variables to control for country (λ_k), sector of operations (ν_j), and survey year (ω_t). The sector dummies control for systematic differences between enterprises operating in different sectors that might affect enterprise performance. Similarly, the country dummies control for differences between countries—such as macroeconomic stability, other government policies, and educational achievement—that might affect both technology use and enterprise performance. That is, the differences in productivity are interpreted as differences between enterprises within the same country. Finally, the dummies for the survey year control for systematic differences in the global economy that might affect enterprise performance and for changes in technology that might affect technology use over time.

Tables 4C.1 through 4C.3 present the regression results of the effect of ICT use on enterprise performance.

Impact of the Quality of Telecommunications Services on the Probability of Firms Using ICT

In order to investigate the impact of telecommunications services on the probability that a firm uses ICT, the following equation was used to estimate how much the quality of telecommunications infrastructure affects e-mail, Web, and computer use:

Table 4C.1 Effect of Computer Use on Different Measures of Enterprise Performance
(regression results)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Indicator	Sales growth	Employment growth	Value added per worker (US$ thousands)	Investment (share of assets)	Re-investment rate	Profitability	Technical efficiency
Observations	8,177	8,710	4,911	3,628	2,089	4,714	4,331
Country and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Computer use	0.0001	–0.0001	0.1712***	0.0003	0.1465***	0.0007*	0.0004***
(Percentage of workers who use computers)	(0.64)	(0.92)	(16.78)	(1.53)	(4.41)	(1.78)	(7.69)
Worker	0.0144***	0.0249***	0.2455	0.0350***	4.1367***	0.0112*	–0.0005
(Natural log)	(4.03)	(11.84)	(1.33)	(9.24)	(7.27)	(1.68)	(0.47)
Age	–0.0746***	–0.0275***	–0.0079	–0.0322***	–5.4862***	–0.0164	–0.0035*
(Natural log)	(11.81)	(7.52)	(0.23)	(4.83)	(–5.75)	(1.33)	(1.88)
Exports	0.0006***	–0.0006***	–0.0019*	0.0000	0.0144	–0.0008**	–0.0000
(Percentage of sales)	(3.20)	(5.38)	(1.95)	(0.23)	(0.47)	(2.30)	(0.36)
Enterprise is majority foreign owned	0.0004	–0.0169*	8.4137***	–0.0041	–12.1374***	0.0119	0.0145***
(Dummy)	(0.02)	(1.82)	(10.39)	(0.27)	(–4.72)	(0.41)	(3.37)
Enterprise is state owned	–0.0267	–0.0237**	–2.4230***	–0.0061	–16.1606***	–0.0273	–0.0113***
(Dummy)	(1.56)	(2.30)	(2.95)	(0.33)	(–4.97)	(0.91)	(2.65)
Constant	–0.0437	0.1033*	1.7257	0.0856	74.1805***	–0.5379	0.6959***
(Dummy)	(0.27)	(1.93)	(0.15)	(0.49)	(6.11)	(1.28)	(11.80)
R^2	0.04	0.12	0.17	..	..	0.05	0.04

Note: .. Not applicable. The numbers in parentheses are *t*-statistics.

***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively. All regressions include sector and year dummies.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Table 4C.2 Effect of E-Mail Use on Different Measures of Enterprise Performance
(regression results)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Indicator	Sales growth	Employment growth	Value added per worker (US$ thousands)	Investment (share of assets)	Re-investment rate	Profitability	Technical efficiency
Observations	9,504	13,285	6,076	3,907	4,878	5,953	5,350
Country and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Uses e-mail to communicate with clients and suppliers	0.0335***	0.0119*	3.4233***	0.0547***	6.8826***	0.0506***	0.0099***
(Dummy)	(3.82)	(1.90)	(8.66)	(4.35)	(3.93)	(2.80)	(3.87)
Worker	0.0091***	0.0207***	–0.2013	0.0257***	3.2737***	–0.0103	–0.0044***
(Natural log)	(2.85)	(9.40)	(1.40)	(5.87)	(5.53)	(1.56)	(4.69)
Age	–0.0750***	–0.0576***	1.0012***	–0.0438***	–4.0490***	0.0012	0.0040**
(Natural log)	(14.57)	(15.72)	(4.20)	(6.37)	(–4.32)	(0.11)	(2.52)
Exports	–0.0000	–0.0003***	0.0048	–0.0004**	–0.0254	0.0002	0.0001
(Percentage of sales)	(0.34)	(2.79)	(0.91)	(2.47)	(–1.02)	(0.75)	(1.57)
Enterprise is majority foreign owned	0.0029	0.0008	6.1198***	0.0263	–4.2040*	0.0338	0.0075*
(Dummy)	(0.21)	(0.09)	(9.93)	(1.52)	(–1.84)	(1.19)	(1.85)
Enterprise is state owned	–0.0632**	–0.1069***	4.5120***	–0.0256	–28.8728***	–0.1108*	0.0200**
(Dummy)	(2.22)	(8.32)	(3.35)	(0.72)	(–3.55)	(1.79)	(2.21)
Constant	0.1022	0.1018**	30.4289***	0.2186	–2.500	–0.1302	0.7523***
(Dummy)	(0.42)	(2.55)	(8.82)	(0.76)	(–0.10)	(0.31)	(28.13)
R^2	0.05	0.10	0.19	..	..	0.05	0.03

Note: .. Not applicable. The numbers in parentheses are *t*-statistics.

***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively. All regressions include sector and year dummies.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

Table 4C.3 Effect of Web Use on Different Measures of Enterprise Performance
(regression results)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Indicator	Sales growth	Employment growth	Value added per worker (US$ thousands)	Investment (share of assets)	Re-investment rate	Profitability	Technical efficiency
Observations	8,926	12,699	5,527	3,710	4,825	5,422	4,900
Country and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Uses Web to communicate with clients and suppliers	0.0203**	0.0178***	2.3402***	0.0210	3.6031**	0.0393**	0.0041
(Dummy)	(2.24)	(2.76)	(5.66)	(1.63)	(2.24)	(1.99)	(1.53)
Worker	0.0135***	0.0204***	–0.0064	0.0319***	3.7100***	–0.0032	–0.0032***
(Natural log)	(4.09)	(8.96)	(0.44)	(6.92)	(6.35)	(0.45)	(3.31)
Age	–0.0777***	–0.0603***	1.0376***	–0.0464***	–4.3009***	0.0017	0.0026
(Natural log)	(14.60)	(15.87)	(4.31)	(6.42)	(–4.54)	(0.15)	(1.61)

(*Table continues on the following page.*)

Table 4C.3 *continued*

Indicator	(1) Sales growth	(2) Employment growth	(3) Value added per worker (US$ thousands)	(4) Investment (share of assets)	(5) Re-investment rate	(6) Profitability	(7) Technical efficiency
Exports	–0.0000	–0.0003***	0.0049	–0.0004**	–0.01675	0.0001	0.0000
(Percentage of sales)	(0.26)	(2.65)	(0.89)	(2.52)	(–0.67)	(0.48)	(1.40)
Enterprise is majority foreign owned	0.0040	0.0025	6.3262***	0.0344*	–4.0198*	0.0346	0.0108***
(Dummy)	(0.28)	(0.27)	(10.37)	(1.91)	(–1.74)	(1.19)	(2.66)
Enterprise is state owned	–0.0670**	–0.1039***	3.1836**	–0.0292	–29.4981***	–0.1277**	0.0168*
(Dummy)	(2.28)	(7.89)	(2.35)	(0.77)	(–3.62)	(1.97)	(1.81)
Constant	–0.0168	0.1082***	2.8770	0.0020	..	–0.1506	0.7878***
(Dummy)	(0.03)	(2.66)	(1.11)	(0.01)	..	(0.36)	(8.88)
R^2	0.05	0.11	0.18	..	..	0.05	0.02

Note: .. Not applicable. The numbers in parentheses are *t*-statistics.

***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively. All regressions include sector and year dummies.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003.

$$\text{ICT Use}_{ijk} = \beta_1 + \beta_2\ \text{Telecom}_{ijk} + \beta_3\ \text{IT Quality}_{ijk} + \beta_4\ \text{X}_{ijk} + \beta_5 C_k + \omega_t + \varepsilon. \quad (4C.2)$$

The dependent variables are the ICT-use variables by firm *i* in sector *j* in country *k*, the same ones used in the previous section: dummy variables indicating that the company uses e-mail and the Web to communicate with clients, and a continuous variable, truncated at zero, indicating the percentage of employees who use computers in their jobs. For the two regressions with dummy variables as the dependent variables, Probit analysis is used. Since the percentage of employees who use computers in their jobs is truncated above at 100 percent (that is, all employees use computers) and below at 0 percent (that is, no employees do), Tobit

Table 4C.4 Effect of Telecommunications Service on IT Use (regression results)

Indicator	(1) Uses e-mail to communicate with clients and suppliers (dummy)	(2) Uses Web to communicate with clients and suppliers (dummy)	(3) Percentage of employees using computers
Observations	7,286	7,194	7,603
Technology use			
Quality of information technology services	0.2254***	0.1387***	3.6647***
(Average for firms in sector/region)	(5.21)	(2.76)	(3.95)
Telecommunications sector performance			
Days to get telephone	–0.0009***	–0.0004***	–0.0465***
(Average for firms in sector/region)	(6.68)	(2.99)	(4.43)
Enterprise characteristics			
Workers	0.1679***	0.1226***	3.0550***
(Natural log)	(31.03)	(24.53)	(13.49)
Age of firm	–0.0348***	–0.0010	–2.5098***
(Natural log)	(4.25)	(0.13)	(6.16)
Exports	0.0009***	–0.0007***	–0.0136

Table 4C.4 *continued*

Indicator	(1) Uses e-mail to communicate with clients and suppliers (dummy)	(2) Uses web to communicate with clients and suppliers (dummy)	(3) Percent of employees using computers
(As a percentage of sales)	(4.15)	(3.52)	(1.16)
Enterprise is foreign owned	0.0884***	0.0077	9.1440***
(Dummy)	(3.58)	(0.37)	(8.94)
Enterprise is state owned	–0.2882***	–0.1940***	–8.0229***
(Dummy)	(6.18)	(4.65)	(7.35)
Country characteristics			
Per capita GDP	0.0939***	0.1764***	7.3547***
(Natural log)	(9.37)	(16.53)	(10.97)

Note: The numbers in parentheses are *t*-statistics.

***, **, * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively. All regressions include sector and year dummies.

Source: Authors' analysis based on data from the World Bank Investment Climate Surveys 2000–2003..

estimation is used for that variable. In all cases the error term, ε_{ijk}, is assumed to have a normal distribution.

The number of days it takes to get a fixed-line telephone is used as a proxy for the quality of telecommunications service as the main independent variable. This measure is used because it is available for more countries than alternative measures. Because of concerns about endogeneity (for example, firms' perceptions about quality might be affected by the use of information technology), average values of the quality variables for firms in the same sector and region of the country are used. Because an individual firm's use of information technology is unlikely to affect other firms' perceptions, this seems a reasonable proxy for quality of service.

The regressions include several additional variables of country- as well as enterprise-level characteristics, such as enterprise size, age, exports as a percentage of sales, and dummy variables representing whether the enterprise is state- or foreign-owned.

Table 4C.4 shows the regression results of the effect of telecommunications.

Endnotes

1. The results are robust to controlling for the possibility that Internet use is endogenous (that is, that causation also runs in the opposite direction).
2. For example, customer databases with a history of client-specific correspondence help managers and employees respond more effectively to customers.
3. See http://rru.worldbank.org/InvestmentClimate/ for a full explication of the survey.
4. The sectors covered in the ICS are Textiles; Leather; Garments; Agro-Industry; Food; Beverages; Metals and Machinery; Electronics; Chemicals and Pharmaceuticals; Construction Materials; Wood and Furniture; Non-metallic and Plastic Materials; Paper, Printing and Publishing; Sports; Information Technology; Other Manufacturing; Telecommunications; Accounting and Financial Products; Advertising and Marketing; Other Services; Retail and Wholesale Trade; Hotels and Restaurants; Transportation; Real Estate and Rental Services; Mining and Quarrying; and Autos and Auto Parts. Although this study covers 56 countries, some countries had more than one survey conducted in different years. Therefore, as shown in annex 4A, some of the regressions include close to 60 surveys.
5. The size of a firm is defined as the sum of the number of permanent and temporary workers. Large firms have more than 100 employees. SMEs range from 10 to 100 employees. Micro firms have fewer than 10 workers.
6. For example, because of the high cost of making international calls in many developing countries, and because of the need of foreign-owned enterprises to keep in touch with their head offices, these enterprises might be more likely to use the Internet than domestic enterprises (Clarke 2004). But foreign-owned enterprises also tend to be more technically efficient.
7. Although, ideally, it would be desirable to control for the educational attainment of the firms' workforce, comparable data were not easily available for the firm surveys used in this study. One concern is that firms with highly educated workers might be more likely to use ICT services and to exhibit higher productivity. Omitting a variable to control for the educational status of workers could bias the coefficients for ICT use upward in the empirical analysis. Another single-country study, however, has found—after controlling for worker and manager education—that total factor productivity (technical efficiency)

was higher in firms in South Africa that use computers more intensively (World Bank 2005).

8. A firm's propensity to invest in new ICT technologies also depends on the effect that other infrastructure services, such as electricity and transport, have on its production process.
9. A common criticism of perception-based measures of the investment climate is that they might not reflect reality. Idiosyncratic factors (for example, the manager's temperament or expectations about sector performance) might determine perceptions about sector performance rather than demonstrating the actual performance of the sector. In this case, however, the perception-based indexes appear to be consistent with objective measures of sector performance even after controlling for other factors that affect perceptions about telecommunications service. Based on a regression analysis, findings showed that managers were more likely to rate telecommunications as a serious problem in countries where it takes a long time to get a fixed-line connection, where service interruptions are more common, and where bribes are needed to get a new connection.
10. The coefficient for bribes is negative but is statistically insignificant as to the regression for Web use.
11. SMEs (with fewer than 250 employees, according to the OECD definition) and micro firms (with fewer than 10 employees) in some developed countries experience similar constraints in ICT adoption, as reported by the OECD survey *ICT, E-Business and SMEs* (2004).
12. According to the ITU (2001), the average cost to build a fully electronic commerce–enabled site was $250,000 in 2001. This figure can range from $500,000 to $2 million for larger companies. WITSA (2000) estimated that the average time to build a fully functioning site was five months, but this often stretched to a year.
13. Costs, however, of both technology and the skills to implement it, are beginning to decline as electronic features are incorporated into existing products and skills become more widely available.
14. Since the variables are in natural logs, the country dummies will remove any exchange rate effects. That is, once country dummies are included, the coefficients on labor, capital, and intermediate inputs will be identical whatever exchange rate is used. In practice, however, the estimates of technical efficiency are virtually identical whether country dummies are included or not. The correlation between the estimates with and without country dummies is about 0.97.
15. In practice, there are too few data to estimate production functions for retail and wholesale trade, hotels and restaurants, transportation, real estate and rental services, and mining and quarrying. Therefore, production functions are estimated for only 21 sectors out of the original 26 sectors listed in the ICS.
16. In practice, results are very similar under different distributional assumptions. The simple correlation between this measure of technical efficiency and estimates assuming a half-normal distribution is 0.97.
17. Because these variables are highly correlated and because they are available for different countries, they are included one at a time. Their coefficients therefore should be interpreted with care. Including all variables simultaneously would result in the sample size being reduced considerably, making it more difficult to estimate the impact of the indicators. As a result, the effects of the different variables on enterprise performance should not be summed. Rather, they should be seen as general indicators of information technology use and interpreted in this light.

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