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Technology Adoption and the Investment Climate:

Firm-Level Evidence for Eastern Europe and Central Asia

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Abstract

The international diffusion of technology presents an opportunity for developing economies distant from the world technological frontier to reduce their income gap relative to advanced economies. It is therefore crucial to understand why, when faced with similar technological alternatives different firms in different countries choose to adopt different vintages of capital. This paper examines technology adoption across firms in Eastern Europe and Central Asia. The findings show that access to complementary inputs—managerial capacity, skilled labor, finance, and good infrastructure —and to international knowledge—through foreign direct investment or exports—is an important correlate of technology adoption. The link between market incentives and technology adoption is more nuanced. Although consumer pressure results in technology adoption, competitor pressure does not, suggesting that only firms with rents are able to adopt technology given substantial resource constraints. Privatized firms exhibit better technology adoption outcomes but only when a clear private owner with a profit incentive is present. Better governance is associated with technology adoption only in the countries that joined the European Union in 2004. Future increases in technology adoption by firms in the region will require complementary reforms of the investment climate.

This paper—a product of the Trade Team, Development Research Group—is part of a larger effort in the department to understand the links between technology diffusion, openness and the investment climate. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at afernandes@worldbank.org.

Technology Adoption and the Investment Climate: Firm-Level Evidence for Eastern Europe and Central Asia*

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I. Introduction

Two central tenets of growth theory are that total factor productivity (TFP) differences can explain cross-country variation in real incomes to a large extent, and that technology, defined broadly as knowledge relevant to production, is an important determinant of TFP across countries and across firms (Easterly and Levine, 2001; Hall and Jones, 1999; Prescott, 1998; Parisi et al., 2006). Understanding cross-country differences in income per capita requires therefore an explanation as to why firms in certain countries employ more advanced technology than firms in other countries (Fagerberg 1994; Parente and Prescott 1994, Iacopetta 2004; Comin et al., 2006). While knowledge generation is to a large extent concentrated in developed economies and access to technology has been restricted in some cases (for example by intellectual property rights), the unprecedented expansion in the volume of trade of capital goods in the last few decades indicates the broader availability of embodied knowledge. According to Keller (2004), foreign sources of technology account for over 90% of TFP growth for most countries. Technology diffusion presents an opportunity for economies distant from the world technology frontier to close the income gap with developed economies (Coe et al., 1997; Caselli and Coleman II, 2001).

Yet, when faced with the same technological alternatives, different firms in different countries choose to adopt different vintages of capital. Why would some firms adopt older vintages of capital when a newer and superior vintage is available? Rosenberg (1972) first argued that technology adoption is a slow and costly process that exhibits substantial heterogeneity across different technologies. Profit-seeking firms will adopt older vintages of capital when market characteristics, characteristics intrinsic to the new vintage of capital and/or country-specific frictions make the adoption of more modern techniques less profitable. Barriers to the adoption of new technologies may take different forms, such as regulatory and legal constraints, bribes that must be paid, but essentially represent a distortion in the relative payoffs facing the entrepreneurs in favor of the sub-optimal technology (Parente and Prescott 1994).

Hall and Khan (2003) summarize the literature on the determinants of technology adoption mainly in developed economies emphasizing the importance of microeconomic factors such as labor skills, access to capital goods, network effects, market structure, firm size, regulatory environment in explaining broad patterns of technology diffusion. When examining cross-country differences, the authors note that other macroeconomic factors such as the level of economic development, market size (Helpman and Krugman 1986), openness to trade and FDI (Keller 2002), and culture can help explain differences in the level of technology diffusion across countries. Also, Comin and Hobijn (2004) show

that the most important determinants of the speed at which a country adopts a broad range of technologies are its human capital endowment, government type, degree of openness to trade, and its adoption of predecessor technologies. More recently, Parente and Prescott (2005) argue that countries have widely divergent living standards not because they have access to different stocks of knowledge, but rather because they differ in the severity of the constraints imposed on the technology choices of their citizenry. Drawing on this literature, a recent study by the World Bank (2008) concludes that the diffusion of international knowledge and technology to a developing country depends on two main factors: (i) the extent of its access to international knowledge and technology (via trade, FDI, contacts with its diaspora, and other communications channels) and (ii) its ability to absorb and adapt international knowledge and technology. This absorptive capacity is determined by the technological literacy and skills of the country's labor force, the availability of financing for innovative firms, sound governance, and a good business environment. Moreover, given the various market imperfections associated with technology and knowledge diffusion, including increasing returns to scale and technological spillovers, that study also finds scope for carefully targeted proactive policies aimed specifically and enhancing technology transfer.

Empirical evidence on the relative impact of various determinants of technology and knowledge diffusion in developing countries at the micro level is still scarce, in part due to the limited availability of data. This paper aims to contribute to filling this gap by investigating how the "investment climate", namely the incentive regime faced by a firm (related to competition, ownership, and governance), access to complementary inputs (skills, credit, and infrastructure), and access to international knowledge affect firms' technology choices. Our analysis exploits a unique dataset - the Business Enterprise and Economic Performance Surveys (BEEPS) of firms in the Eastern Europe and Central Asia (ECA) region in 2002 and 2005 - which combines information on the investment climate with measures of technological update at the firm level. Interestingly, according to the 2005 BEEPS data, three quarters of the firms in the ECA region consider the acquisition of machinery and equipment to be the most relevant source of technological update. Thus, our proxies for technological update are ISO certification and web-use by firms.

Our results show that access to complementary inputs - skilled labor, managerial capacity, R&D, finance and to a lesser extent, good infrastructure - are positively associated with technology adoption. Results for the relationship between market incentives and ISO certification or web-use are more nuanced: (i) while consumer pressure is related to more technology use, competitor pressure is not, (ii) privatized firms exhibit better technology adoption outcomes only in presence of a clear private owner

with a profit incentive, and (iii) better governance seems to be associated with technology adoption only in EU-8 countries.[1] Our results also indicate that access to international knowledge - through FDI or exports – is positively correlated with ISO certification and web-use, which can suggests the relevance of international technology spillovers.

The paper is organized as follows. Section II describes the conceptual framework. Section III describes the empirical strategy and the data. Section IV presents the main results and Section V summarizes the main conclusions.

II. Conceptual Framework

We assume that firms make a profit-maximizing cost/benefit assessment of different alternatives when deciding whether to adopt new technology. A firm decides to adopt a particular new technology if the corresponding expected net payoffs are larger than those of the alternatives, including the alternative of not adopting it. Besides the cost of the technology itself, different investment climate factors may affect the expected net payoffs from the adoption of modern technology. Without the ambition of completeness, in the rest of this section we draw on a wide literature to lay out three groups of investment climate factors that may affect those payoffs. In doing so, we implicitly define a set of hypotheses that will subsequently be tested using firm-level survey data from the ECA region.

II. 1 Complementary Inputs: Skills, Finance, and Physical Infrastructure

A firm's access to complementary inputs can affect both the adjustment costs as well as the benefits that the firm derives from the adoption of new technology. First, both theoretical models and empirical evidence document how low *labor skills* can delay a firm's modern technology adoption due to the inability to operate advanced equipment - which tends to be skill-biased - or because learning is technology-specific and there is a high cost of retraining workers (Alesina and Zeira, 2006; Berdugo et al., 2005; Navaretti et al., 2001). Furthermore, evidence from industrial countries suggests that in settings where labor market institutions do not allow wages or internal training to offset high hiring and firing costs, the latter reduce firms' incentives for innovation and for the adoption of new technologies, and lead to lower productivity performance (Scarpetta and Tressel 2004). The lack of highly qualified *managerial capacity* (or entrepreneurship) can also constrain the firm's adoption of

[1] EU-8 countries are the countries that joined the European Union on May 1st 2004: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, and Slovenia.

advanced technology as it reduces the information on available technological solutions for its needs and could increase its adjustment costs (Cohen and Levinthal, 1989).

Second, even though capital goods are considered good collateral in developed countries, failure to regulate the movable collateral regime in developing countries may constrain smaller firms' *access to credit*, restricting their adoption of new technologies. Depending on the technological gap between existing and new technologies and on the associated adjustment costs, complementary physical investments may be needed, in which case access to credit becomes an even more important input for technological update. Based on country, industry, and firm level studies, Levine (2004) finds that there is causal evidence of a role of financial development for growth.[2]

Third, based on the potential impact of transport infrastructure on outsourcing and computer use in the production process, infrastructure availability and quality can also play a decisive role in a firm's decision to acquire and use new vintages of capital. The importance of *physical infrastructure* for firm productivity and economic growth finds strong support from empirical work for OECD countries as well as developing countries (Roller and Waverman, 2001; Esfahani and Ramirez, 2003; World Bank, 2005a).

II.2 Market Incentives: Private Ownership and Control, Competition, and Contract Enforcement

The firm's technology adoption decision is also likely to be determined by market incentives which refer to four core aspects of a competitive market economy. First, *private ownership and control* establish profit-maximization as the 'modus operandi' of the firm and should drive investment in the most productive technologies with ensuing productivity gains (Brown et al., 2007).

Second, an important additional condition is strong *product market competition* from domestic and foreign rivals and/or demand from consumers which encourage incumbents to direct their investments towards new and more productive technologies - product upgrades and/or costs reductions - rather than towards rent-seeking activities (Baumol 1990; Aghion and Schankerman 2004).[3]

Third, sound legal institutions that guarantee adequate *protection of property rights and contract enforcement* are critical for growth and for the development of market economies *(*North, 1990; Acemoglu et al., 2004; Djankov et al., 2006). Acemoglu et al. (2007) show how greater contractual

[2] See also Gatti and Love (2006) on the links between firm performance and access to finance.
[3] Consistent with that argument, Comin and Hobijn (2004) find that the importance of openness to trade in determining the speed at which a country adopts advanced technologies is due to the fact that openness introduces pressures from foreign competition on incumbents, thereby reducing their payoff from lobbying the government to deter the adoption of new technologies.

incompleteness leads to the adoption of less advanced technologies and how that incompleteness may generate sizable productivity differences across countries with different contracting institutions.

Finally, firms need to be confident that they will be able to reap the benefits from their technology adoption investments, as in the initial stages of the adoption process investments in new technology may even generate productivity losses related to capital and skills specificities, adjustment costs, and learning-by-doing (Pavlova, 2001). Adjustment and learning costs are proportional to the technology gap. In this sense, a *predictable economic and regulatory policy environment* is a fourth key market incentive affecting the firm's decision to adopt new technology.

II.3 Access to International Knowledge

The firm's technology adoption decision relates to its *access to international knowledge* which can be transferred via FDI or through the participation in export markets. Openness to trade and FDI have been shown to be critical mechanisms for knowledge diffusion across countries (Coe et al., 1997; Keller, 2004). Openness to FDI introduces competitive pressure on firms but also allows firms to be exposed to global best practice technology and management techniques (Djankov and Hoekman, 2000; Arnold and Javorcik, 2005). Domestic firms that participate in export markets may increase their knowledge absorption from the interaction with buyers in advanced markets (Fernandes and Isgut, 2007; Wagner, 2007). Thus, firms with foreign ownership and those participating in export markets are likely to face lower costs and be more likely to engage in the adoption of advanced technology.

III. Empirical Strategy and Data

III.1 Empirical Strategy

Our empirical strategy consists of testing jointly the various hypotheses discussed in Section II: namely that firms face lower costs of adjustment and higher benefits from technology adoption and thus are more likely to engage in the adoption of advanced technology if they (i) have better access to complementary inputs, (ii) face stronger market incentives, and (iii) have better access to international knowledge. For this purpose, we assume that profit-maximizing firms decide whether or not to adopt advanced technology if the benefits from this decision are larger than its costs.[4] Let π^*_{ijc} be the net benefits (benefits minus costs) for firm *i* in sector *j* in country *c*. If *Adoption* is a dummy variable that equals one alternatively if firm *i* is ISO-certified, or if firm *i* uses the web, then we have that:

[4] A similar type of approach was used by Almeida and Fernandes (2008) to study the importance of openness for technological innovation decisions of firms in developing countries.

$$Adoption_{ijc} = \begin{cases} 1 \; if \pi^*_{ijc} > 0 \\ 0 \; otherwise. \end{cases} \qquad (1)$$

We allow the unobserved net benefits π^*_{ijc} to be a function of variables proxying for complementary inputs Inp_{ijc}, for market incentives Inc_{ijc}, and for access to international knowledge Kno_{ijc} in a linear form: $\pi^*_{ijc} = \alpha Inp_{ijc} + \beta Inc_{ijc} + \gamma Kno_{ijc} + I_j + GDPpc_c + \varepsilon_{ijc}$, where I_j are sector fixed effects, $GDPpc_c$ is the country GDP per capita, and ε_{ijc} captures unobserved firm characteristics influencing the adoption decision. Thus, the probability of adopting advanced technology for firm *i* is given by:

$$\Pr(Adoption_{ijc} = 1) = \Pr(\varepsilon_{ijc} > -\alpha Inp_{ijc} - \beta Inc_{ijc} - \gamma Kno_{ijc} - I_j - GDPpc_c). \qquad (2)$$

Assuming that the residuals ε_{ijc} are normally distributed, we can estimate this equation by maximum likelihood (probit).

The adoption of advanced technology is measured either by the firm's choice of ISO certification or by the firm's choice of using the web for business operations. ISO certification indicates the achievement of internationally accepted standards and technical regulations. Hence, it can be used as a proxy of the adoption of advanced technology for firms in developing countries. Specifically, ISO 9000 norms are a set of international standards and guidelines which serve as the basis for establishing quality management systems at manufacturing and services firms (ISO, 1998). ISO 9000 certification is awarded to quality processes within a firm and requires a detailed review and documentation of the firm's production processes to be in accordance with ISO quality system requirements.[5] ISO-certification also facilitates the entry of firms into global supply chains which allows the transfer of technical and organizational knowledge from technologically advanced buyers - usually multinational corporations (MNCs) - to local firms (Arora and Aundi, 1999; Humphrey and Schmitz, 2000).

Web-use is treated as a proxy for the firm's use of information and communication technology (ICT) in business operations. A very large body of literature documents a strong positive relationship between ICT and productivity at the aggregate, industry, and firm levels, particularly for the U.S., during the second half of the 1990s (Jorgenson and Stiroh, 2000; Cohen et al., 2004; Triplett and Bosworth, 2004). The jump in productivity of the U.S. service sector during this period, epitomized by

[5] Corbett et al. (2005) show that the adoption of global industry standards and technical regulations through ISO certification is one of the most important forms of introducing product and process technology upgrading and increasing productivity for U.S. firms. Also, Blind et al. (2005) find that over 60% of product and process innovators in the U.K. use technical standards as a source of information, which is twice the share of firms that cite universities or research laboratories as a source of information.

the revolution in retailing brought about by Wal-Mart via its substantial investment in ICT-based methods, subsequently spread to other ICT-using manufacturing industries. As such, ICT is considered the preeminent 'General Purpose Technology' of the past two decades as it has driven economy-wide growth by spreading over a range of sectors and prompting them to further innovate (Bresnahan and Trajtenberg, 1995; Helpman and Trajtenberg, 1996).

III.2 Data

Our analysis is based on firm-level data from the Business Environment and Enterprise Performance Survey (BEEPS) collected by the World Bank and the European Bank for Reconstruction and Development in 28 countries in the ECA region in 2002 and in 2005.[6] The samples consist of cross-sections of 6667 firms in 2002 and 9655 firms in 2005. We also construct a panel sample of 2892 firms which were surveyed both in 2002 and in 2005.[7] The surveys cover a large range of manufacturing and services industries and are designed to be representative of the universe of firms according to the industry and location within each country.[8] In addition to information on ISO-certification and web-use, the surveys collect information on firm ownership structure, size, composition of labor force, participation in trade, R&D expenditures, access to credit, and various measures of the constraints faced in conducting business. Appendix Table A1 defines all the variables used in the analysis while Appendix Tables A2-A3 show the composition of the samples across countries and sectors. Appendix Table A4 provides summary statistics for all the investment climate variables.

Figure 1 shows the shares of firms that adopted advanced technology by country and sub-region within ECA. In 2002, the share of firms across the ECA region that is ISO-certified is 13.6%, with the highest share being (not surprisingly) displayed by the EU-8 countries (15.9%) and the lowest by Turkey (7.6%). The share of firms that use the web in 2002 is 58.2% across the ECA region, but ranging from 37.1% in the CIS outside Russia and Ukraine (labeled as 'Other CIS') to 76.4% in the EU-8 countries. In 2005, 12.5% of firms in the sample are ISO-certified, with the lowest share being displayed by the 'Other CIS' region (8.9%) and the highest being displayed by the EU-8 countries

[6] The information collected in the BEEPS surveys is based on a 1.5-2 hours interview with the firm manager. Detailed information on the surveys can be obtained at http://go.worldbank.org/RQQXYJ6210. Throughout the paper we will refer to firms as being the unit of analysis, although the surveys collect data on plants.

[7] This panel sample has been used by Safavian and Sharma (2007) to study the determinants of firm access to finance.

[8] However, we should emphasize that the 2002 sample and the panel sample have a relatively larger share of firms in services industries (61.4% and 62% respectively) while the 2005 sample is split evenly between manufacturing and services (49.6% and 50.4% respectively).

(15.5%). The proportion of firms that use the web across the ECA region in 2005 is 67.4%, ranging from 83.5% in the EU-8 countries to 49.2% in the "Other CIS".

Table 1 shows a substantial degree of heterogeneity in technology adoption across sectors, with firms in the manufacturing sector being significantly more likely to be ISO-certified and use the web in their operations than firms in other sectors. Firms in the mining and quarrying and construction industries are significantly more likely than the rest of the sample to have adopted ISO certification but are around the average for web-use. In contrast, the share of firms in other services sectors that adopted either of these technologies is significantly lower (with some exceptions such as the real estate industry) despite the evidence that ICT has led to substantial productivity gains recently in the services sector in the US and Europe. Our findings on ISO certification are consistent with global experience whereby certification is more prevalent in the manufacturing sector where signals of quality are important for export competitiveness.

We should note that we find ISO certification and web-use to be strongly correlated with firm performance both in the 2002 and in the 2005 samples. ISO-certified firms and web-users exhibit higher average value-added per worker faster sales growth, and pay higher wages than firms that do not adopt those modern technologies.[9]

IV. Main Results

In this section, we discuss our main results obtained from probit estimation of Equation (2) for ISO-certification and for web-use. To proxy for complementary inputs, we consider measures of worker skills and managerial capacity, R&D efforts, access to finance, and the quality of infrastructure - electricity and telecommunications. To proxy for market incentives, we consider the type of ownership of the firm (private or recently privatized), the degree of control by majority shareholders, firm size, measures of competition, and an index measuring the quality of governance based on the quality of contract enforcement, the predictability of government regulations and the bureaucratic burden felt by firms. To proxy for access to international knowledge, we consider foreign ownership (full or through a joint venture) and the firm's participation in export markets. All variables are defined in Appendix Table 1.

Our probit regressions include GDP per capita which controls for country heterogeneity in technology adoption that is not captured by complementary inputs, market incentives, nor access to

[9] These findings are obtained from regressions that control for industry fixed effects and for GDP per capita. The regression results are available from the authors upon request.

international knowledge.[10] Moreover, we allow the standard errors to be adjusted for clustering at the country level to account for possible correlations in technology adoption decisions across firms within a country. Finally, we include sector fixed effects in the probit regressions since sector-specific differences in technology, product demand, or competition can be crucial in determining firms' incentives to adopt new technology (Cohen and Levinthal, 1989).

A key methodological issue with our estimation needs to be raised at this point. Our main results from probit regressions for ISO-certifications and for web-use are shown in Table 2 using either the BEEPS 2002 sample or the BEEPS 2005 sample and in Table 5 using the BEEPS panel sample.[11] The results in Table 2 are based on cross-sections of firms in ECA countries in 2002 or 2005 and hence can identify systematic correlations but not causation between complementary inputs, market incentives, and access to international knowledge on the one hand and ISO certification or web-use on the other hand. For example, the estimated effects of some of the investment climate factors may reflect omitted managerial ability or other omitted firm characteristics or may suffer from reverse causality.[12] Our strategy to address this problem is threefold. First, our regressions include a large set of firm-level and location-level characteristics (i.e., all the factors linked to complementary inputs, to market incentives, and to access to international knowledge) therefore minimizing the possibility that the estimates suffer from an omitted variables bias. However, our findings based on the cross-sections of firms in 2002 and in 2005 could still be partly driven by unobservable firm characteristics. Second, to compute our infrastructure and governance indexes, we average firm responses to the corresponding survey questions (listed in Appendix Table 1) at the location level to correct for the potential endogeneity of firm perceptions on the quality of infrastructure and governance. The probit regressions can thus exploit the within-country variation in those investment climate factors. Third, we estimate our main specifications based on the BEEPS panel sample which allows us to control for unobserved firm invariant characteristics which may influence both the technology adoption decisions as well as their correlates. The disadvantage of this approach is the short panel dimension of the data (only two years of data per firm) and the smaller sample size of the panel relative to the cross-sections. With these caveats in mind we now discuss our main findings presented in Tables 2-5.

[10] Including country fixed effects in the probit regressions is not feasible in our framework due to their collinearity with the infrastructure and governance indexes which are location specific.
[11] All tables report the marginal effects from probit regressions at mean values of the independent variables.
[12] Firms with more able managers are more likely to adopt advanced technology but are also more likely to hire a larger share of skilled workers and to participate in export markets. Thus, the effect of the share of skilled workers and of export shares in the technology adoption regressions may simply reflect omitted characteristics.

IV.1 Complementary Inputs – Cross Sectional Results

The results in Table 2 suggest that firms employing a relatively larger share of professionals (i.e., engineers, accountants, scientists) are significantly more likely to be ISO-certified in 2002 and to use the web both in 2002 and 2005. The coefficients in column (3) for the BEEPS 2002 sample imply that an increase in a firm's share of professionals by one standard deviation (22.1%) would be (ceteris paribus) associated with a 1.4% increase in the likelihood of adopting ISO certification and with an 8.3% increase in the likelihood of web-use. Managerial education is also strongly positively associated with ISO-certification and web-use. Specifically, in 2002 firms that are run by managers with a college or post-graduate degree are 6.5% and 37.7% more likely to, respectively, be ISO-certified and be web-users, with all else constant. While ISO-certified firms are more likely to be run by old managers, web-use is more frequent in firms run by younger managers.

Firms with a higher R&D intensity are significantly more likely to be ISO-certified and especially to use the web. An increase in the firm's R&D intensity by one standard deviation (5.6%) is associated with a 2.4% increase in the likelihood of web-use, all else constant.

Our findings provide indirect evidence of skill-biased technological change by showing the importance of complementary investments in skills and R&D for technology adoption in the ECA region. Our findings are also consistent with the absorptive capacity arguments of Cohen and Levinthal (1989, p. 593) whereby firms invest in R&D not only to pursue innovation directly but also to "develop and maintain their broader capabilities to assimilate and exploit externally available information". R&D activities are likely to have spillover effects onto managerial activities, as firms learn more about their technological bottlenecks and possible solutions through R&D activities and managers become informed through their interaction with researchers and engineers. In sum, firms with higher shares of professionals and higher R&D intensity have better capacity to process information, i.e., to identify technological problems and solutions. Finally, we should note that for the vast majority of firms in the ECA region which do not employ cutting-edge technology, R&D activities are likely to be focused on adopting and adapting technology to local conditions as pointed out by Cohen and Levinthal (1989): e.g., in-house technology adoption and adaptation by firms' engineers or contracting of technological services to local research institutes and individual scientists.

Access to finance is positively and strongly associated with ISO-certification and web-use. Based on the BEEPS 2005 sample, a firm with access to a bank loan is 4.5% more likely to be ISO-certified and 15% more likely to use the web, ceteris paribus. Access to finance may be crucial not

only for firms to adopt advanced technology but also to make the complementary investments needed to absorb and use efficiently those advanced technologies. Our findings provide evidence of an important micro channel through which finance may affect growth in ECA: i.e., by increasing the likelihood of adoption of advanced technology by firms.

Better infrastructure (indicated by a higher value of the index) is significantly positively associated with web-use. Since our measure of infrastructure captures the quality of the communications network in the firm's location, this finding simply reflects the fact that such quality is likely to be fundamental for the internet technology to be efficiently used by the firm. However better infrastructure is negatively associated with ISO certification, significantly so for the BEEPS 2002 sample. This result is at odds with the findings for Brazil in World Bank (2005b). One possible rationale for this counter-intuitive sign is that the effect of infrastructure on ISO certification operates through other variables also included in our regressions – e.g., foreign ownership – and as a result, the coefficient on the infrastructure index captures only partially its effect on ISO certification. Another possible rationale is that our infrastructure index does not capture the quality of the road infrastructure. Accounting for the costs of remoteness and the risk of losses in transit would be important to determine the likelihood of ISO certification by a firm. Nevertheless, we should note that our infrastructure index does exhibit sensible values, which are substantially higher for EU-8 and South Eastern European countries plus Turkey (with the exception of Albania) which are characterized by better infrastructure than for CIS countries which are characterized by worse infrastructure.

Our findings on complementary inputs are not driven by any specific sub-group of countries within the ECA region. In fact, we show in Table 3 the results from estimating Equation (2) separately across three country groups: EU-8 countries, CIS countries, and South Eastern European countries plus Turkey.[13] The importance of human capital, R&D intensity, and access to finance for ISO certification and for web-use is confirmed in the three country groups. We also find a positive effect of better infrastructure on web-use and a negative – although weak – effect of better infrastructure on ISO certification in the three country groups.

Finally, we should note that our results on complementary inputs do not suffer from multicollinearity problems since the coefficients for the BEEPS 2002 and the BEEPS 2005 samples are qualitatively - and even quantitatively - almost unchanged when we estimate a variant of Equation

[13] The group of South Eastern European countries includes Albania, Bosnia and Herzegovina, Bulgaria, Croatia, FYR Macedonia, Romania, and Serbia and Montenegro.

(2) where we exclude the market incentives factors and the factors related to access to international knowledge.

IV.2 Market Incentives – Cross Sectional Results

The results in Table 2 show that privatized firms are not more likely - and are less likely in the BEEPS 2005 sample - to be ISO-certified or use the web. Private firms from the origin are 12.5% more likely to be web-users based on the BEEPS 2002 sample. However, according to the BEEPS 2005 sample, private firms from the origin do not differ significantly from other firms in their adoption of ISO certification nor their web-use. Hence, privatized firms do not seem to be a vehicle for technology adoption and ensuing productivity gains in ECA countries, which contradicts the recent evidence on productivity gains due to privatization in Brown et al. (2007). To pursue this seemingly counter-intuitive result further, we estimate a simpler version of Equation (2) that includes only the recently privatized dummy along with industry dummies and GDP per capita.[14] The results show that privatized firms are significantly more likely to be ISO-certified (in 2002 and 2005) and use the web (in 2005). The fact that the significant positive coefficients on the dummy for privatized firms disappear or are reversed in the regressions with all factors included suggests that the advantage of privatized firms in terms of technology adoption is due to the better complementary inputs, the better market incentives, and the better access to international knowledge which they face.

The proxy for the concentrated control of ownership shares is found in Table 2 to be significantly negatively associated with ISO certification and web-use. This result is counter-intuitive since firms with better corporate control - for which the concentration of ownership is a proxy - are expected to have better incentives to adopt new technology as the profit motive (maximization of the value of the firm) is present, in contrast to the firms with more diffuse ownership. In order to account for the counter-intuitive results, we estimate a modified version of Equation (2) which includes the interaction between the privatized dummy and the proxy for concentrated control of ownership shares.[15] The coefficient on the interaction term is generally positive and is significant in the case of web-use in 2005. This finding suggests that privatized firms display better technology adoption outcomes only when the control issue is solved, i.e., when there is a clear private owner with a profit incentive and empowered to change.

[14] The results from those regressions are available from the authors upon request.
[15] The results from those regressions are available from the authors upon request.

The estimates in Table 2 show that firms with smaller market shares in 2002 are significantly less likely to be ISO-certified or use the web. Firms charging lower price-cost margins in 2005 are also less likely to be ISO-certified or use the web, though the effects are weak.[16] Moreover, we find that the pressure to innovate from competitors is only weakly positively correlated with technology adoption, with the exception of a significant correlation with web-use in 2005. However, we find that strong pressure to innovate from consumers increases significantly the likelihood of a firm being ISO-certified or using the web.

Given the challenges involved in measuring the degree of market competition faced by firms, we check the robustness of our results just discussed by replacing the dummies for the pressure to innovate from consumers and competitors by two alternative measures of competition based on Carlin et al. (2004). In columns (1)-(2) and (5)-(6) of Table 4, we use a measure of the elasticity of demand faced by the firm and find that firms facing a more elastic demand (i.e., whose customers would switch to buying the product from competitors as a result of a price increase) are less likely to be ISO-certified or use the web.[17] In columns (3)-(4) and (7)-(8) of Table 4, we use a measure of the total number of competitors faced by the firm in its main product in the domestic market and find no difference in ISO certification or web-use for firms facing no competitors versus firms facing 1-3 competitors or more than 4 competitors.

Taken together, our findings suggest that in ECA countries, concentration is more conducive to technology adoption than competition. This finding is consistent with the argument by Schumpeter (1942) that competition can be detrimental to innovation as it reduces the rents that successful innovators can appropriate. This finding is also consistent with the argument by Carlin et al. (2004) that firms in transition economies face resource constraints that make rents important in financing technology adoption. Accordingly, the results in Table 2 show that larger firms are significantly more likely to adopt advanced technology. The marginal effects are particularly large for web-use and suggest that, within a sector, firms with more than 250 workers are about 25% more likely to use the web than firms with less than 50 workers. Additionally, these findings on size are consistent with two related arguments. First, large firms may benefit from economies of scale in the adoption of new

[16] The BEEPS 2002 survey provides information on market shares but also on price-cost margins both of which can be used to proxy for the competitive environment facing the firm. The regressions based on the BEEPS 2002 sample including price-cost margins provide qualitatively similar results: i.e., firms charging lower price-cost margins in 2002 are less likely to be ISO-certified or use the web. The BEEPS 2005 survey provides only information on price-cost margins. Therefore, that is the variable used to proxy for the competitive environment facing the firm in the regressions for the BEEPS panel sample.

[17] See Appendix Table A1 for the definition of these alternative measures of competition.

technology and have more capacity to finance technology adoption in imperfect financial markets settings (Cohen and Klepper, 1996). Note, however, that our regressions already control explicitly for firm access to finance. Second, the economies of scale from which large firms benefit allow them to operate with a more efficient division of labor resulting in better conditions for mechanization and technological upgrade.

The relationship between governance and technology adoption in Table 2 is more nuanced. Better governance (indicated by a higher value of the index) is negatively associated with all types of technology adoption, significantly so for ISO certification in 2002 and for web-use in 2005. In Table 3 we show that these results for governance actually differ across country groups, while the results on other proxies for market incentives are similar across country groups. For firms in EU-8 countries, better governance is associated with more frequent ISO certification and more frequent web-use. This finding is also true to some extent in South Eastern European countries and Turkey for web-use. In these two country groups, and particularly in the EU-8, predation and rent seeking opportunities have been reduced and thus better governance provides the right market incentives for more technology adoption. That is not the case in CIS countries, which drive the negative correlation between governance and technology adoption shown in the ECA-wide regressions in Table 2. While this result may appear counter-intuitive, we can rationalize it as follows. First, this result may reflect reverse causality. Firms that are ISO-certified or use the web are likely to perform better, be more profitable, and hence be more visible to government officials and more subject to inspections, visits, and bribe extraction. Indeed proxies for bribe extraction enter the calculation of the governance index. Second, the governance result is consistent with the results for competition. In locations where governance is weaker due to poor property rights enforcement, high potential for expropriation and corruption, the firms that are more able to extract rents are those that have more capabilities to adopt advanced technology.

Finally, we should note that our results on market incentives do not seem to suffer from multicollinearity problems since the coefficients for the BEEPS 2002 and the BEEPS 2005 samples are qualitatively unchanged when we estimate a variant of Equation (2) where we exclude the complementary inputs factors and the factors related to access to international knowledge.

IV.3 Access to International Knowledge – Cross Sectional Results

Table 2 shows that foreign ownership is significantly positively associated with the adoption of new technology. Relative to their domestic counterparts, fully foreign-owned firms are 4.9% more

likely to be ISO-certified and 17.1% more likely to use the web, while joint ventures are 3.2% more likely to be ISO-certified and 13.4% more likely to use the web in 2005. This finding is consistent with that in Clarke (2001) and is likely to reflect the fact that these firms are embodied in international networks requiring the frequent use of communications technology and that they compete in global markets which require the use of state of the art technological know-how through internationally recognized technical standards. Exporters are also significantly more likely to be ISO-certified or use the web. In column (4), an increase in the firm's export share by one standard deviation (21.3%) is associated with an 8.1 % increase in the likelihood of web-use, all else constant. This finding likely reflects the fact that exporters learn about new technologies through their interaction with foreign buyers. While the strong positive association between the participation in export markets and technology adoption is found across the three groups of countries in Table 3, the effects of foreign ownership are strong only in CIS countries and in South Eastern European countries and Turkey. In EU-8 countries the knowledge advantage of foreign-owned firms relative to domestic firms is less marked.

Note again that our findings on access to international knowledge do not suffer from multicollinearity problems since the coefficients for the BEEPS 2002 and the BEEPS 2005 samples are qualitatively unchanged when we estimate a variant of Equation (2) where we exclude the factors linked to complementary inputs and market incentives.

IV.4 Input Markets, Market Incentives, and Access to International Knowledge - Panel Results

The results discussed so far suggest important correlations between complementary inputs, market incentives, and access to international knowledge on the one hand, and ISO certification or web-use on the other hand. However, since the results are based on cross-sections of firms in ECA countries in 2002 and in 2005, they do not allow us to interpret the estimated effects as causal. Problems of omitted firm characteristics as well as reverse causality could bias the estimated coefficients in Tables 2-4. While we do not have valid instruments to identify causal effects of the correlates of technology adoption, we observe a subset of our firms at two points in time. Therefore, we are able to apply panel data estimation techniques - probit regressions with random effects – to the BEEPS panel. The corresponding results are shown in Table 5. In this case, we estimate the determinants of ISO certification and of web-use controlling for unobserved firm invariant effects. As mentioned earlier, the two drawbacks of this approach are the small panel dimension of the data and the smaller sample size. The probit regressions with random effects allow us to analyze how changes

in the adoption of ISO certification and how changes in web-use by firms in ECA are related to changes in complementary inputs, in market incentives, and in access to international knowledge.

The estimated effects of complementary inputs on technology adoption confirm the results obtained using the 2002 and 2005 cross-sections. We find that firms increasing their share of professionals and firms gaining access to finance between 2002 and 2005 are significantly more likely to become ISO-certified or to start using the web. The effects of R&D intensity on ISO certification are weaker in the panel regressions but they are still positive and strong for web-use. Finally, our panel results show that in locations experiencing improvements in infrastructure between 2002 and 2005 (as indicated by an increase in the value of the index), the likelihood that firms use the web increases but their likelihood of being ISO-certified decreases.

The estimated effects of market incentives on technology adoption are weaker in the panel regressions than in the cross-sectional regressions. Firms that become privatized over the 2002-2005 period are less likely (though weakly) to engage in technology adoption than other firms. Firms whose ownership share of the largest shareholder increases between 2002 and 2005 are less likely to be ISO-certified and to use the web, significantly so for web-use. However, the results from regressions that include an interaction between the privatized dummy and the ownership share of the largest shareholder (in addition to the levels of the variables) show a positive coefficient interaction effect in the case of web use.[18] Thus, these findings are similar to those obtained for the 2002 and 2005 cross-sections and indicate that firms experiencing an increase in ownership concentration face an incentive to adopt advanced technology only when there is a clear private owner with a profit incentive.

As in the cross-sectional regressions, Table 5 shows that firms reducing their price-cost margins between 2002 and 2005 are less likely to be ISO-certified or use the web, though the effects are weak. Firms that facing increased pressure from competitors to innovate and those facing increased pressure from consumers to innovate in 2005 are more likely to become ISO-certified and to use the web, but the coefficients are not significant. The results in Table 5 show that larger firms are significantly more likely to adopt advanced technology between 2002 and 2005. Overall, the panel findings provide some evidence that increased concentration is more conducive to technology adoption than increased competition and that there are demand pull reasons for the adoption of advanced technology in ECA countries, but the evidence is weak.

[18] These results are available from the authors upon request.

The estimates in Table 5 show that in locations where governance improved between 2002 and 2005 (indicated by an increase in the value of the index), the likelihood of web-use by firms increases while that of ISO certification decreases.

Finally, the estimated effects of access to international knowledge on technology adoption are strong in the panel regressions and qualitatively similar to those in the cross-sectional regressions. Majority as well as minority foreign ownership and the participation in export markets increase significantly the likelihood of firms in the ECA region being ISO-certified and using the web.

V. Conclusions

This paper examines the relationship between the investment climate and technology adoption for firms in Eastern European and Central Asian countries using the 2002 and 2005 rounds of the World Bank Business Environment and Enterprise Performance Surveys as well as a panel based on those two survey rounds. We divide investment climate factors into three groups - complementary inputs, market incentives, and access to international knowledge - and estimate several strong correlations of those factors with the adoption of advanced technology as proxied by ISO-certification and web-use by firms.

Our findings have implications for policy reforms aimed at enabling faster and greater adoption of advanced technologies by the private sector in Eastern Europe and Central Asia. Specifically, we find that firms with access to the appropriate complementary inputs, namely skilled labor, managerial capacity, R&D, finance (and to a lesser extent good infrastructure) and to international knowledge, either through FDI or exporting activities, are more likely to be ISO-certified or use the web**.** Our results suggest that the relationship between market incentives and ISO certification or web-use is more nuanced. While pressures from consumers generate demand for firms in Eastern Europe and Central Asia to adopt advanced technology, pressures from competitors do not, which may seem counter-intuitive in a developed economy setting but is consistent with previous literature that argues that most firms in Eastern Europe and Central Asia face very substantial resource constraints (particularly financial resources) and thus only those with rents are able to finance technology adoption. Accordingly, we find that larger firms are significantly more likely to adopt advanced technology, particularly through web-use. Our findings also suggest that privatized firms exhibit better technology adoption outcomes only when there is a clear private owner with a profit incentive and empowered to change. As with competition, the negative association that we find between governance and technology adoption on average in the ECA region is counter-intuitive but the effects are very

small and driven by the CIS countries. By contrast, this relationship is reversed in the EU-8 countries where better governance is associated with stronger protection of property rights and contract enforcement, more business-friendly policies and where the regulatory regime does in fact provide incentives for technology adoption. These findings suggest that for CIS countries reducing the opportunities for rent-seeking and 'harassment' of successful firms by authorities and improvements in financial intermediation are likely to be associated with more frequent adoption of new technology. Together with the aforementioned finding that in environments with severe credit constraints, firms with substantial rents are more likely to adopt advanced technology, this underscores the importance of improving market incentives in conjunction with efforts to improve access to international knowledge and the availability of critical complementary inputs.

The broad policy implication of our findings is therefore that in order to increase technology adoption by firms in Eastern Europe and Central Asia, there is a need for *complementary* reforms of the investment climate: improvements in the access to international knowledge, an increase in the availability of inputs complementary to knowledge within a wider framework of improving market incentives.

References

Acemoglu, D., Johnson, S. and J. Robinson (2005). "Institutions as the Fundamental Cause of Long-Run Growth," in Aghion, P. and S. Durlauf (Eds.) *Handbook of Economic Growth*, 385-472 Elsevier Science Publishers.

Acemoglu, D., Antras, P. and E. Helpman (2007). "Contracts and Technology Adoption," *American Economic Review* 97(3), 916-943.

Aghion, P. and M. Schankerman (1999). "Competition, Entry and the Social Returns to Infrastructure in Transition Economies," *Economics of Transition* 7(1), 79-102.

Aghion, P. and M. Schankerman (2004). "On the Welfare Effects and Political Economy of Competition-Enhancing Policies," *Economic Journal* 114(498), 800-824.

Alesina, R. and J. Zeira (2006). "Technology and Labor Regulations," NBER Working Paper No. 12581.

Almeida., R. and A. Fernandes (2008). "Openness and Technological Innovations in Developing Countries: Evidence from Firm-Level Surveys," *Journal of Development Studies* forthcoming.

Alvarez, R. and R. Robertson (2004). "Exposure to Foreign Markets and Plant-Level Innovation: Evidence from Chile and Mexico," *Journal of International Trade and Economic Development* 13(1), 57-87.

Arnold, J. and B. Javorcik (2005). "Gifted Kids or Pushy Parents? Foreign Acquisitions and Plant Productivity in Indonesia," World Bank Policy Research Working Paper 3597.

Arora A. and J. Aundi (1999). "Quality Certification and the Economics of Contract Software Development A Study of the Indian Software Service Companies," NBER Working Paper No. 7260.

Baumol, W. (1990). Entrepreneurship: Productive, Unproductive and Destructive. *Journal of Political Economy* 98(5), 893-921.

Blind, K., Temple, P., Swann, P., and G. Williams (2005). "The Empirical Economics of Standards," DTI Economics Paper 12, UK Department of Trade and Industry, London. UK.

Berdugo, S. (2005). "Delays in Technology Adoption, Appropriate Human Capital, Natural Resources and Growth," Hebrew University mimeo.

Bresnahan, T. and M. Trajtenberg (1995). "General Purpose Technologies 'Engines of Growth'?," *Journal of Econometrics* 65(1), 83-108.

Brown, J., Earle, J. and A. Telegdy (2006). "The Productivity Effects of Privatization: Longitudinal Estimates from Hungary, Romania, Russia, and Ukraine," *Journal of Political Economy* 114(1), 61-99.

Caselli, F., and W. Coleman II (2001). "Cross-Country Technology Diffusion: the Case of Computers," *American Economic Review* 91(2), 328-335.

Carlin, W., Schaffer, M., and P. Seabright (2004). "A Minimum of Rivalry: Evidence from Transition Economies on the Importance of Competition for Innovation and Growth," *The B.E. Journal of Economic Analysis and Policy (Contributions)* 3(1).

Clarke, G. (2004). "The Effect of Enterprise Ownership and Foreign Competition on Internet Diffusion in the Transition Economies." *Comparative Economic Studies* 46(2), 341-370.

Coe, D., Helpman, E., and A. Hoffmaister (1997). "North-South Spillovers," *Economic Journal* 107(440), 134-149.

Cohen, W. and R. Levin (1989). "Empirical Studies of Innovation and Market Structure," in Schmalensee, R. and R. Willig (Eds.) *Handbook of Industrial Organization*, vol. II, 1059-1107. Elsevier Science Publishers.

Cohen, W. and D. Levinthal (1989). "Innovation and Learning: The Two Faces of R&D," *Economic Journal* 99(397), 569-596.

Cohen, W. and S. Klepper (1996). "Firm Size and the Nature of Innovation within Industries: the Case of Process and Product R&D," *Review of Economics and Statistics* 78(2), 232-243.

Cohen, D., Garibaldi, P. and S. Scarpetta (2004). *The ICT Revolution: Productivity Differences and the Digital Divide*. Oxford University Press.

Comin, D. and B. Hobijn (2004). "Cross-Country Technology Adoption: Making the Theories Face the Facts," *Journal of Monetary Economics* 51(1), 39-83.

Comin, D., Hobijn, B. and E. Rovito (2006). "Five Facts You Need to Know About Technology Diffusion," NBER Working Paper No. 11928.

Comin, D., Easterly, W., and E. Gong (2006). "Was the Wealth of Nations Determined in 1000 B.C.?," NBER Working Paper No. 12657.

Corbett, C., Montes-Sancho, M., and D. Kirsch (2005). "The Financial Impact of ISO 9000 Certification in the United States: An Empirical Analysis," *Management Science* 51(7), 1046–1059.

Djankov, S. and B. Hoekman (2000). "Foreign Investment and Productivity Growth in Czech Enterprises," *World Bank Economic Review* 14(1), 49-64.

Djankov, S., McLiesh, C. and R. Ramalho (2006). "Regulation and Growth," *Economics Letters* 92(3), 395-401.

Easterly, W. and R. Levine (2001). "What Have we Learned from a Decade of Empirical Research on Growth? It's Not Factor Accumulation: Stylized Facts and Growth Models," *World Bank Economic Review* 15(2), 177-219.

Esfahani, H. and M. Ramirez (2003). "Institutions, Infrastructure, and Economic Growth," *Journal of Development Economics* 70(2), 443-477.

Fagerberg, J. (1994). "Technology and International Differences in Growth Rates," *Journal of Economic Literature* 22(3), 1147-1175.

Fernandes, A. and A. Isgut (2007). "Learning-By-Exporting Effects: Are They for Real?," World Bank mimeo.

Gatti, R. and I. Love (2006). "Does Access to Credit Improve Productivity? Evidence from Bulgarian Firms," World Bank Policy Research Working Paper 3921.

Guler, I., Guillen, M. and J. Macpherson (2002). "Global Competition, Institutions, and the Diffusion of Organizational Practices: The International Spread of ISO 9000 Quality Certificates," *Administrative Science Quarterly* 47(2), 207-232.

Hall, B. and B. Khan (2003). "Adoption of New Technology," NBER Working Paper No. 9730.

Hall, R. and C. Jones (1999). "Why Do Some Countries Produce so Much More Output per Worker than Others?," *Quarterly Journal of Economics* 114(1), 83-116.

Helpman, E. and M. Trajtenberg (1996). "Diffusion of General Purpose Technologies," NBER Working Paper No. 5773.

Humphrey, J. and H. Schmitz (2000). "Governance and Upgrading: Linking Industrial Cluster and Global Value Chain Research," IDS Working Paper 120, Institute of Development Studies, University of Sussex, Brighton, UK.

Iacopetta, M. (2004). "Dissemination of Technology in Market and Planned Economies," *The B.E. Journal of Macroeconomics (Contributions)* 4(1).

ISO (1998). *Selection and Use of ISO 9000*. ISO, Geneva.

Jorgenson, D. (2001). "Information Technology and the U.S. Economy," *American Economic Review* 91(1), 1-32.

Keller, W. (2002). "Trade and the Transmission of Technology," *Journal of Economic Growth* 7(1), 5-24.

Keller, W. (2004). "International Technology Diffusion," *Journal of Economic Literature* 42(3), 752-782.

Levine, R. (2004). "Finance and Growth: Theory and Evidence," in Aghion, P. and Durlauf, S. (Eds.) *Handbook of Economic Growth*, Elsevier Science, The Netherlands.

Navaretti, G., Soloaga, I. and W. Takacs (2001). "Vintage Technologies and Skill Constraints: Evidence from U.S. Exports of New and Used Machines," *World Bank Economic Review* 14(1), 91-109.

Neumayer, E. and R. Perkins (2005). "Uneven Geographies of Organizational Practice: Explaining the Cross-National Transfer and Adoption of ISO 9000," *Economic Geography* 81(3), 237-259.

North, D. (1990). *Institutions, Institutional Change, and Economic Performance*. Cambridge University Press, Cambridge, New York.

Parente, S. L., and E. C. Prescott (1994). "Barriers to Technology Adoption and Development," *Journal of Political Economy* 102(2), 298-321.

Parente, S. L., and E. C. Prescott (2005), "A Unified Theory of the Evolution of International Income Levels," in P. Aghion and S. Durlauf (Eds.) *Handbook of Economic Growth* vol I. Elsevier Science Publishers.

Parisi, M., Schiantarelli, F., and A. Sembenelli (2006). "Productivity, Innovation and R&D: Micro Evidence for Italy," *European Economic Review* 50(8), 2037-2061.

Pavlova, A. (2001). "Adjustment Costs, Learning-by-Doing, and Technology Adoption under Uncertainty," MIT Sloan Working Paper No. 4369-01.

Prescott, E. (1998). "Lawrence R. Klein Lecture 1997: Needed: A Theory of Total Factor Productivity**,"** *International Economic Review* 39(3), 525-551.

Roller, L. and L. Waverman (2001). "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach," *American Economic Review* 91(4), 909-923.

Rosenberg, N. (1972). "Factors Affecting the Diffusion of Technology," *Explorations in Economic-History* 10(1), 3-33.

Safavian, M. and S. Sharma (2007). "When Do Creditor Rights Work?," *Journal of Comparative Economics* 35(3), 484-508.

Scarpetta, S. and T. Tressel (2004). "Boosting Productivity via Innovation and Adoption of New Technologies: Any Role for Labor Market Institutions?" World Bank Policy Research Working Paper 3273.

Schumpeter, J. (1942). *Capitalism, Socialism, and Democracy*. Harper, New York.

Triplett, J. and B. Bosworth (2004). *Productivity in the U.S. Services Sector: New Sources of Economic Growth*. Brookings Institution Press, Washington DC.

Wagner, J. (2007). "Exports and Productivity: A Survey of the Evidence from Firm Level Data," *The World Economy* 30(1), 60-82.

World Bank (2005a). *Creating a Better Investment Climate for Everyone*.

World Bank (2005b). *Investment Climate Assessment Brazil*.

World Bank (2007). The Path to Prosperity: Productivity Growth in Eastern Europe and the Former Soviet Union.

World Bank (2008). Global Economic Prospects 2008: Technology Diffusion in the Developing World.

Zeira, J. (1998). "Workers, Machines, and Economic Growth," *Quarterly Journal of Economics* 113(4), 1091-1117.

Figure 1. Technology Adoption across ECA Countries

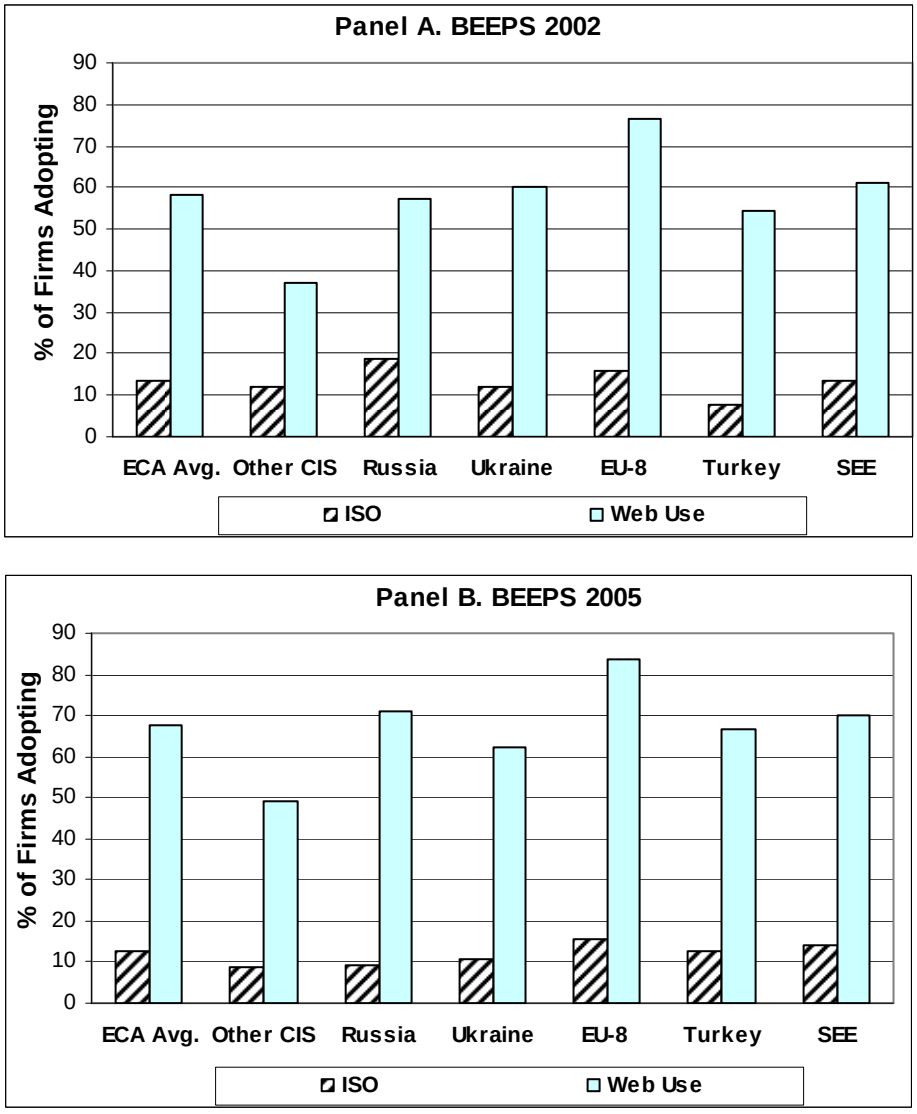

Table 1. Technology Adoption across Industries

	ISO-Certification		Web-Use	
	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample
ECA Average	*13.6*	*12.5*	*58.2*	*67.4*
Mining and Quarrying Energy-Related	36.7**	14.3	70.0	75.0
Mining and Quarrying Not Energy-Related	21.3	19.4	62.5	70.1
Manufacturing				
Food Beverages and Tobacco	23.6***	16.2***	54.1*	57.0***
Textiles	17.4	7.9***	58.4	63.0**
Leather	9.7	8.3	58.1	54.2*
Wood	23.8*	7.1*	50.0	60.0
Pulp and Paper	11.2	13.8	81.0***	84.1***
Petroleum	8.3	16.7	91.7***	100.0***
Chemicals	26.6**	36.6***	78.8***	88.1***
Rubber and Plastics	24.5*	23.3**	62.3***	88.9***
Nonmetallic Minerals	17.2	20.3**	54.0	64.2
Metals	24.4***	19.0***	65.2*	77.2***
Machinery and Equipment	33.8***	24.9***	79.9***	82.1***
Electrical and Optical Equipment	34.9***	30.4***	81.1***	88.7***
Transport Equipment	42.3***	42.6***	86.8***	87.2***
Other Manufacturing	20.3*	11.6	64.9	70.7
Services				
Construction	17.4***	15.9***	56.7	69.9*
Wholesale and Retail Trade	8.7***	8.0***	50.0***	62.3***
Hotels and Restaurants	6.2***	7.1***	42.2***	53.0***
Transport, Storage, and Communications	10.0***	11.0	71.8***	78.5***
Real Estate and Business Activities	10.9**	9.2***	71.4***	79.5***
Other Services	5.1***	4.5***	50.1***	53.7***

Notes: Values are in percentage. ***, **, and * indicates a statistical difference from the rest of the sample at 1% 5%, and 10% confidence levels, respectively.

Table 2: Correlates of Technology Adoption – Cross-Sectional Regressions

	Dependent Variable is:			
	ISO Certification Dummy		Web-Use Dummy	
	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample
	(1)	(2)	(3)	(4)
Complementary Inputs				
Share of Professionals	0.065	0.068	0.377	0.343
	[0.025]***	[0.016]***	[0.039]***	[0.045]***
Manager with College Education Dummy	0.037		0.234	
	[0.008]***		[0.023]***	
Manager Age	0.001		-0.003	
	[0.000]***		[0.001]**	
R&D Intensity	0.162	0.575	0.424	1.575
	[0.068]**	[0.140]***	[0.234]*	[0.668]**
Access to Finance Dummy	0.046	0.042	0.117	0.156
	[0.010]***	[0.010]***	[0.018]***	[0.014]***
Infrastructure Index	-0.016	-0.005	0.082	0.079
	[0.006]***	[0.005]	[0.028]***	[0.014]***
Market Incentives				
Dummy for Recently Privatized Firm	0.02	-0.028	0.001	-0.061
	[0.017]	[0.018]	[0.031]	[0.046]
Dummy for Private Firm (From Origin)	0.01	-0.04	0.125	0.006
	[0.015]	[0.026]	[0.033]***	[0.034]
Ownership Share of Largest Shareholder	-0.001	-0.033	-0.069	-0.138
	[0.019]	[0.018]*	[0.037]*	[0.029]***
Dummy for Market Share Less than 5%	-0.055		-0.135	
	[0.014]***		[0.024]***	
Price-Cost Margin (%)		0.005		0.005
		[0.026]		[0.062]
Dummy for Pressure to Innovate from Competitors Being Important	-0.001	0.013	0.003	0.041
	[0.010]	[0.011]	[0.019]	[0.016]**
Dummy for Pressure to Innovate from Consumers Being Important	0.019	0.021	0.044	0.023
	[0.009]**	[0.009]**	[0.014]***	[0.015]
Dummy for Firms with 50 - 249 Workers	0.066	0.082	0.162	0.195
	[0.017]***	[0.018]***	[0.023]***	[0.017]***
Dummy for Firms with More than 250 Workers	0.102	0.161	0.252	0.243
	[0.025]***	[0.026]***	[0.022]***	[0.017]***
Governance Index	-0.009	-0.006	-0.013	-0.04
	[0.004]**	[0.005]	[0.015]	[0.015]***
Access to International Knowledge				
Dummy for Fully Foreign-Owned	0.073	0.049	0.277	0.171
	[0.020]***	[0.022]**	[0.037]***	[0.031]***
Joint Venture Dummy	0.049	0.032	0.195	0.134
	[0.025]**	[0.017]*	[0.020]***	[0.030]***
Export Share	0.082	0.069	0.296	0.379
	[0.024]***	[0.018]***	[0.044]***	[0.052]***
Observations	5589	7968	5625	7965

Notes: Marginal effects at mean values from probit regressions are shown. Robust standard errors clustered by country in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10% confidence levels, respectively. The regressions include also industry dummies and GDP per capita. Higher values of the infrastructure (governance) index indicate better infrastructure (governance).

Table 3: Correlates of Technology Adoption Across Country Groups

	EU - 8 Countries				**CIS Countries**			
	Dependent Variable is:				Dependent Variable is:			
	ISO Certification Dummy		Web-Use Dummy		ISO Certification Dummy		Web-Use Dummy	
	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Complementary Inputs								
Share of Professionals	0.003	0.091	-0.001	0.136	0	0.049	-0.007	0.366
	[0.000]***	[0.025]***	[0.001]	[0.056]**	[0.001]	[0.021]**	[0.001]***	[0.075]***
Manager with College Education Dummy	0.108		0.234		-0.024		0.459	
	[0.039]***		[0.036]***		[0.025]		[0.065]***	
Manager Age	0.034		0.148		0.017		0.206	
	[0.011]***		[0.021]***		[0.011]		[0.034]***	
R&D Intensity	0.148	0.648	0.258	3.813	0.103	0.502	0.751	1.372
	[0.132]	[0.393]*	[0.067]***	[0.684]***	[0.078]	[0.219]**	[0.403]*	[0.899]
Access to Finance Dummy	0.057	0.049	0.098	0.055	0.039	0.019	0.078	0.177
	[0.021]***	[0.018]***	[0.021]***	[0.011]***	[0.014]***	[0.011]*	[0.033]**	[0.033]***
Infrastructure Index	-0.027	-0.038	-0.066	0.032	-0.015	-0.004	0.112	0.115
	[0.064]	[0.017]**	[0.057]	[0.009]***	[0.005]***	[0.008]	[0.030]***	[0.030]***
Market Incentives								
Dummy for Recently Privatized Firm	0.046	-0.061	-0.035	-0.004	-0.015	-0.014	0.033	-0.09
	[0.028]*	[0.023]***	[0.032]	[0.034]	[0.016]	[0.038]	[0.044]	[0.080]
Dummy for Private Firm (From Origin)	0.008	-0.124	0.003	-0.029	0.016	-0.005	0.198	0.037
	[0.023]	[0.042]***	[0.014]	[0.010]***	[0.026]	[0.040]	[0.038]***	[0.065]
Ownership Share of Largest Shareholder	0.032	-0.069	-0.075	-0.103	-0.043	-0.011	-0.076	-0.115
	[0.031]	[0.036]*	[0.035]**	[0.016]***	[0.031]	[0.021]	[0.066]	[0.047]**
Dummy for Market Share Less than 5%	-0.082		-0.094		-0.03		-0.096	
	[0.024]***		[0.022]***		[0.015]*		[0.037]***	
Price-Cost Margin (%)		-0.075		-0.057		0.046		0.19
		[0.060]		[0.033]*		[0.047]		[0.140]
Dummy for Pressure to Innovate from Competitors Being Important	-0.017	0.064	0.002	0.022	0.007	-0.013	0.008	0.036
	[0.014]	[0.018]***	[0.020]	[0.009]**	[0.011]	[0.012]	[0.019]	[0.023]
Dummy for Pressure to Innovate from Consumers Being Important	-0.004	-0.002	0.029	0.012	0.023	0.021	0.028	0.022
	[0.017]	[0.019]	[0.018]	[0.013]	[0.014]*	[0.014]	[0.021]	[0.018]
Dummy for Firms with 50 - 249 Workers	0.124	0.11	0.1	0.087	0.051	0.042	0.208	0.228
	[0.043]***	[0.038]***	[0.020]***	[0.013]***	[0.023]**	[0.012]***	[0.046]***	[0.030]***
Dummy for Firms with More than 250 Workers	0.23	0.228	0.151	0.081	0.048	0.082	0.333	0.336
	[0.037]***	[0.046]***	[0.014]***	[0.013]***	[0.032]	[0.018]***	[0.033]***	[0.032]***
Governance Index	0.004	-0.007	0.007	0.028	-0.005	-0.011	-0.041	-0.052
	[0.014]	[0.007]	[0.020]	[0.015]*	[0.003]	[0.004]***	[0.013]***	[0.014]***
Access to International Knowledge								
Dummy for Fully Foreign-Owned	0.047	0.048	0.083	0.068	0.141	0.055	0.447	0.231
	[0.031]	[0.044]	[0.032]***	[0.023]***	[0.031]***	[0.033]*	[0.055]***	[0.071]***
Joint Venture Dummy	0.02	0.053	0.086	0.067	0.057	0.027	0.257	0.132
	[0.036]	[0.031]*	[0.031]***	[0.023]***	[0.037]	[0.025]	[0.026]***	[0.059]**
Export Share	0.056	0.073	0.181	0.232	0.067	0.054	0.314	0.479
	[0.016]***	[0.022]***	[0.045]***	[0.054]***	[0.043]	[0.019]***	[0.057]***	[0.065]***
Observations	1702	2490	1721	2465	2391	3428	2404	3441

Table 3 continued

	Southern European Countries and Turkey			
	Dependent Variable is:			
	ISO Certification Dummy		Web-Use Dummy	
	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample
	(9)	(10)	(11)	(12)
Complementary Inputs				
Share of Professionals	0.001	0.09	0.001	0.415
	[0.001]	[0.025]***	[0.002]	[0.069]***
Manager with College Education Dummy	0.137		0.247	
	[0.035]***		[0.080]***	
Manager Age	0.024		0.27	
	[0.021]		[0.038]***	
R&D Intensity	0.289	0.598	-0.009	1.347
	[0.155]*	[0.232]***	[0.383]	[0.779]*
Access to Finance Dummy	0.037	0.068	0.119	0.155
	[0.007]***	[0.018]***	[0.032]***	[0.023]***
Infrastructure Index	-0.008	-0.003	0.135	0.04
	[0.010]	[0.005]	[0.058]**	[0.017]**
Market Incentives				
Dummy for Recently Privatized Firm	0.031	-0.006	0.035	0.048
	[0.052]	[0.032]	[0.077]	[0.058]
Dummy for Private Firm (From Origin)	-0.005	-0.022	0.045	0.014
	[0.032]	[0.048]	[0.041]	[0.066]
Ownership Share of Largest Shareholder	0.017	-0.049	-0.02	-0.154
	[0.036]	[0.033]	[0.072]	[0.040]***
Dummy for Market Share Less than 5%	-0.055		-0.104	
	[0.010]***		[0.048]**	
Price-Cost Margin (%)		0.004		-0.053
		[0.042]		[0.069]
Dummy for Pressure to Innovate from Competitors Being Important	0.013	0.02	-0.024	0.027
	[0.019]	[0.019]	[0.039]	[0.021]
Dummy for Pressure to Innovate from Consumers Being Important	0.028	0.028	0.037	0.034
	[0.015]*	[0.010]***	[0.034]	[0.013]***
Dummy for Firms with 50 - 249 Workers	0.044	0.11	0.115	0.211
	[0.010]***	[0.027]***	[0.023]***	[0.020]***
Dummy for Firms with More than 250 Workers	0.056	0.245	0.22	0.249
	[0.030]*	[0.049]***	[0.043]***	[0.023]***
Governance Index	-0.021	-0.009	0.045	0.034
	[0.009]**	[0.023]	[0.027]*	[0.040]
Access to International Knowledge				
Dummy for Fully Foreign-Owned	0.055	0.054	0.256	0.145
	[0.047]	[0.049]	[0.056]***	[0.063]**
Joint Venture Dummy	0.045	0.02	0.141	0.149
	[0.032]	[0.035]	[0.043]***	[0.059]**
Export Share	0.102	0.068	0.28	0.241
	[0.051]**	[0.066]	[0.087]***	[0.071]***
Observations	1486	2023	1497	2008

Notes: Marginal effects at mean values from probit regressions are shown. Robust standard errors errors clustered by country in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10% confidence levels, respectively. The regressions include also industry dummies and GDP per capita. Higher values of the infrastructure (governance) index indicate better infrastructure (governance).

Table 4: Correlates of Technology Adoption – Cross-Sectional Regressions with Alternative Measures of Competition

	Dependent Variable is:							
	ISO Certification Dummy				Web-Use Dummy			
	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample	BEEPS 2002 Sample	BEEPS 2005 Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Complementary Inputs								
Share of Professionals	0.001	0.069	0.001	0.084	-0.003	0.355	-0.003	0.197
	[0.000]***	[0.016]***	[0.000]***	[0.018]***	[0.002]**	[0.044]***	[0.002]**	[0.039]***
Manager with College Education Dummy	0.068		0.064		0.374		0.374	
	[0.023]***		[0.024]***		[0.040]***		[0.040]***	
Manager Age	0.036		0.036		0.227		0.228	
	[0.008]***		[0.008]***		[0.022]***		[0.022]***	
R&D Intensity	0.152	0.564	0.155	1.03	0.414	1.549	0.414	2.68
	[0.069]**	[0.145]***	[0.068]**	[0.285]***	[0.233]*	[0.661]**	[0.231]*	[0.712]***
Access to Finance Dummy	0.049	0.044	0.048	0.043	0.121	0.162	0.12	0.099
	[0.010]***	[0.011]***	[0.010]***	[0.014]***	[0.017]***	[0.015]***	[0.018]***	[0.013]***
Infrastructure Index	-0.014	-0.006	-0.013	-0.007	0.083	0.079	0.083	0.036
	[0.006]**	[0.005]	[0.006]**	[0.007]	[0.028]***	[0.016]***	[0.028]***	[0.007]***
Market Incentives								
Dummy for Recently Privatized Firm	0.028	-0.029	0.028	-0.033	0.006	-0.044	0.002	-0.017
	[0.018]	[0.018]	[0.017]	[0.031]	[0.030]	[0.043]	[0.031]	[0.037]
Dummy for Private Firm (From Origin)	0.016	-0.041	0.017	-0.048	0.129	0.019	0.126	0.024
	[0.016]	[0.026]	[0.015]	[0.036]	[0.032]***	[0.035]	[0.034]***	[0.040]
Ownership Share of Largest Shareholder	-0.004	-0.036	-0.004	-0.062	-0.075	-0.141	-0.073	-0.066
	[0.018]	[0.017]**	[0.018]	[0.026]**	[0.035]**	[0.029]***	[0.036]**	[0.028]**
Dummy for Market Share Less than 5%	-0.05		-0.047		-0.133		-0.134	
	[0.014]***		[0.014]***		[0.025]***		[0.024]***	
Price-Cost Margin (%)		0.012		-0.025		-0.02		-0.053
		[0.028]		[0.033]		[0.061]		[0.038]
Dummy for Elasticity of Demand: If Prices Increased by 10% Customers Would Still Buy From Firm but Slightly Lower Quantities	-0.009	-0.013			0.013	-0.002		
	[0.011]	[0.010]			[0.017]	[0.019]		
Dummy for Elasticity of Demand: If Prices Increased by 10% Customers Would Still Buy From Firm but Much Lower Quantities	-0.013	-0.008			0.002	-0.065		
	[0.012]	[0.010]			[0.025]	[0.022]***		
Dummy for Elasticity of Demand: If Prices Increased by 10% Customers Would Buy From Competitors	-0.031	-0.012			-0.03	-0.092		
	[0.013]**	[0.009]			[0.025]	[0.023]***		
Dummy for Firm Facing 1-3 Competitors in Domestic Market			0.025	0.002			0.094	0.002
			[0.042]	[0.044]			[0.076]	[0.043]
Dummy for Firm Facing 4 or More Competitors in Domestic Market			-0.015	-0.011			0.073	-0.005
			[0.039]	[0.046]			[0.082]	[0.036]
Dummy for Firms with 50 - 249 Workers	0.065	0.081	0.065	0.109	0.164	0.196	0.165	0.088
	[0.016]***	[0.019]***	[0.017]***	[0.024]***	[0.022]***	[0.017]***	[0.023]***	[0.012]***
Dummy for Firms with More than 250 Workers	0.101	0.154	0.098	0.191	0.252	0.232	0.253	0.102
	[0.025]***	[0.026]***	[0.025]***	[0.031]***	[0.023]***	[0.018]***	[0.022]***	[0.015]***
Governance Index	-0.01	-0.006	-0.01	-0.015	-0.014	-0.038	-0.014	-0.016
	[0.004]**	[0.005]	[0.004]**	[0.008]*	[0.016]	[0.016]**	[0.016]	[0.009]*
Access to International Knowledge								
Dummy for Fully Foreign-Owned	0.077	0.051	0.071	0.062	0.268	0.179	0.273	0.091
	[0.021]***	[0.022]**	[0.021]***	[0.030]**	[0.038]***	[0.029]***	[0.038]***	[0.015]***
Joint Venture Dummy	0.051	0.032	0.049	0.023	0.194	0.131	0.194	0.045
	[0.024]**	[0.017]*	[0.025]**	[0.026]	[0.020]***	[0.029]***	[0.020]***	[0.021]**
Export Share	0.076	0.069	0.076	0.082	0.305	0.405	0.304	0.179
	[0.025]***	[0.019]***	[0.024]***	[0.030]***	[0.043]***	[0.053]***	[0.044]***	[0.033]***
Observations	5650	8076	5666	4146	5687	8073	5705	4143

Notes: Marginal effects at mean values from probit regressions are shown. Robust standard errors clustered by country in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10% confidence levels, respectively. The regressions include also industry dummies and GDP per capita. Higher values of the infrastructure (governance) index indicate better infrastructure (governance).

Table 5: Correlates of Technology Adoption – Panel Regressions

	Dependent Variable is:	
	ISO Certification Dummy	Web-Use Dummy
	BEEPS Panel Sample	
	(1)	(2)
Complementary Inputs		
Share of Professionals	0.809	0.794
	[0.192]***	[0.240]***
R&D Intensity	1.695	4.93
	[1.043]	[1.335]***
Access to Finance Dummy	0.263	0.608
	[0.089]***	[0.107]***
Infrastructure Index	-0.086	0.179
	[0.040]**	[0.046]***
Market Incentives		
Dummy for Recently Privatized Firm	-0.247	-0.246
	[0.176]	[0.214]
Dummy for Private Firm (From Origin)	-0.053	0.207
	[0.156]	[0.188]
Ownership Share of Largest Shareholder	-0.079	-0.735
	[0.156]	[0.185]***
Price-Cost Margin (%)	0.136	0.541
	[0.296]	[0.346]
Dummy for Pressure to Innovate from Competitors		
Being Important	0.109	0.085
	[0.109]	[0.115]
Dummy for Pressure to Innovate from Consumers		
Being Important	0.16	0.178
	[0.100]	[0.109]
Dummy for Firms with 50 - 249 Workers	0.502	0.584
	[0.114]***	[0.152]***
Dummy for Firms with More than 250 Workers	0.824	1.565
	[0.147]***	[0.243]***
Governance Index	-0.052	0.035
	[0.036]	[0.040]
Access to International Knowledge		
Dummy for Fully Foreign-Owned	0.261	1.239
	[0.164]	[0.279]***
Joint Venture Dummy	0.532	0.64
	[0.155]***	[0.223]***
Export Share	0.685	1.482
	[0.185]***	[0.304]***
Observations	2310	2699

Notes: Marginal effects at mean values from probit regressions are shown. Robust standard errors clustered by country in parentheses. ***, **, and * indicates statistical significance at 1%, 5%, and 10% confidence levels, respectively. The regressions include also industry dummies and GDP per capita. Higher values of the infrastructure (governance) index indicate better infrastructure (governance).

Appendix Table A1. Variable Definitions

Variable Name	Definition
ISO Certification	Dummy variable equal to 1 if the firm obtained a new quality accreditation (ISO 9000) in the three years prior to the survey.
Web Use	Dummy variable equal to 1 if the firm uses email and the internet regularly in its interactions with clients and suppliers.
Age	Year of the survey minus the year when the firm started operations.
Size Categories	Based on the total number of permanent workers employed by the firm.
Manager with College Education or More	Dummy variable equal to 1 if the firm's general manager highest level of education is a university degree or a higher university (post-graduate) degree.
Manager Age	Age of the firm's general manager.
Share of Professionals	Percentage of the firm's current permanent full time workers that are professionals (e.g., accountants, engineers, scientists).
R&D Intensity	Share in total firm sales of R&D expenditures (including wages and salaries of R&D personnel, materials, R&D related education and training costs).
Access to Finance Dummy	Dummy variable equal to 1 if the firm has a bank loan or overdraft.
Infrastructure Index	First principal component derived from factor analysis of (1) the average in the firm's city of the number of days with power outages or surges from the public grid and (2) the average in the firm's city of the number of days with unavailable mainline telephone service in the year prior to the survey.
Dummy for Recently Privatized Firm	Dummy variable equal to 1 if the firm was established as the privatization of a state-owned firm.
Dummy for Private Firm (From Origin)	Dummy variable equal to 1 if the firm is originally private from the time of start-up.
Ownership Share of Largest Shareholder	Percentage of the firm's equity owned by the largest shareholder.
Dummy for Market Share Equal to Less than 5%	Dummy variable equal to 1 if the firm's percetnage of the total market sales is less than 5% (available only in BEEPS 2002).
Price-Cost Margin (%)	Margin by which the firm's sales price for its main product line or main line of services in the domestic exceeds its operating costs (i.e. materials inputs costs plus wages costs but not overheads and depreciation).
Dummy for Pressure to Innovate from Competitors Being Important	Dummy variable equal to 1 if the firm ranks pressure from domestic or foreign competitors as being fairly important or very important for the firm's decisions about developing new products or services and markets.
Dummy for Pressure to Innovate from Consumers Being Important	Dummy variable equal to 1 if the firm ranks pressure from customers as being fairly important or very important for the firm's decisions about developing new products or services and markets.
Elasticity of Demand Faced by Firm	If the firm were to raise the prices of its main product line or main line of services 10% above their current level in the domestic market (after allowing for any inflation) what would happen assuming that the firm's competitors maintained their current prices: (1) customers would continue to buy from the firm in the same quantities as now, (2) customers would continue to buy from the firm but at slightly lower quantities, (3) customers would continue to buy from the firm but at much lower quantities, (4) many customers would buy from the firm's competitors instead.
Number of Competitors	Number of competitors faced by the firm in its main product in the domestic market: none, 1-3, or 4 or more.
Governance Index	First principal component derived from factor analysis of (1) the 100% minus the percentage of firms in the firm's city that report that it is frequently, usually, or always true that firms in their line of business to have to pay some irregular "additional payment/gifts" to get things done with regard to customs, taxes, licenses, regulations, services, (2) the percentage of firms in the firm's city that tend to agree, agree in most cases, or strongly agree with the statement "I am confident that the legal system will uphold my contract and property rights in business disputes", (3) the percentage of firms in the firm's city that tend to agree, agree in most cases, or strongly agree that the interpretations of the laws and regulations affecting the firm are consistent and predicatable, and (4) 100% minus the average in the firm's city of the percentage of senior management time spent dealing with public officials about the application and interpretation of laws and regulations and to get or to maintain access to public services in the year prior to the survey.
Dummy for Fully Foreign-Owned	Dummy variable equal to 1 if 100% of the firm's capital is owned by foreigners.
Joint Venture Dummy	Dummy variable equal to 1 if more than 0% but less than 100% of the firm's capital is owned by foreigners.
Export Share	Dummy variable equal to 1 if the firm exports some of its output directly or indirectly.
GDP per Capita (log)	Values in constant 2000 USD for the year 1995 (Source: World Development Indicators)

Notes: The source is the BEEPS 2002 or the BEEPS 2005 unless otherwise stated.

Appendix Table A2. Country Composition of the Samples

	BEEPS 2002 Sample		BEEPS 2005 Sample		BEEPS Panel Sample	
	No. Firms	% of Total	No. Firms	% of Total	No. Firms	% of Total
Albania	170	2.55	204	2.11	130	4.50
Armenia	171	2.56	351	3.64	98	3.39
Azerbaijan	170	2.55	350	3.63	136	4.70
Belarus	250	3.75	325	3.37	92	3.18
BiH	182	2.73	200	2.07	..	..
Bulgaria	250	3.75	300	3.11	178	6.15
Croatia	187	2.80	236	2.44	122	4.22
Czech	268	4.02	343	3.55	72	2.49
Estonia	170	2.55	219	2.27	138	4.77
FYROM	170	2.55	200	2.07	68	2.35
Georgia	174	2.61	200	2.07	116	4.01
Hungary	250	3.75	610	6.32	118	4.08
Kazakhstan	250	3.75	585	6.06	120	4.15
Kyrgyzstan	173	2.59	202	2.09	80	2.77
Latvia	176	2.64	205	2.12	108	3.73
Lithuania	200	3.00	205	2.12	112	3.87
Moldova	174	2.61	350	3.63	64	2.21
Poland	500	7.50	975	10.10	156	5.39
Romania	255	3.82	600	6.21	128	4.43
Russia	506	7.59	601	6.22	82	2.84
Slovakia	170	2.55	220	2.28	58	2.01
Slovenia	188	2.82	223	2.31	150	5.19
Tajikistan	176	2.64	200	2.07	36	1.24
Turkey	514	7.71	557	5.77	94	3.25
Ukraine	463	6.94	594	6.15	294	10.17
Uzbekistan	260	3.90	300	3.11	56	1.94
Yugoslavia	250	3.75	300	3.11	86	2.97
Total	6667	100.00	9655	100.00	2892	100.00

Appendix Table A3. Industry Composition of the Samples

	BEEPS 2002 Sample		BEEPS 2005 Sample		BEEPS Panel Sample	
	No. Firms	% of Total	No. Firms	% of Total	No. Firms	% of Total
Mining and Quarrying Energy	30	0.45	28	0.29	4	0.14
Mining and Quarrying Not Energy	48	0.72	67	0.69	25	0.86
Food, Beverages, and Tobacco	401	6.01	1098	11.37	157	5.43
Textiles	214	3.21	668	6.92	85	2.94
Leather	31	0.46	48	0.50	16	0.55
Wood	64	0.96	85	0.88	24	0.83
Pulp and Paper	137	2.05	189	1.96	93	3.22
Petroleum	12	0.18	6	0.06	3	0.10
Chemicals	80	1.20	101	1.05	38	1.31
Rubber and Plastics	53	0.79	90	0.93	29	1.00
Nonmetallic Minerals	100	1.50	123	1.27	39	1.35
Metals	161	2.41	637	6.60	77	2.66
Machinery and Equipment	134	2.01	374	3.87	56	1.94
Electrical and Optical Equipment	111	1.66	115	1.19	44	1.52
Transport Equipment	53	0.79	47	0.49	17	0.59
Other Manufacturing	134	2.01	181	1.87	63	2.18
Total Manufacturing and Mining	*1763*	*26.4*	*3857*	*39.9*	*770*	*26.6*
Construction	808	12.12	929	9.62	328	11.34
Wholesale and Retail Trade	2027	30.40	2389	24.74	835	28.87
Hotels and Restaurants	457	6.85	532	5.51	195	6.74
Transport, Storage, and Communications	524	7.86	629	6.51	216	7.47
Real Estate and Business Activities	675	10.12	833	8.63	359	12.41
Other Services	413	6.19	486	5.03	189	6.54
Total Services	*4904*	*73.5*	*5798*	*60.0*	*2122*	*73.4*
Total	6667	100.00	9655	100.00	2892	100.00

Appendix Table A4. Summary Statistics

	BEEPS 2002 Sample		BEEPS 2005 Sample		BEEPS Panel Sample	
	Mean	Obs	Mean	Obs	Mean	Obs
ISO Certification Dummy	13.6%	6610	12.5%	9655	14.0%	2887
Web-Use Dummy	58.2%	6667	67.4%	9655	65.4%	2892
Number of Permanent Workers	143	6636	102	9654	109	2888
Share of Professionals	18.0%	6572	17.0%	9519	20.0%	2634
Manager with College Education Dummy	70.2%	6611	-	-	-	-
Manager Age (Years)	44.6	6610	-	-	-	-
R&D Intensity	2.0%	6667	0.3%	6984	1.2%	2892
Access to Finance Dummy	40.3%	6655	42.1%	9655	42.7%	2888
Number of Days with Power Outages	11.0	6656	9.7	9645	15.9	2881
Number of Days with Unavailable Telephone Lines	5.8	6653	1.7	9635	3.2	2868
Recently Privatized Firm Dummy	14.4%	6667	13.7%	9655	15.9%	2892
Pressure to Innovate from Competitors Dummy	74.1%	6586	75.2%	9538	73.4%	2852
Pressure to Innovate from Consumers Dummy	71.7%	6560	72.2%	9466	69.2%	2838
Dummy for Firms that Report Need to Bribe Frequently	26.0%	6634	20.2%	9606	23.5%	2840
Percentage of Time Spent by Managers Dealing with Regulations	7.5%	6634	5.3%	9040	6.6%	2781
Dummy for Firms that Trust the Legal System	54.3%	6647	54.9%	9634	55.8%	2867
Dummy for Firms that Believe Regulations are Predictable	42.4%	6649	44.5%	9637	44.7%	2874
Dummy for Market Share Less than 5%	65.7%	6667	-	-	-	-
Price-Cost Margin (%)	18.9%	5656	22.7%	8460	20.4%	2045
Full Foreign Ownership Dummy	6.6%	6667	5.1%	9655	7.4%	2892
JV Dummy (Foreign Ownership<100%)	9.5%	6667	6.8%	9655	6.4%	2892
Export Share	11.4%	6636	10.1%	9642	10.6%	2886

Note: For R&D intensity we assume that missing values represent R&D expenditures equal to 0.