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Globalization and Innovation in Emerging Markets†

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Globalization brings opportunities and pressures for domestic firms in emerging markets to innovate and improve their competitive position. Using data from 27 emerging market economies, we estimate the effects of foreign competition and linkages with foreign firms on innovation by domestic firms. We provide robust evidence of a positive relationship between foreign competition and innovation, broadly defined. The supply chain of multinational enterprises and trade are also important channels. There is no evidence for an inverted U relationship between innovation and foreign competition. Moreover, the relationship between globalization and innovation does not differ across the manufacturing and service sectors. (*JEL* F02, F23, M16, O33)

With the opening of borders to trade and foreign investment, globalization brings opportunities and pressures for domestic firms in emerging market economies to improve their competitive position. Whereas considerable attention has been paid to the effects of globalization on productivity of firms in emerging market economies,[1] very little is known about the mechanisms through which horizontal and vertical relationships with foreign firms and international trade improve efficiency in domestic firms. Innovation is a presumed conduit through which globalization affects productivity, yet there is little research testing the relationship between globalization and innovation. In this paper, we examine the impact of competition from, and linkages with, foreign firms on innovation by domestic firms in emerging market economies. We use several measures of innovation, akin to the broad measures of managerial innovation pursued by Nicholas Bloom and John Van

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[1] Various literatures examine the impact of globalization on efficiency of firms in emerging markets. For a review of the literature on foreign direct investment, see Holger Görg and David Greenaway (2004). For a review of the trade literature, see Joachim Wagner (2007).

Reenen (2007) and Ann Bartel, Casey Ichniowski, and Kathryn Shaw (2007) in the context of advanced economies.

Several models are particularly relevant for our empirical work. They assume that two broad mechanisms are important determinants of the level of innovation in a firm: knowledge transfers and competition, which may be brought about through various channels, including the entry of foreign firms (foreign direct investment—FDI) and international trade. A recent model by John Sutton (2007a) focuses on knowledge transfers, while works from Joseph A. Schumpeter (1943) to Philippe Aghion et al. (2004, 2005) focus on competition.

In Sutton's (2007a) model, a firm's competitiveness depends not only on its productivity but also on the quality of its product, with productivity and quality jointly determining a firm's "capability." An important prediction of this model is that after an initial shakeout phase, firms in emerging markets will strive to adjust by raising their capabilities.[2] Sutton suggests that the process will be influenced by the vertical transfer of capabilities to the emerging market economies through the supply chain of multinational enterprises (MNEs), an argument also present in the international business literature on FDI that we discuss below.[3] In a parallel to Sutton's work, there is a large literature asking whether exporting and importing activities of domestic firms raise their efficiency—presumably through innovations induced by the exposure of the domestic firms to more advanced practices and technologies (see Wagner 2007). In line with Sutton's conceptual framework and the trade literature, we test whether or not firms in emerging markets that enter the supply chain with foreign firms, or export and import, increase their innovative activities.

The second broad literature on the effects of globalization emphasizes the relationship between product market competition and innovation by incumbent firms. Many economists since Kenneth J. Arrow (1962) have traditionally argued that competition is good for an economy by providing incentives for efficient organization of production, putting downward pressure on costs, and motivating innovation. On the other hand, Schumpeter (1943) argued that large firms operating in concentrated markets are the most powerful engine of progress, and the most likely to innovate, because they can more easily appropriate the returns from inventive activity. Similarly, Paul Romer (1990) and Aghion and Peter Howitt (1992), among others, stress that product market competition reduces monopoly rents that induce innovation. Recently, Aghion et al. (2004, 2005) have shown that the effect of competition on firms' or industries' willingness to innovate depends on their level of efficiency (technology). In particular, competition is expected to spur innovation by firms close

[2] This first shakeout phase has also been referred to as the reallocative effects of trade liberalization and entry of foreign firms. For a theoretical and empirical paper focusing on the reallocative effects, see Marc J. Melitz (2003) and Nina Pavcnik (2002), respectively. These works suggest that globalization can raise the aggregate productivity via adjustments on the extensive margin (the exit of inefficient firms) rather than the intensive margin (productivity enhancements of incumbent firms). In the present study, we will be observing the effects on the remaining incumbent firms and examining the importance of adjustment on the intensive margin.

[3] Interestingly, from the standpoint of our research, Sutton argues that "… it is the 'middle group' countries of Eastern Europe, along with China and India, who are best placed to be the most dramatic beneficiaries of the present globalization, not—or not primarily—because of trade liberalization per se, but because of the virtuous dynamic that follows as part of the general package of liberalization of foreign direct investment and capability transfer." (Sutton 2007a, F483)

to the efficient frontier (those with highest efficiency), while it discourages innovation by firms that are far from the frontier. In Aghion et al. (2004), the predictions arise from a Schumpeterian model in which incumbent firms that are closer to the frontier have an incentive to innovate when faced with a potential (foreign) entrant in order to retain their market. Firms that are far from the frontier cannot compete with the more efficient entrant and competition simply reduces their expected benefits from innovation. Competition thus provides incentives for innovation for the more efficient domestic firms and a disincentive for the less efficient ones.

A slightly different argument is presented in Aghion et al. (2005), which states that firms close to the efficiency frontier are spurred by competition to innovate and increase their efficiency because competition reduces their pre-innovation rents (rents obtained if the firms do not innovate). Innovation enables these efficient firms to escape competition and increase their post-innovation rents or maintain them at their previous levels. In contrast, competition discourages firms that are far from the frontier from innovating because it negatively affects their post-innovation rents. Innovation does not help these laggard firms escape competition.[4] The balance between the opposing effects of competition on the two types of firms enables Aghion et al. (2004, 2005) to derive the prediction that the effect of the intensity of product market competition on the extent of innovation is in the form of an inverted U.

Based on these models, we test the following ceteris paribus predictions:

(i) Globalization brings foreign competition to emerging markets, and the anticipated effect of this competition on innovation by domestic firms depends on the underlying theoretical model:
   a. The effect of competition on innovation is negative.
   b. The effect of competition on innovation is positive.
   c. The effect of competition on innovation is in the form of inverted U.
   d. The effect of competition on innovation is positive for firms that are close to the efficiency frontier, and negative for firms that are far from the frontier.

(ii) Globalization stimulates innovation by domestic firms in emerging market economies through the vertical transfer of capabilities. Specifically:
   a. Firms that supply a larger share of sales to MNEs innovate more than firms that sell more to the domestic market.
   b. Firms that export a larger share of their sales innovate more than firms that sell more to the domestic market.
   c. Firms that import a larger share of their inputs innovate more than firms that buy a larger share of their inputs on the domestic market.

[4] In the model, the proportion of laggard and efficient firms is endogenous and depends on equilibrium innovation intensities. When competition is low, there is a larger fraction of efficient (neck-and-neck competing) incumbent firms and the "escape-competition" effect is likely to dominate the Schumpeterian effect. When competition is high, there is a larger fraction of laggard firms with low profits, and the Schumpeterian (negative) effect of competition on innovation is likely to dominate.

In testing the above hypotheses, we make several contributions. First, we focus on innovation, which has not been greatly studied in emerging markets, rather than on gains in productivity, which has been widely studied. This shift in focus is desirable because theories usually make predictions about the effects on innovation by firms rather than about the (derived) productivity effect. Furthermore, as argued by Gorodnichenko (2008), measured productivity captures the revenue generating ability of firms (which includes both market power and technology level) rather than the technology level of firms. Second, our analysis nests various channels of globalization, and we can assess the relative importance of different aspects of globalization for innovative activity of firms in emerging markets. Importantly, in contrast to the literature, we utilize information on direct linkages of domestic firms with foreign firms (e.g., whether a domestic firm is a supplier to foreign firms) instead of the typical measures of vertical linkages at the industry level, which rely on input-output tables (e.g., Beata Smarzynska Javorcik 2004). Third, we exploit a unique unified survey covering over 11,500 firms in a broad array of sectors in 27 countries. Thus, unlike other studies, we are able to analyze firms in both manufacturing and services and exploit cross-country variation.[5]

Our main findings are: greater pressure from foreign competition stimulates innovation; vertical relationships (supplying multinationals as well as exporting and importing) induce innovation by domestic firms; there is no evidence for an inverted U relationship between innovation and competition in either the more efficient or laggard firms, and the relationship between globalization and innovation does not vary across the manufacturing and service sectors. These findings are very robust.

The paper is organized as follows. We begin in Section I by describing our data and econometric specification. Section II presents the estimates of our baseline specification, which tests the main hypotheses (i) a–c and (ii) a–c. In Section III, we confront issues of endogeneity and carry out robustness checks. Among other things, we construct a measure of barriers to entry from survey responses; validate this index using external information on firm survival, turnover, and profitability rates; and use the index as an instrumental variable for foreign pressure. Upon tackling these issues, we proceed with testing the more nuanced hypothesis (i)d in Section IV, as well as examining whether the globalization-innovation relationship is significantly different for the manufacturing and service sectors. Section V concludes the paper.

I. Data and Econometric Specification

To test the predictions outlined in the previous section, we use data from the 2002 and 2005 Business Environment and Enterprise Performance Survey (BEEPS), a joint initiative of the European Bank for Reconstruction and Development (EBRD) and the World Bank Group. These are large surveys of 6,500 firms in 2002, and 7,900 firms in 2005, in 27 transition countries.[6] An important feature is the inclusion

[5] In the working paper version (Gorodnichenko, Svejnar, and Terrell 2008), we use the cross-country variation in these data to examine the importance of business climate and institutional factors for innovation. We find that these factors have small, if any, quantitative effects.

[6] In both years, the surveys were administered to 15 countries from Central and Eastern Europe (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia,

of firms in the service sector, which is the new dynamic (yet understudied) sector in these economies. The surveys relied on the same sampling frames and used identical questionnaires in all countries. To ensure that the samples are representative of the relevant population of firms, the surveys used stratified random sampling. For example, in each country, the sectoral composition of the sample in terms of manufacturing[7] versus services[8] was determined by their relative contribution to gross domestic product (GDP). Firms that operate in sectors subject to government price regulation and prudential supervision, such as banking, electric power, rail transport, and water and waste water were excluded from the sample. The sample includes very small firms with as few as two employees and firms with up to 10,000 employees. Moreover, the data include firms in the rural areas as well as large cities. Hence, these data enable us to analyze diverse firms in a large number of countries.

In addition, the dataset contains a panel component, where 1,443 firms that were surveyed in 2002 were surveyed again in 2005.[9] We use these panel data for robustness checks, where we verify that the timing of the values of variables in our baseline econometric specifications does not affect our results. However, our analysis relies primarily on the pooled 2002 and 2005 data since many variables of interest have a retrospective component in each survey date, and because it is hard to detect robust relationships with a small panel of heterogeneous firms, especially when we use many control variables.

An important advantage of our data is that firms self-report various types of innovation activity. Hence, we are able to define innovation broadly as the development and upgrading of new products, adoption of new technologies or obtaining quality accreditation. Specifically, we use binary variables based on answers to the question about whether firms have undertaken any of the following initiatives in the last three years: successfully developed a major new product line or upgraded an existing product line, hereafter *New Product*; acquired new production technology, hereafter *New Technology*; obtained a new quality accreditation (such as ISO 9001, 9002 or 14000, AGCCP, etc.), hereafter *New Accreditation*.

Given that the respondent's determination of whether a new product or service was developed or upgraded is subjective, we also use the variable *New Accreditation* as a formal affirmation that the quality of the product has been upgraded according to some widely accepted standards. For example, ISO 9000 is a family of standards for quality management systems, maintained by the International Organization for Standardization and administered by accreditation and certification bodies.[10] In

Poland, Romania, Serbia and Montenegro, Slovak Republic, and Slovenia), 11 countries from the former Soviet Union (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine and Uzbekistan) and Turkey. In neither year could the survey be administered in Turkmenistan. The analytical data include only about 11,500 firms due to missing observations in variables of interest.

[7] Manufacturing includes mining and quarrying, construction, manufacturing, and agro-processing.

[8] Service sector includes: transportation, storage, and communications; wholesale, retail, repairs; real estate, business services; hotels and restaurants; other community, social, and personal activities; and commerce.

[9] The relatively small size of the panel should not be associated with intensive exit of firms in these countries. The exit rate was about 8 percent (average across countries). The size of the panel is mainly brought about by a refusal of firms to participate in the new wave of the survey (42 percent) and an inability to reach eligible responders within firms (25 percent).

[10] Although the standards originated in manufacturing during WWII, when there were quality problems in many British high-tech industries, they are now employed across a wide range of sectors. A "product," in ISO

order to ensure the quality of a product, the standards certify the process by which a product is manufactured or delivered.[11] Hence, *New Accreditation* captures "process innovation" as well as "product/service innovation."

These measures of innovation are an improvement over the more commonly used measures of patents and R&D expenditures. Patents are generally viewed as having three weaknesses. First, they measure inventions rather than innovations. Second, the tendency to patent varies across countries, industries, and processes. Third, firms often protect their innovations by using methods other than patents (maintaining technological complexity, industrial secrecy, and lead time over competitors).

Using R&D expenditures may also be inappropriate because not all innovations are generated by R&D expenditures, R&D does not necessarily lead to innovation (it is an input rather than output), and formal R&D measures are biased against small firms (Jonathan Michie 1998; Daniele Archibugi and Giorgio Sirilli 2001). More important from the point of view of this paper is that these types of innovations are less likely to be observed in emerging market economies. Domestic firms are expected to engage more in imitation and adaptation of already created and tested technologies, rather than generating new inventions or expending resources on R&D. This is substantiated in our data, where the vast majority (75 percent) of firms who answered that they acquired a new technology said that it was embodied in new machinery or equipment that was purchased or licensed from other sources. Only 17 percent said the technology was developed by the firm.[12] Perhaps, most importantly, the measures we use capture management innovations, which can be argued to be more important than inventions for improving a firm's competitiveness and efficiency.

The BEEPS data also permit us to capture, at the firm level, the effects of pressure from foreign competition. In particular, we use responses about the severity of foreign competition, expressed by the chief executive officer of the firm on a 1–4 scale, from "not important" to "very important." (See a description of this and all the other variables in Appendix Table A1.) We note that this variable captures the pressure that domestic firms feel from local production by foreign firms in their markets and imports competing with their products.

We use three variables for vertical linkages between domestic and foreign firms, which allow transfer of capabilities or knowledge spillovers: *SMNE*, the share of a firm's sales to multinational enterprises; *Exports*, the share of sales exported; and *Imports*, the share of inputs imported. Whereas *SMNE* can be construed as capturing downstream relationships with foreign firms within the country, *Exports* can be viewed as capturing downstream relationships with foreign firms outside the country.

vocabulary, can mean a physical object or a service.

[11] For example, the requirements in ISO 9001 include: a set of procedures that cover all key processes in the business; monitoring processes to ensure they are effective; keeping adequate records; checking output for defects, with appropriate corrective action where necessary; regularly reviewing individual processes and the quality system itself for effectiveness; and facilitating continual improvement.

[12] One may be concerned that a vast majority of new technology is due to imitation and wonder whether our results extend to genuine in-house innovations made within firms. We applied our econometric specification (discussed below) to two in-house measures of innovation—positive R&D expenditures and "new technology developed by the firm"—and found very similar effects.

To test whether firms that are further away from the efficiency frontier innovate less than firms that are closer to the frontier, we define the frontier as the best (the most efficient one-third of) foreign firms (within an industry, country and year) in terms of measured productivity, and then calculate each domestically-owned firm's distance from the frontier. We would like to use total factor productivity (TFP, which we compute in equation (2)) to measure the distance from the frontier because it is the most intuitive measure. However, since firms are reluctant to report levels of sales, capital, and other key variables, we can only compute TFP for less than one-half of the firms in our sample. Hence, we use distance from the frontier based on TFP in our robustness check, but, in our baseline specifications, we propose an alternative measure of distance that allows us to keep the sample size as large as possible.

Our alternative distance measure draws on the matching literature (e.g., Paul R. Rosenbaum 2002), which assumes that firms that are similar in a set of observed characteristics are likely to have similar efficiency. Conversely, if the observed characteristics of domestic firms are different from those of the best (in terms of TFP) foreign-owned firms, the domestic firms are likely to be less efficient than the best foreign-owned firms. Specifically, we measure the distance between a domestically-owned firm i and the leading foreign-owned firms in an industry and country with the Mahalanobis distance, equal to

$$distance_i = \min_{j \in F} \left\{ \left(\mathbf{x}_i^D - \mathbf{x}_j^F \right)' \mathbf{S}_{\mathbf{x}}^{-1} \left(\mathbf{x}_i^D - \mathbf{x}_j^F \right) \right\},$$

where superscript F denotes the best foreign-owned firms, j indexes the best foreign-owned firms, and superscript D denotes domestic companies. $\mathbf{S}_x$ is the covariance matrix of the vector of observed characteristics $\mathbf{x}$. The inverse of the covariance matrix of observable characteristics $\mathbf{x}$ works as a weighting matrix, which takes into account the correlations between variables (no double counting) and makes the units of measurement and relative variability in $\mathbf{x}$ irrelevant. For example, if $\mathbf{x}$ consists of two uncorrelated variables, capacity utilization (CU) and employment (L), and there is only one foreign firm, then the distance from the frontier for a domestic firm i is $distance_i = (CU_i - CU^F)^2/\text{var}(CU) + (L_i - L^F)^2/\text{var}(L)$, where CU^F is capacity utilization of the foreign firm, L^F is employment of the foreign firm, and $\text{var}(CU)$ and $\text{var}(L)$ are the variance of capacity utilization and employment in the sample, respectively. If there is more than one foreign firm embodying the frontier, we take the distance to the closest foreign firm.

The vector of observed characteristics $\mathbf{x}$ contains the size of the firm in terms of the logarithm of number of employees; the structure of employment in terms of educational attainment (share with vocational school, secondary school, college), skill level (classified by BEEPS), as well as share of managers, share of professional workers, and share of permanent workers; capacity utilization in terms of machinery and labor; markup; share owned by largest shareholder(s); and growth rates (of sales revenue and capital). Domestic firms are matched only to foreign-owned firms in the same industry, country, and year. Since the distance is skewed, we take $\log(1 + distance)$ as the distance from the frontier in our specification. The larger the Mahalanobis distance, the further the domestic firm is from the best foreign firms in its industry/country.

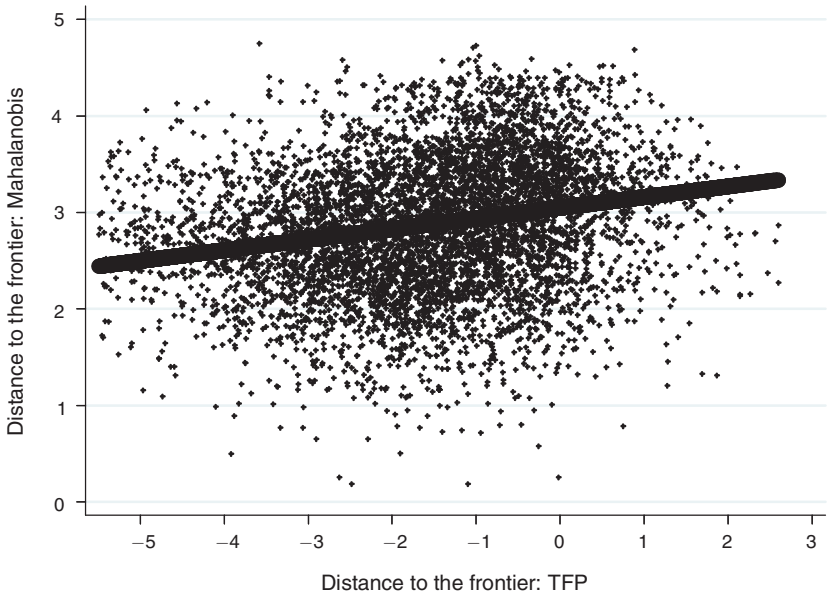

FIGURE 1. ALTERNATIVE MEASURES OF DISTANCE: MAHALANOBIS VERSUS TFP-BASED

Notes: The figure plots distance from the frontier measured by Mahalanobis (vertical axis) and measured by TFP (horizontal axis). All measures of distance are on log scale. Each point represents a firm observation. TFP is computed as in equation (2). Solid line is the fitted regression line. Correlation between these two measures is 0.21.

As may be seen from Figure 1, the Mahalanobis distance is correlated with the TFP-based distance. The raw correlation between the variables is 0.21, which is substantial given the amount of heterogeneity observed in the data. Furthermore, the correlation remains almost equally strong, even after we control for other factors such as industry, country, and time fixed effects. Hence, although conceptually, perhaps, less appealing than the TFP-based distance,[13] the Mahalanobis distance is a reasonably good proxy for distance from the frontier.

We estimate the following baseline probit specification with the pooled data in the 2002 and 2005 BEEPS for domestically owned firms (i.e., with no foreign ownership):

$$
\begin{aligned}
(1)\quad I_{isct} = \Phi\ \{&\alpha_1 ForComp_{isct} + \beta_0 SMNE_{isct} + \beta_1 Export_{isct} + \beta_2 Import_{isct} \\
&+ \delta_1 \log(1 + distance_{isct}) + \gamma_0 \ln L_{isc,t-3} + \gamma_1 (\ln L_{isc,t-3})^2 + \gamma_2 Edu_{isc,t-3} \\
&+ \gamma_3 Skill_{isc,t-3} + \gamma_5 Age_{isct} + \gamma_6 CNM_{isct} + \gamma_8 SOE_{isct} + \psi Loc_{isct} \\
&+ \gamma_9 Markup_{isct} + \lambda_s + \vartheta_c + \omega_t + error\},
\end{aligned}
$$

[13] Admittedly, the similarity of observed characteristics does not always imply that firms have the same level of productivity. See Gregory Clark (1987) and James A. Schmitz, Jr. (2005) for examples.

where I is a dummy variable equal to one if the firm reported an innovation, and zero otherwise; Φ denotes cumulative density function of a standard normal random variable; and i, s, c, and t index firms, sectors, countries, and time, respectively. Variables dated with period $t-3$ are taken from retrospective questions about the firm's performance three years prior to the current date. The first variable *ForComp* captures pressure from foreign competition. The next three explanatory variables capture vertical linkages or transfer of capabilities: *SMNE*, the share of sales to multinational enterprises; *Export*, the share of export in sales; and *Import*, the share of imported inputs.[14] The variable *distance* is the (Mahalanobis) distance from the technological frontier.

In addition to sector (λ_s), country (ϑ_c), and year (ω_t) fixed effects,[15] the following variables are included to control for a number of firm-specific factors deemed to be important in the literature.[16]

L (the number of employees) and L^2 measure the size of the firm. The argument for including size is that large companies have more resources to innovate and can benefit from economies of scale in R&D production and marketing.[17]

EDU (the share of workers with a university education) and *SKILL* (the share of skilled workers) capture human capital in the firm. These variables might be expected to be positively correlated with innovation if *EDU* reflects the involvement of workers in R&D, and more skilled workers (*SKILL*) are able to give feedback to the firm on how to improve a product.

Age of the firm is the log of the number of years since the firm began operations in the country. Two hypotheses are plausible: one suggesting that older firms developed routines that are resistant to innovation, and another suggesting that older firms will accumulate the knowledge necessary to innovate. There is evidence for both hypotheses.

CNM is a dummy equal to one if the firm competes in the national markets and zero otherwise (e.g., when a firm only competes in a regional or local market). We expect *CNM* to have a positive effect on innovation, given that the firm operates in a larger market.

State Owned Enterprise (*SOE*) is a dummy variable equal to one if the government owns 50 percent or more of the firm and zero otherwise. This variable is expected to be negatively correlated with innovation for a variety of reasons, including a poor system of rewards for innovative activities in these enterprises.

Location (*Loc*) is a set of dummies for size of population, where the firm is operating or headquartered. This will control for potential differences in knowledge available in larger versus smaller cities.

[14] Note that, in contrast to previous literature, we have firm-level variables describing linkages instead of industry-level variables (e.g., Irene Bertschek 1995 and Javorcik 2004).

[15] Controlling for industry, country, and time fixed effects is important because certain industries, countries, or time periods may be more prone to report introduction of new goods, technologies, and accreditation, and we do not want to bias our results if our regressors systematically co-vary with these episodes of more intensive reporting of innovative activity.

[16] See Nizar Becheikh, Rejean Landry and Nabil Amara (2006) for a review of the literature on innovation.

[17] This variable is probably one of the most studied firm characteristics determining innovation, in part, because it is also one of Schumpeter's (1943) hypotheses.

Finally, we also include, in some specifications, the variable *Markup,* or the price-to-cost ratio*,* which is used in related studies of advanced economies (e.g., Aghion et al. 2005 and Stephen J. Nickell 1996) to estimate the effect of competition faced by each firm.[18] Since we focus on the effect of foreign competition, we do not use markup in our base specification. Nevertheless, the question arises as to whether our estimated coefficient on foreign competition may suffer from an omitted variable bias because we do not control for domestic competition or for the possibility that foreign firms tend to enter less competitive industries. Therefore, we also have estimated regressions that include markup as an additional control variable.

In Appendix Table A1, we report a detailed description of the variables, and in Appendix Table A2, we report their means and standard deviations for the whole sample of domestically owned firms (defined as firms with zero share of foreign ownership). As may be seen from Appendix Table A2, there is considerable variation in the key variables.

II. Main Findings: Baseline Specification

In this section, we present estimates of equation (1), which test the main hypotheses (i) a–c and (ii) a–c described in the previous section. Our baseline specification for each of the three types of innovation is reported in Table 1. The first finding is that greater pressure from foreign competition has a positive effect on two of our three types of innovation, holding constant vertical linkages with foreign firms and a number of control variables (including markup, which does not affect any of the coefficients of interest). Firms feeling that pressure from foreign competition is "high" are more likely to upgrade their product and acquire a new technology than firms that feel this pressure is "not at all important." Converted to marginal effects (reported in Appendix Table A3), the estimated coefficients in Table 1 indicate that a unit increase in foreign pressure (e.g., moving from reporting pressure is low to pressure has a medium effect or moving from medium to high) is associated with approximately 1.9 percentage points higher innovative activity in the areas of new product or new technology. This is a quantitatively large effect. A one standard deviation increase in foreign pressure corresponds to about a 7 percent increase in the probability of developing a new product and a 4 percent increase in new technology.[19] However, the coefficient on foreign pressure is not statistically significant for new accreditation. We also estimate a specification that includes squared *ForComp* and find that none of the coefficients on the squared terms were significantly different from zero. We conclude that the forces of foreign competition stimulate the

[18] Firms that charge a larger markup are deemed to have less competition. The advantage of markup over a market share or Herfindahl index is that it does not require a precise definition of geographic and product markets. Alternatively, we could have used self-reported information on the number of competitors that a firm faces locally and nationally, which is provided by the BEEPS data. We do not use these data since the number of firms does not necessarily capture competition, but rather the "reallocation effect." As Sutton (2007b) argues, an increase in competition can lead to higher concentration (intensive margin) and a lower number of firms surviving in the market (extensive margin).

[19] This number is derived as follows. The standard deviation of pressure from *foreign competition* is 1.121, and the marginal effect is 0.019 for new technology and new product. Hence, the increase in probability is $1.121 \times 0.019 = 0.021$. Dividing this by the unconditional probabilities of new product (0.56) and new technology (0.3) yields 4 ($0.021/0.56 = 0.0375$) and 7 ($0.021/0.3 = 0.07$) percent, respectively.

Table 1—Baseline Specification for All Firms

	(1)	(2)	(3)
Panel A. New product			
Competition			
Pressure from foreign competition	0.048***	0.113*	0.048***
	(0.013)	(0.069)	(0.013)
(Pressure from foreign competition)^2		−0.014	
		(0.014)	
Vertical transfer of capability			
Share of sales to MNEs	0.265***	0.263***	0.260***
	(0.069)	(0.069)	(0.069)
Export share	0.298***	0.298***	0.296***
	(0.080)	(0.080)	(0.080)
Import share	0.377***	0.376***	0.372***
	(0.039)	(0.039)	(0.039)
Ability			
Distance (Mahalanobis)	−0.039*	−0.039*	−0.040*
	(0.022)	(0.022)	(0.022)
Controls			
ln L, $t-3$	0.128***	0.128***	0.129***
	(0.032)	(0.032)	(0.032)
$(\ln L)^2$, $t-3$	−0.005	−0.005	−0.005
	(0.004)	(0.004)	(0.004)
Share of skilled workers, $t-3$	0.020	0.021	0.017
	(0.046)	(0.046)	(0.046)
Share of workers with university. ed. $t-3$	0.233***	0.232***	0.230***
	(0.052)	(0.052)	(0.052)
Firm's age	−0.055***	−0.055***	−0.052***
	(0.020)	(0.020)	(0.020)
State owned dummy	−0.236***	−0.235***	−0.232***
	(0.046)	(0.046)	(0.046)
Compete in national markets	0.228***	0.227***	0.231***
	(0.034)	(0.034)	(0.034)
Markup			0.630***
			(0.112)
Observations	11,078	11,078	11,078

(*Continued*)

processes of developing or upgrading a new product and of acquiring a new technology but not the process of obtaining a new accreditation. There is no support for an inverted U relationship between foreign competition and innovation.

Vertical transfer of capability from foreign to domestic firms (stressed by Sutton 2007a and the FDI spillover literature) is significant for all three forms of innovation. As may be seen in Table 1, firms that have stronger vertical relationships with multinationals, either domestically (by supplying them) or out of the country (by exporting or importing), innovate more than firms that have weaker relationships with multinationals. Holding everything else constant, an increase in the share of sales to MNEs or foreign markets, or the share of imported inputs, by 1 percent is associated with increasing innovation in products by 10 to 15 percentage points, increasing innovation in technology by 8 to 10 percentage points, and increasing

Table 1—Baseline Specification for All Firms (*Continued*)

	(1)	(2)	(3)
Panel B. New technology			
Competition			
Pressure from foreign competition	0.056***	0.138**	0.056***
	(0.013)	(0.070)	(0.013)
(Pressure from foreign competition)^2		−0.018	
		(0.015)	
Vertical transfer of capability			
Share of sales to MNEs	0.250***	0.246***	0.244***
	(0.068)	(0.068)	(0.068)
Export share	0.251***	0.251***	0.248***
	(0.074)	(0.074)	(0.074)
Import share	0.293***	0.292***	0.288***
	(0.039)	(0.039)	(0.039)
Ability			
Distance (Mahalanobis)	−0.037*	−0.037*	−0.040*
	(0.023)	(0.023)	(0.023)
Controls			
ln L, $t-3$	0.127***	0.128***	0.127***
	(0.034)	(0.034)	(0.034)
$(\ln L)^2$, $t-3$	−0.004	−0.004	−0.004
	(0.005)	(0.005)	(0.005)
Share of skilled workers, $t-3$	−0.016	−0.014	−0.019
	(0.048)	(0.048)	(0.048)
Share of workers with university. ed. $t-3$	0.203***	0.201***	0.200***
	(0.055)	(0.055)	(0.055)
Firm's age	−0.050**	−0.050**	−0.046**
	(0.020)	(0.020)	(0.020)
State owned dummy	−0.112**	−0.112**	−0.108**
	(0.047)	(0.047)	(0.048)
Compete in national markets	0.211***	0.209***	0.214***
	(0.035)	(0.035)	(0.035)
Markup			0.627***
			(0.114)
Observations	10,991	10,991	10,991

(*Continued*)

innovation in accreditation by 4 to 7 percentage points (see Appendix Table A3). These magnitudes are economically significant since a 1 standard deviation increase in these variables corresponds to a 5 to 10 percent increase in innovative success. Vertical transfers are less influential in obtaining a new accreditation than in upgrading a product or acquiring a new technology, but overall vertical transfers of capability are statistically and economically strong for all types of innovation.

It is interesting to note that firms that are further away from the frontier (in terms of the Mahalanobis distance) are less likely to innovate in terms of developing a new product or acquiring new technology. Increasing the distance to foreign firms by one standard deviation decreases innovative activity by approximately 1 percentage point, which is a relatively modest amount. Distance is not significantly related to

Table 1—Baseline Specification for All Firms (*Continued*)

	(1)	(2)	(3)
Panel C. New Accreditation			
Competition			
Pressure from foreign competition	0.026	0.107	0.026
	(0.017)	(0.088)	(0.017)
(Pressure from foreign competition)^2		−0.017	
		(0.018)	
Vertical transfer of capability			
Share of sales to MNEs	0.405***	0.402***	0.405***
	(0.076)	(0.076)	(0.076)
Export share	0.470***	0.470***	0.471***
	(0.082)	(0.082)	(0.082)
Import share	0.233***	0.232***	0.233***
	(0.051)	(0.051)	(0.051)
Ability			
Distance (Mahalanobis)	−0.020	−0.019	−0.019
	(0.028)	(0.028)	(0.028)
Controls			
ln L, $t-3$	0.295***	0.295***	0.295***
	(0.047)	(0.047)	(0.047)
$(\ln L)^2$, $t-3$	−0.014**	−0.014**	−0.014**
	(0.006)	(0.006)	(0.006)
Share of skilled workers, $t-3$	−0.098	−0.097	−0.098
	(0.064)	(0.064)	(0.064)
Share of workers with university. ed. $t-3$	0.222***	0.220***	0.222***
	(0.072)	(0.072)	(0.072)
Firm's age	0.023	0.023	0.023
	(0.025)	(0.025)	(0.025)
State owned dummy	0.027	0.027	0.027
	(0.056)	(0.056)	(0.056)
Compete in national markets	0.276***	0.274***	0.276***
	(0.047)	(0.047)	(0.047)
Markup			−0.008
			(0.154)
Observations	11,040	11,040	11,040

Notes: The table reports estimates of equation (1), where location, time, country, and industry fixed effects are included, but not reported. Definitions of the variables are in Appendix Table A1. Robust standard errors are in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

obtaining a new quality accreditation, although the sign and point estimate of the coefficient are similar to those for the other two types of innovation.

There are a number of interesting findings with respect to the control variables in Table 1. First, larger firms tend to innovate more than smaller firms, which is consistent with the finding in the vast majority of studies on innovation (see e.g., Becheikh, Landry, and Amara 2006) and Schumpeter's (1943) hypothesis. The size effect is linear (and with very similar coefficients) for new product and new technology, but it is increasing at a decreasing rate for new accreditation. Second, the effect of human capital varies by how it is measured. Having a higher share of skilled workers does

not affect the probability of developing a new product, acquiring new technology, or obtaining a new accreditation. On the other hand, as the share of workers with a university education rises, all three types of innovation are boosted. These findings stress the need for a highly educated labor force to improve the capabilities of the product or service. To take an extreme example, a firm with 100 percent of its employees having a university degree would be 3 to 9 percentage points more innovative than a firm with no university-educated employees. Third, older (more mature) firms are less likely to innovate with respect to product and technology, but have the same probability of obtaining a new accreditation as new firms. For example, a 10-year-old firm has a 5 percentage points lower incidence of successful innovations than a newly born firm. Fourth, state-owned firms are 9 percentage points less likely to innovate than privately owned firms in terms of product and 4 percentage points less likely to innovate than privately owned firms in terms of technology, but they are no more or less likely to acquire a new accreditation. Fifth, firms that compete/operate in national markets are more likely to innovate in any of the three areas than firms that only compete/operate in a local or regional market. This may reflect both the capability of the firms operating in the larger national market, as well as the characteristics of the national as opposed to local environment. Finally, domestic competition, proxied by markup, has a positive effect on innovation, which is consistent with the results in Wendy Carlin, Mark Schaffer, and Paul Seabright (2004) who use an early wave of BEEPS and a similar econometric framework. The corresponding marginal effect of increasing markup by 10 percentage points, which is approximately 1 standard deviation of the markup in the sample, is associated with a 2.1 to 2.3 percentage point increase in the probability of introducing a new product or a new technology (see Appendix Table A3 for marginal effects).[20] On the other hand, product market competition does not have an effect on the third dimension of innovation, namely obtaining a new accreditation.

In concluding this section, we note that the coefficients on the explanatory variables are less often significant for obtaining a new accreditation than for upgrading a product or acquiring a new technology. However, the coefficients on downstream linkages with MNEs are relatively large for obtaining a new accreditation compared to those for the other two types of innovation. We conjecture that accreditation may be obtained as a precondition for either selling to MNEs or exporting. In support for this conjecture, Isin Guler, Mauro F. Guillén, and John Muir MacPherson (2002) cite evidence that multinationals prefer suppliers who are accredited in one or more of the family of ISO 9000 standards. Many government agencies in countries around the world have come to require the same of their contractors. There is also abundant anecdotal evidence suggesting that quality accreditation (ISO 9000) spread through Asia and Latin America in the early 1990s as they tried to boost their exports (see e.g., various issues of *Chemical Week* in 1994 and 1995).

[20] Economic theory does not provide unambiguous predictions on the sign of the relationship between competition and innovation. Likewise, Morton I. Kamien, and Nancy L. Schwartz (1975) and Wesley M. Cohen and Richard C. Levin (1989), in their reviews of the empirical literature, conclude that the effect of concentration on innovation varies across industries, and the sign of the relationship can be both positive and negative. Although addressing our finding of a positive association between markups and innovation is beyond the scope of the paper, we conjecture that this finding captures the fact that firms need resources to innovate, and with largely underdeveloped capital markets in emerging market economies, markups provide funding for innovative activities.

III. Econometric Issues and Robustness Checks

In this section, we carry out a battery of econometric and measurement checks to verify that our results are robust. The baseline specification potentially has endogeneity issues given our firm-level measures of competition and transfer of capabilities. Therefore, we estimate our model using instrumental variables for foreign pressure. As our key instrument, we construct an index of barriers to entry based on firms' responses about regulations. We validate the index using external information on firm survival, turnover, and profitability rates. We also carry out a robustness check for our Mahalanobis measure of the distance to the frontier and report the results of several other robustness tests that exploit the panel data in the BEEPS

A. *Endogeneity of Foreign Competition*

Is the innovative activity being spurred by the foreign competition or is the pressure from foreign competition the result of the innovative activity? Unfortunately, economic theory does not make clear predictions about the sign of the resulting bias of the regression coefficients. Both positive and negative feedback between competition and innovation are possible. If, for example, firms successfully innovate, they may be able to prevent entry of new firms into the market (as noted, for example, by Aghion et al. 2005, and Richard Blundell, Rachel Griffith, and John Van Reenen 1999). The same endogeneity problem may exist with markup. Another source of correlation between competition and error term in our regression can be measurement error, which leads to attenuation bias.

Variables that capture the regulation of an industry might be considered good instrumental variables (IV) for competition in general, and for foreign pressure in particular, since they affect entry of new firms, but not necessarily innovative activity. BEEPS provide several questions about regulations, of which we selected the following two.

> Q1. Thinking now of unofficial payments/gifts that a firm like yours would make in a given year, could you please tell me how often would they make payments/gifts for the following purposes [score on 1 (Never) to 6 (Always) scale]:
>
> a) To obtain business licenses and permits;
>
> b) To deal with occupational health and safety inspections;
>
> c) To deal with fire and building inspections;
>
> d) To deal with environmental inspections;
>
> e) To influence the content of new legislation, rules, decrees, etc.
>
> Q2. Can you tell me how problematic are these different factors for the operation and growth of your business [score on 1 (No obstacle) to 4 (Major obstacle) scale]:
>
> a) Access to land;
>
> b) Title or leasing of land;
>
> c) Customs and trade regulations;

d) Business licensing and permits;

e) Labor regulations.

The advantage of these questions is that they provide a measure of entry barriers at the firm level, in contrast to the previous literature, which used more aggregated variables such as movements in exchange rates and changes in tariffs (e.g., Marianne Bertrand 2004; Aghion et al. 2005). This difference is important because variability at the firm level dwarfs variability at the macroeconomic level, and thus our instruments are much more informative. At the same time, Q1 and Q2, by capturing barriers to entry, preserve the spirit of the instrumental variables used in the previous literature.

Any given sub-question may be a weak instrument because it captures only one facet of barriers to entry and does not provide a holistic picture of impediments to entry. Therefore, we construct an "index of barriers to entry" by normalizing firm's answers to each question to have the same scale and variability (a standard deviation of one), and then summing up the normalized responses across all questions (Q1a–Q1e, Q2a–Q2e) for each firm.[21] This index provides a simple transparent summary statistic for various impediments that firms face in starting or operating a business. Larger values of the index are interpreted as higher barriers to entry.

To verify that this statistic provides a meaningful measure of barriers to entry, we regressed measures of firm profitability (from BEEPS) as well as industry-level entry, survival, and firm turnover (from Eric Bartelsman, John Haltiwanger, and Stefano Scarpetta 2004) on the index. The results, reported in Table 2, suggest that a larger value of our index is associated with a higher incidence of positive profits and lower firm turnover (and entry rate in particular), as well as higher firm survival rates. All of these findings are consistent with industries being more protected when the index is higher. We conclude that the index captures barriers to entry and, hence, we may expect it to serve as a reasonable instrumental variable for pressure from foreign competition.

We also include the average response about foreign pressure of all other firms in the same industry/country/year as an instrument. This instrument is aimed at fixing the attenuation bias since the average response of firms in a country-industry-year cell is less likely to be contaminated with the measurement error.

The IV results are presented in Table 3. We find that our instruments have good statistical properties. The first-stage *F*-statistic suggests that excluded variables have strong predictive power for pressure from foreign competition. Likewise Anderson's canonical correlation test rejects the null that the instruments are irrelevant. The point estimates in the IV convey the same message we had from standard probit estimates; greater pressure from foreign competition spurs innovation in introducing new products and adopting new technologies, and it has no effect on certification.

[21] We also explored an alternative strategy when we chose instruments using formal statistical selection criteria developed by Donald W. K. Andrews (1999) and Alastair R. Hall and Fernanda P. M. Peixe (2003). These criteria select correctly excluded variables with strong predictive power in the first stage. The results with this alternative strategy are qualitatively similar to those that we present in the paper.

Table 2—Barriers to Entry and Firm Turnover

	Incidence of zero profits Probit	Turnover rate OLS	Survival rate OLS	Entry rate OLS
Index of barriers to entry	−0.010***	−0.953***	0.904**	−0.190**
	(0.003)	(0.181)	(0.440)	(0.081)
Observations	8,248	59	62	60

Notes: The table reports separate correlations of our "index of barriers to entry" (described in Section III) with firm profitability, and rates of firm turnover, survival, and entry. In all specifications, country and industry fixed effects are included, but not reported. The dependent variable in the probit specification (first column) is equal to one if a firm reported no (zero) profits and equal to zero otherwise. Year fixed effects are also included, but not reported, in the probit equation. The firm turnover, entry rates, and firm survival rate, from Bartelsman, Haltiwanger and Scarpetta (2004), are provided for the following five transition countries at the 2-digit NACE industry level: Estonia, Latvia, Hungary, Romania, and Slovenia. For these specifications, barriers to entry are measured as the median response in a given country and industry. Turnover, survival and entry rates are in percent. Robust standard errors are in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 3—Instrumented versus Noninstrumented Estimates of Foreign Competition and Markup

	New product		New technology		New accreditation	
Pressure from foreign competition	0.546***	0.518***	0.380***	0.296***	−0.076	−0.098
	(0.080)	(0.101)	(0.089)	(0.097)	(0.114)	(0.125)
Markup		1.421*		1.973***		0.477
		(0.780)		(0.749)		(0.930)
Cragg-Donald Wald *F*-statistic	126.8***	54.3***	127.6***	54.9***	127.0***	54.7***
Anderson canonical corr. LM statistic	249.4***	161.6***	250.8***	163.4***	249.7***	162.6***
First stage fit, *F*-statistic						
Markup		111.5***		106.7***		110.8***
Foreign pressure	126.8***	84.9***	127.6***	85.5***	127.0***	85.0***
Observations	11,003	11,003	10,913	10,913	10,966	10,966

Notes: The table reports estimates of equation (1), where location, time, country, and industry fixed effects, as well as other controls are included, but not reported. IV probit is implemented as in Newey (1987). The null hypothesis for tests based on the Anderson canonical correlation LM statistic is that the matrix of reduced form coefficients does not have full rank (i.e., the system is under-identified). Cragg-Donald Wald *F*-statistic tests the null of weak instruments. First stage fit *F*-statistic reports the values of the *F*-statistic for the null that coefficients on excluded variables (instruments) in the first stage are jointly equal to zero. In the specifications that exclude markup, the instruments are barriers to entry and the response of other firms to the question about foreign pressure in the same industry/country/year cell. In the specifications that include markup, the instruments are augmented with the response of other firms to the question about markup in the same industry/country/year cell. Robust standard errors are in parentheses. The asterisks at the first stage *F*-statistic and the Anderson canonical correlation LM statistic show the significance level at which the corresponding null hypothesis is rejected.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

The relative magnitudes of the IV and standard probit estimates deserve some discussion. We believe there are two explanations for the relatively large IV estimates. First, if our IV is correcting for measurement error in foreign competition, it should remove attenuation bias and result in a larger coefficient. This correction would be large only if the size of the signal-to-noise ratio is relatively small. Although the signal-to-noise ratio necessary to explain this big increase in the estimate is on the

high-end of the range for subjective assessments in surveys, it is not implausible especially given that responses are based on a discrete scale.[22]

Second, foreign pressure could be particularly strong for stagnant industries (typically industries dominated by old firms), and since stagnant (old) industries tend to innovate less (as seen in Table 1), this would lead to a negative correlation between foreign competition and the error term in equation (1). This would result in a negative bias in the OLS estimates, which the IV estimate corrects. Although we do not have a measure of how stagnant an industry is, this account is indirectly supported by the data. In particular, there is a strong positive correlation between the average age of firms in an industry and reported foreign pressure. Furthermore, older firms appear to be crowded out by foreign firms, i.e., as foreign pressure increases in an industry (measured as the share of output in an industry produced by foreign firms), the average age of the firms declines. In order to present conservative estimates, we continue with the OLS approach.

B. *Robustness of the Distance Measure*

To test the robustness of the Mahalanobis distance measure, we reestimate the baseline equation with a measure that captures differences in efficiency using the total factor productivity (TFP). We compute TFP using the cost share for labor, material, and capital (computed for each firm and aggregated for a given industry in each country and year), and adjust it for capacity utilization (CU),

$$\ln TFP_{isct} = \ln Y_{isct} - \bar{s}^{L}_{sc} \ln L_{isct} - \bar{s}^{M}_{sc} \ln M_{isct} - \bar{s}^{K}_{sc} \ln K_{isct} - \ln CU_{isct}, \tag{2}$$

where i, s, c, and t index firms, industries, countries, and time; $\bar{s}^{L}_{sc}, \bar{s}^{M}_{sc}, \bar{s}^{K}_{sc}$, are labor, materials, and capital cost shares; Y is sales; L is number of employees; M is the value of materials; and K is the replacement value of capital. We then estimate the *TFP*-based distance measure as the difference between log *TFP* of the top third of the most efficient foreign firms in a given industry and country, and log *TFP* of each domestic firm in the same industry and country.[23]

Since only about one-half of the firms report sales revenue, and even fewer report capital, our TFP-measure is available for only 5,548 firm observations. Despite this, we find that the coefficients on TFP-based distance are similar to those of the Mahalanobis distance in suggesting that there is a negative and significant relationship between distance and innovation (Table 4). Hence, our basic results are robust

[22] To put this discussion into perspective, consider the size of measurement errors reported in other surveys. A common way to get a lower bound on the measurement error is to check the test-retest correlation (where the same question is asked after a period of time). In this simple check (typically within one hour or one day), the correlation between test-retest responses is about 0.3–0.5, which implies that the signal to noise ratio has to be about ½. (See Alan B. Krueger and David A. Schkade 2008 for a brief survey of measurement errors in measures of well-being.) Given that test-retest correlations are typically estimated for a very short period of time, it is entirely plausible that as the time between test-retest questions expands, the correlation falls, since some respondents will find it harder to recall what they reported in the first-round question.

[23] Similar to computing the Mahalanobis distance, the top third of foreign firms is defined as the set of firms with *TFP* above the sixty-sixth percentile.

Table 4—Baseline Specification for All Firms Using TFP-Based Distance

	New product	New technology	New accreditation
Competition			
Pressure from foreign competition	0.052***	0.061***	0.021
	(0.019)	(0.019)	(0.023)
Vertical transfer of capability			
Share of sales to MNEs	0.458***	0.311***	0.409***
	(0.108)	(0.097)	(0.108)
Export share	0.286**	0.190*	0.360***
	(0.112)	(0.101)	(0.112)
Import share	0.418***	0.242***	0.180**
	(0.059)	(0.058)	(0.072)
Ability			
Distance (TFP)	−0.031**	−0.026*	−0.044***
	(0.013)	(0.013)	(0.017)
Observations	5,094	5,032	5,054

Notes: The table reports estimates of equation (1), where location, time, country, and industry fixed effects, as well as other controls are included, but not reported. Definitions of the variables are in Appendix Table A1. *TFP* is calculated using equation (2). TFP-based distance is the log difference between the average of the top third within a given country/industry/year cell foreign firms' TFP and that of a domestic firm. Robust standard errors are in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

to alternative measures of the distance from the frontier. Because we lose so many observations with the TFP-based measure of distance, we use the Mahalanobis distance throughout the paper with the exception of this section.

C. *Reverse Causality and the Timing of Measurement of Variables*

Our variables for competition, vertical transfer of capabilities, and distance are reported in the years of the survey (2002 and 2005), while innovation is measured over the preceding three-year periods (1999–2002 and 2002–2005, respectively). As a result, there is a potential problem that the causality runs from the dependent variable to the explanatory variables such that, for example, firms that have innovated are able to sell more to MNEs than firms that have not innovated. We address this potential problem in two ways.

First, the reverse causality is less of a problem if the values of the explanatory variables in question (*SMNEs, export, import,* and *ForComp*) do not vary much over a given three-year period. Within the subsample of about 1,000 BEEPS firms for which we could link the 2002 and 2005 survey data and create a panel, the correlation coefficients between the 2002 and 2005 values of *exports*, *imports*, and *SMNE*, respectively, are relatively high (0.95, 0.93 and 0.42, respectively). The pressure from *foreign competition* is a categorical variable, and the probability of reporting the same value (staying in the same group) is about 50 percent. Hence, these coefficients show considerable persistence, especially when one considers that a number of the variables are expressed as shares.

Second, we replicate our estimates on the panel subsample of BEEPS firms, which allows us to regress innovation measured for the period 2002–2005 on the 2002 values of competition, vertical transfers, and distance from the frontier (using both the TFP-based and Mahalanobis measures). By construction, these "initial value" regressions eliminate the possibility that the relationship between a firm's innovation and competition, vertical transfers, and distance from the frontier is brought about by contemporaneous shocks to these variables, or by reverse causality. However, because the panel subsample is much smaller than the entire sample, we must use a more parsimonious specification. Therefore, we check whether and how our findings are affected by the change in specification and the smaller sample size. In particular, we include only the country and industry fixed effects as control variables and exclude the nine control variables in equation (1). Moreover, we include competition by itself. Finally, the majority of the non-zero values in the share of sales to MNEs, share of exports, and share of imports variables are close to unity (greater than 90 percent). Hence, also taking into account the small sample size, we convert these variables from shares into dummy variables, where zero means no sales to MNEs, exports, etc.

In order to assess what drives the difference, if any, between the estimates from the full sample and panel data, we estimate the more parsimonious specification for various samples:

(a) the full sample, using pooled *2002 and 2005* data on *all* firms and *current* (contemporaneous) values of the explanatory variables, as in the base specification;
(b) the pooled *2002 and 2005* data on the *panel* of firms, using *current* values of the explanatory variables;
(c) the *2005* data on the *panel* of firms, using *current* values of the explanatory variables; and
(d) the *2005* data on the *panel* of firms, using three-year *lagged* values of the explanatory variables.

The model in (a) reveals whether the more parsimonious specification applied to the full sample yields similar results to those in the base specification reported in Table 1. It also provides a benchmark against which to compare the estimates from the panel subsample. The estimation in (b) is identical to that in (a), except that it uses the panel subsample of firms. Comparing the estimates in (b) to those in (a) permits us to establish whether, for the purposes of our study, the panel is a representative subsample of the full sample. The estimation in (c) is identical to (b), but uses only the 2005 part (i.e., the more recent half) of the panel. Comparing the estimates in (c) to those from (b) permits us to infer how much significance, if any, we lose by using only the more recent half of the panel data observations. Finally, the results in (d) represent the ideal specification, which explains innovation over the 2002–2005 period with the lagged (2002) values of the explanatory variables.[24] Comparing the results in (c)

[24] This uses data from the 2005 part of the panel for the dependent variable and data from the 2002 part of the panel for the explanatory variables.

and (d) enables us to assess the difference in the estimated coefficients between the specifications using the current versus the lagged values of the explanatory variables.

The coefficients from each of these four specifications are presented in Table 5 for the competition, transfer of capability, and distance variables. First, a comparison of the coefficients in column 1 of each panel in Table 5 to the coefficients in Table 1 indicates that applying the more parsimonious model to the full sample yields similar coefficient signs, point estimates, and significance on all the variables, with the only notable difference being that the coefficients on *pressure from foreign competition* are somewhat larger in the parsimonious specification.

A comparison of the results in column 1 with column 2 in each of the three panels of Table 5 indicates that going from over 11,500 observations in the full pooled sample to about 2,000 observations in the pooled panel data, holding constant the specification, maintains the signs and, in most instances, also maintains the significance of the key coefficients.

Comparing columns 2 and 3 in each of the three panels of Table 5 demonstrates that going from the 2,000 pooled panel observations for 2002 and 2005 to 1,000 observations for 2005 (but estimating the same equation which still has contemporaneous values of the independent variables) maintains all signs and reduces the significance of just two coefficients.[25] Finally, moving from columns 3 to 4, i.e., using the lagged (2002) rather than the current (2005) values of the explanatory variables with the 2005 panel observations, reduces the significance on three and increases the significance on another two of the 24 coefficients. Interestingly, in the two cases in which the coefficients become significant (*SMNE* for New Product and New Technology), they also become similar to the corresponding coefficients in the full sample estimates in column 1 of Table 5 and the corresponding coefficients in the base model in Table 1.

In view of the recent literature about reverse causality in the relationship between exporting and the efficiency of firms (see e.g., Melitz 2003), we take an additional step in assessing whether there is evidence of reverse causality in the relationship between exporting and innovation. For the export share, we can construct $t-3$ values using retrospective questions about growth rates of export (including the first year of export status) and sales, as well as the current year information on the export share in total sales and the level of sales. The estimated coefficients (not reported in tabular form) are nearly identical to the results reported in the baseline specification: 0.311 for new product, 0.257 for new technology, and 0.450 for new accreditation (all significant at 1 percent). We can conclude that firms that exported a larger share of their sales three years ago are more likely to be innovating today.[26]

Overall, the results in Table 5 suggest that using the large pooled sample of 2002 and 2005 data with the current values of the competition, transfer of capability, and distance variables is a reasonable empirical strategy that does not generate major biases in the estimated coefficients.

[25] The number of observations in the panel drops to 1,000 because of missing variables.

[26] We do not use this measure in our analysis because many firms are reluctant to report the level of sales, and the sample size for the regressions based on export share dated at $t-3$ shrinks to about 6,000 observations.

Table 5—Testing for Endogeneity Due to the Timing of the Variables

	Full sample (current) (1)	2002 & 2005 panel (current) (2)	2005 panel (current) (3)	2005 panel (lagged) (4)
Panel A. New product				
Pressure from foreign competition	0.109***	0.048*	0.061**	0.084**
	(0.011)	(0.028)	(0.030)	(0.039)
Vertical transfer				
Sales to MNEs	0.308***	0.356***	0.191	0.305***
	(0.033)	(0.083)	(0.120)	(0.108)
Export share	0.296***	0.463***	0.444***	0.371***
	(0.032)	(0.084)	(0.115)	(0.116)
Import share	0.368***	0.338***	0.319***	0.182**
	(0.025)	(0.061)	(0.088)	(0.086)
Distance				
Distance (Mahalanobis)	−0.075**	−0.129**	−0.121*	−0.117
	(0.020)	(0.053)	(0.072)	(0.075)
Distance (TFP)	−0.039***	−0.092***	−0.064*	−0.072*
	(0.012)	(0.027)	(0.041)	(0.041)
Panel B. New technology				
Pressure from foreign competition	0.100***	0.053*	0.113***	0.072*
	(0.011)	(0.028)	(0.040)	(0.039)
Vertical transfer				
Sales to MNEs	0.213***	0.158**	0.065	0.264**
	(0.032)	(0.079)	(0.119)	(0.108)
Export share	0.213***	0.204***	0.315***	0.189*
	(0.031)	(0.076)	(0.109)	(0.110)
Import share	0.307***	0.255***	0.283***	0.146
	(0.026)	(0.064)	(0.092)	(0.091)
Distance				
Distance (Mahalanobis)	−0.076***	−0.044	−0.051	−0.054
	(0.021)	(0.052)	(0.073)	(0.073)
Distance (TFP)	−0.035***	−0.069**	−0.062*	−0.067*
	(0.012)	(0.025)	(0.037)	(0.038)
Panel C: New Accreditation				
Pressure from foreign competition	0.108***	0.099***	0.065	0.059
	(0.014)	(0.033)	(0.048)	(0.045)
Vertical transfer				
Sales to MNEs	0.344***	0.374***	0.294**	0.366***
	(0.033)	(0.079)	(0.122)	(0.109)
Export share	0.423***	0.494***	0.466***	0.442***
	(0.033)	(0.079)	(0.112)	(0.114)
Import share	0.212***	0.190***	0.298***	0.125
	(0.028)	(0.067)	(0.098)	(0.094)
Distance				
Distance (Mahalanobis)	−0.095***	−0.046	−0.036	−0.026
	(0.025)	(0.066)	(0.096)	(0.096)
Distance (TFP)	−0.060***	−0.026	−0.002	−0.005
	(0.014)	(0.030)	(0.043)	(0.044)

Notes: Pressure from foreign competition enters the regressions separately. Vertical transfer of capability (sales to MNEs, export, import), Mahalanobis Distance and TFP-based Distance enter the regressions separately. Sales to MNEs, export share, and import share are set as dummy variables equal to one for positive values. Full Sample is with current RHS values; 2002 and 2005 panel is with current RHS values; 2005 panel is with both current and lagged RHS values. The coefficients in column 1 differs from the corresponding entries in Table 1 because other controls in Table 5 are excluded. Location type, time, country, and industry fixed effects are included, but not reported. Robust standard errors are in parentheses.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

IV. Additional Findings

In this section, we proceed with testing the remaining prediction (i)d outlined at the beginning of this paper, namely whether the effects of competition and vertical transfer of capabilities on innovation vary with the efficiency level of firms. Given the nature of our data, unlike other studies, we are able to estimate these effects separately for manufacturing and services, and see if the results are materially different across these two sectors.

A. *Firm Heterogeneity and Innovation*

The key prediction from the Aghion et al. (2004, 2005) models is that firms closer to the frontier are spurred by competition to innovate, while those far from the frontier are discouraged from innovating (prediction (i)d at the beginning of this paper). In order to test this prediction, we estimate equation (1) separately for three groups of firms, according to where they lie in the Mahalanobis distance to the frontier—the closest one-third ("close"), middle one-third ("middle") and farthest one-third ("far").

Examining the coefficients on *pressure from foreign competition* in the close, middle, and far columns of Table 6, we find no systematic support for this hypothesis. Increases in foreign competition spur product and technology innovation among firms that are "close to" as well as "far from" the frontier at about the same rate and for both sets of firms, it has no effect on accreditation.

A key hypothesis with respect to the relationship between vertical transfer of capabilities and innovation found in the FDI spillover literature is that firms closer to the frontier are in a better position than firms farther from the frontier to imitate (absorb) the technology of foreign firms. As may be seen from Table 6, we do not find support for this hypothesis in any of our three vertical transfer variables. Virtually all the coefficients are highly significant and, for most cases one cannot reject the hypothesis that the effects are the same for firms that are close to and far from the efficiency frontier.

In sum, Sutton's (2007a) prediction that the vertical transfer of capability is an important phenomenon is strongly supported, and the effect seems to be strong across the board irrespective of the relative efficiency of domestic firms. However, we do not find support for an inverted U relationship or for the prediction that firms further from the frontier are discouraged from innovating by competition, while firms close to the frontier are spurred by competition to innovate.

B. *Manufacturing versus Services*

Finally, we note that the effects of globalization may vary across different sectors of the economy if, for example, one sector comprises primarily tradables and the other nontradables. We therefore test whether the innovation effects of competition and vertical linkages with foreign firms are different for firms in manufacturing than for those in services. This manufacturing-service sector distinction is also useful because the service sector is rapidly gaining in importance in many emerging market

Table 6—Testing for the Interaction between Distance and Competition

	Distance to the Frontier		
	Close (1)	Middle (2)	Far (3)
Panel A. New product			
Competition			
Pressure from foreign competition	0.071***	0.022	0.053**
	(0.022)	(0.022)	(0.023)
Vertical transfer of capability			
Share of sales to MNEs	0.162	0.358***	0.277**
	(0.121)	(0.131)	(0.116)
Export share	0.268*	0.180	0.382***
	(0.139)	(0.142)	(0.137)
Import share	0.411***	0.250***	0.447***
	(0.071)	(0.067)	(0.068)
Observations	3,746	3,695	3,637
Panel B: New technology			
Competition			
Pressure from foreign competition	0.058**	0.060***	0.056**
	(0.023)	(0.023)	(0.023)
Vertical transfer of capability			
Share of sales to MNEs	0.297**	0.243*	0.204*
	(0.121)	(0.126)	(0.109)
Export share	0.293**	0.111	0.343***
	(0.130)	(0.134)	(0.127)
Import share	0.264***	0.288***	0.309***
	(0.071)	(0.071)	(0.066)
Observations	3,714	3,665	3,609
Panel C: New Accreditation			
Competition			
Pressure from foreign competition	0.016	−0.026	0.026
	(0.028)	(0.030)	(0.029)
Vertical transfer of capability			
Share of sales to MNEs	0.363***	0.590***	0.319**
	(0.131)	(0.148)	(0.124)
Export share	0.415***	0.489***	0.661***
	(0.142)	(0.150)	(0.147)
Import share	0.249***	0.208**	0.262***
	(0.089)	(0.097)	(0.089)
Observations	3,718	3,685	3,613

Notes: The table reports estimates of equation (1), where location, time, country, and industry fixed effects as well as other controls are included, but not reported. Definitions of the variables are in Appendix Table A1. Close denotes the lowest third of firms in terms of distance to foreign firms. Far denotes the greatest third of firms in terms of distance to foreign firms. Location, time, country, and industry fixed effects are included, but not reported. Robust standard errors are in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

economies, and existing studies of FDI and innovation have almost invariably had access only to data on manufacturing, and thus failed to analyze services. The estimates in Table 7 indicate that there is not much difference in the innovation effect of foreign competition between firms in manufacturing and services. The effects of vertical transfer of capabilities are very similar in manufacturing and services. The results indicate that the effect of globalization is broad-based and relatively similar in firms that produce goods and firms that generate services.

V. Concluding Remarks

Motivated by the growing theoretical literature on globalization and innovation, as well as the limited empirical evidence in this area, we use rich firm-level data from the 27 emerging market economies (primarily postcommunist countries) to test predictions about the effects of foreign competition, and vertical linkages with foreign firms, on domestic firms' innovative activities. We focus on innovation because it is a key channel through which firms in emerging markets try to become and stay competitive, and existing literature concentrates primarily on the productivity effects of globalization, assuming (but not showing) that the mechanism underlying these effects is innovation.

Our main findings are that: greater pressure from foreign competition stimulates innovation by domestic firms in emerging market economies; supplying multinationals, as well as exporting and importing (vertical relationships), induce innovation; there is no evidence for an inverted U relationship between innovation and competition; and the relationship between globalization and innovation does not vary across the manufacturing and service sectors or with the distance to the technological frontier.

Our first set of findings provides robust evidence of the positive relationship between foreign competition and innovation in emerging market economies, an area that has been under-researched. Our second set of findings provides empirical support for the view of Sutton (2007a) and others who argue that emerging market economies benefit from globalization through the vertical transfer of capability from foreign to domestic firms. We find this effect to be substantial for all three types of innovation that we study, suggesting that the supply chain of multinational enterprises and international trade are an important means for domestic firms to raise their capability. Our third and fourth set of findings indicate that the effects of globalization on innovation are all-encompassing, rather than affecting only a subset of firms.

The implication of these findings is that policy measures stimulating foreign direct investment and international trade enhance domestic welfare through greater innovative activities of domestic firms. We provide a solid basis for policies that focus on facilitating innovation through both foreign competition and vertical linkages in a broad spectrum of domestic firms—not just those in manufacturing or that are technologically more advanced. Our finding that vertical linkages with foreign firms stimulate innovation provides the missing mechanism for (and is consistent with) the literature on the effects of FDI on productivity. Our result that foreign competition spurs innovation appears to be at odds with this FDI literature, which generally

Table 7—Testing for Response in Manufacturing versus Services

	Manufacturing (1)	Services (2)
Panel A. New product		
Competition		
Pressure from foreign competition	0.048**	0.060***
	(0.022)	(0.018)
Vertical transfer of capability		
Share of sales to MNEs	0.289**	0.197*
	(0.119)	(0.106)
Export share	0.283**	0.264**
	(0.121)	(0.122)
Import share	0.469***	0.275***
	(0.073)	(0.054)
Observations	3,756	5,297
Panel B. New technology		
Competition		
Pressure from foreign competition	0.041**	0.070***
	(0.020)	(0.020)
Vertical transfer of capability		
Share of sales to MNEs	0.311***	0.275**
	(0.106)	(0.109)
Export share	0.289***	0.226*
	(0.104)	(0.126)
Import share	0.254***	0.277***
	(0.065)	(0.059)
Observations	3,723	5,260
Panel C. New Accreditation		
Competition		
Pressure from foreign competition	0.007	0.041
	(0.025)	(0.027)
Vertical transfer of capability		
Share of sales to MNEs	0.411***	0.477***
	(0.112)	(0.133)
Export share	0.417***	0.716***
	(0.113)	(0.142)
Import share	0.278***	0.139*
	(0.079)	(0.082)
Observations	3,737	5,284

Notes: The table reports estimates of equation (1), where location, time, country, and industry fixed effects, as well as other controls are included, but not reported. Definitions of the variables are in Appendix Table A1. Robust standard errors are in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

finds that higher foreign competition, when measured in a relatively aggregate form as higher "presence of foreign firms" in an industry, has a negative or no significant impact on efficiency of domestic firms in developing countries (see e.g., Gorg and Greenaway 2004). We hypothesize that this discrepancy may be arising because we measure foreign competition at the firm level, while the FDI literature has generally used aggregate measures, such as the share of foreign output or employment in an industry. In future research, it will be desirable to reconcile these conflicting findings by using firm-level rather than industry-level measures of foreign competition in the productivity studies.

Appendix

Table A1—Definition of Variables

Variable name	Variable definition	BEEPS question
Newproduct	New product or upgrade existing product	Dummy variable. Has your company undertaken any of the following initiatives over the last 36 months? Dummy variable is equal to one if 'yes' to any of the two questions: - Developed successfully a major new product line - Upgraded an existing product line
Newtech	New technology is implemented	Dummy variable = 1 if answer is affirmative to question: Has your firm acquired new production technology over the last 36 months?
Newaccred	New accreditation is received	Dummy variable = 1 if answer is affirmative to question: Has your company obtained a new quality accreditation (ISO 9001, 9002 or 14,000, AGCCP, etc.) over the last 36 months?
ForComp	Pressure from foreign competition	How would you rate the importance of pressure from foreign competition on key decisions about your business with respect to "Reducing the production costs of existing products or services": None — Not important Low — Slightly important Medium — Fairly important High — Very important
SMNE	Share of sales to MNEs	Share of sales to multinationals located in your country (not including your parent company, if applicable)
EXPORT	Export share	Share of sales exported directly or indirectly through a distributor
IMPORT	Import share	Share of your firm's material inputs and supplies that are imported directly or indirectly through a distributor
L	Labor	Number of permanent and temporary employees 36 month ago
CU	Capacity utilization	Level of utilization of facilities/man power relative to the maximum output possible using its facilities/man power at the time
K	Capital	The estimate of the replacement value of the physical production assets used by your firm (land, building, equipment)
M	Materials	The estimate of the material input costs and bought in components/services corresponding to your firm's total sales

(*Continued*)

Table A1—Definition of Variables (*Continued*)

Variable name	Variable definition	BEEPS question
SKILL	Share of skilled workers, 3 years ago	What share of your current permanent, full-time workers were skilled workers 36 months ago?
EDU	Share of workers with higher education, 3 years ago	What share of the workforce at your firm had some university education 36 months ago?
Age	Log (firm's age)	Year of survey minus the year when the firm was established (minimum age is two years). For the year established: In what year did your firm begin operations in this country?
SOE	State owned	Government is the major shareholder (50 percent+)
CNM	Compete in national markets	Does your firm compete in the national market (i.e., whole country) for its main product line or service or does it serve primarily the local market (i.e., region, city, or neighborhood)? Yes = 1
LOC	Location	Type of location: capital; other city over 1 million; other 250,000–1,000,000; Other 50,000–250,000; Under 50,000
Markup	Markup	Considering your main product line or main line of services in the domestic market, by what margin does your sales price exceed your operating costs (i.e., the cost of material inputs plus wage costs but not overhead and depreciation)?

Table A2—Summary Statistics

	Mean	SD
Innovation variables		
New product	0.562	0.496
New technology	0.302	0.459
New accreditation	0.129	0.335
Competition		
Pressure from foreign competition	2.017	1.121
Vertical transfer of capability		
Share of sales to MNEs	0.066	0.196
Export share	0.069	0.187
Import share	0.258	0.359
Ability		
Distance (Mahalanobis)	3.034	0.706
Distance (TFP)	0.364	0.377
Controls		
$\ln L$, 3 years ago	3.000	1.604
$(\ln L)^2$, 3 years ago	11.577	11.530
Share of skilled workers, 3 years ago	0.487	0.309
Share of workers with university education, 3 years ago	0.272	0.290
Firm's age	2.367	0.777
State owned	0.118	0.322
Compete in national markets	0.667	0.471
Markup	0.209	0.118
Location		
Capital	0.313	0.464
Other, over 1 million	0.060	0.237
Other, 250,000–1,000,000	0.157	0.364
Other, 50,000–250,000	0.224	0.417
Under 50,000	0.241	0.428

Table A3—Baseline Specification for All Firms; Marginal Effects Evaluated at Means

	(1)	(2)	(3)
Panel A. New product			
Competition			
Pressure from foreign competition	0.019***	0.044*	0.019***
	(0.005)	(0.027)	(0.005)
(Pressure from foreign competition)^2		−0.005	
		(0.006)	
Vertical transfer of capability			
Share of sales to MNEs	0.104***	0.103***	0.102***
	(0.027)	(0.027)	(0.027)
Export share	0.116***	0.116***	0.116***
	(0.031)	(0.031)	(0.031)
Import share	0.147***	0.147***	0.147***
	(0.015)	(0.015)	(0.015)
Ability			
Distance (Mahalanobis)	−0.015*	−0.015*	−0.016*
	(0.009)	(0.009)	(0.009)
Controls			
ln L, $t-3$	0.050***	0.050***	0.050***
	(0.012)	(0.012)	(0.012)
$(\ln L)^2$, $t-3$	−0.002	−0.002	−0.002
	(0.002)	(0.002)	(0.002)
Share of skilled workers, $t-3$	0.008	0.008	0.007
	(0.018)	(0.018)	(0.018)
Share of workers with university ed. $t-3$	0.091***	0.091***	0.090***
	(0.020)	(0.020)	(0.020)
Firm's age	−0.022***	−0.022***	−0.020***
	(0.008)	(0.008)	(0.008)
State owned dummy	−0.093***	−0.093***	−0.092***
	(0.018)	(0.018)	(0.018)
Compete in national markets	0.090***	0.089***	0.091***
	(0.013)	(0.013)	(0.013)
Markup			0.246***
			(0.044)
Observations	11,078	11,078	11,078

(*Continued*)

Table A3—Baseline Specification for All Firms; Marginal Effects Evaluated at Means (*Continued*)

	(1)	(2)	(3)
Panel B. New technology			
Competition			
Pressure from foreign competition	0.019***	0.046**	0.019***
	(0.004)	(0.023)	(0.004)
(Pressure from foreign competition)^2		−0.006	
		(0.005)	
Vertical transfer of capability			
Share of sales to MNEs	0.084***	0.084***	0.085***
	(0.023)	(0.023)	(0.023)
Export share	0.085***	0.085***	0.085***
	(0.025)	(0.025)	(0.025)
Import share	0.099***	0.099***	0.099***
	(0.013)	(0.013)	(0.013)
Ability			
Distance (Mahalanobis)	−0.013*	−0.013*	−0.013*
	(0.008)	(0.008)	(0.008)
Controls			
ln L, $t-3$	0.043***	0.043***	0.043***
	(0.011)	(0.011)	(0.011)
$(\ln L)^2$, $t-3$	−0.001	−0.001	−0.001
	(0.002)	(0.002)	(0.002)
Share of skilled workers, $t-3$	−0.005	−0.005	−0.005
	(0.016)	(0.016)	(0.016)
Share of workers with university ed. $t-3$	0.069***	0.068***	0.069***
	(0.019)	(0.019)	(0.019)
Firm's age	−0.017**	−0.017**	−0.017**
	(0.007)	(0.007)	(0.007)
State owned dummy	−0.037**	−0.037**	−0.037**
	(0.015)	(0.015)	(0.015)
Compete in national markets	0.070***	0.070***	0.070***
	(0.011)	(0.011)	(0.011)
Markup			0.627***
			(0.114)
Observations	10,991	10,991	10,991

(*Continued*)

Table A3—Baseline Specification for All Firms; Marginal Effects Evaluated at Means (*Continued*)

	(1)	(2)	(3)
Panel C. New Accreditation			
Competition			
Pressure from foreign competition	0.004	0.016	0.004
	(0.003)	(0.014)	(0.003)
(Pressure from foreign competition)^2		−0.003	
		(0.003)	
Vertical transfer of capability			
Share of sales to MNEs	0.062***	0.062***	0.062***
	(0.012)	(0.012)	(0.012)
Export share	0.072***	0.072***	0.072***
	(0.013)	(0.013)	(0.013)
Import share	0.036***	0.036***	0.036***
	(0.008)	(0.008)	(0.008)
Ability			
Distance (Mahalanobis)	−0.003	−0.003	−0.003
	(0.004)	(0.004)	(0.004)
Controls			
ln L, $t-3$	0.045***	0.045***	0.045***
	(0.007)	(0.007)	(0.007)
$(\ln L)^2$, $t-3$	−0.002**	−0.002**	−0.002**
	(0.001)	(0.001)	(0.001)
Share of skilled workers, $t-3$	−0.015	−0.015	−0.015
	(0.010)	(0.010)	(0.010)
Share of workers with university ed. $t-3$	0.034***	0.034***	0.034***
	(0.011)	(0.011)	(0.011)
Firm's age	0.004	0.004	0.004
	(0.004)	(0.004)	(0.004)
State owned dummy	0.004	0.004	0.004
	(0.009)	(0.009)	(0.009)
Compete in national markets	0.040***	0.039***	0.040***
	(0.006)	(0.006)	(0.006)
Markup			−0.001
			(0.024)
Observations	11,040	11,040	11,040

Notes: The table reports estimates of equation (1), where location, time, country, and industry fixed effects are included, but not reported. Definitions of the variables are in Appendix Table A1. Robust standard errors are in parentheses and the number of observations is in brackets.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

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