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# GLOBALIZATION AND INNOVATION IN EMERGING MARKETS

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## ABSTRACT

Globalization brings opportunities and pressures for domestic firms in emerging markets to innovate and improve their competitive position. Using data on firms in 27 emerging market economies, we estimate the effects of foreign competition, vertical linkages with foreign firms, and international trade on several types of innovation by domestic firms. Using instrumental variables and a battery of checks, we provide robust evidence of a positive relationship between foreign competition and innovation and show that the supply chain of multinational enterprises and international trade are also important channels. There is no evidence for an inverted U relationship between innovation and foreign competition. The relationship between globalization and innovation does not differ across the manufacturing and service sectors.



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# 1. Introduction

With the opening of borders to trade and foreign investment, globalization brings opportunities and pressures for domestic firms in emerging market economies to innovate and improve their competitive position. Many of these pressures and opportunities operate through increased competition from and linkages with foreign firms. In this paper, we examine the determinants of innovation by domestic firms in emerging market economies. Our focus is on the effect of competition and transfer of capabilities stemming from globalization, which may be brought about through various channels, including the entry of foreign firms (foreign direct investment – FDI), trade, and increased competitive responses by domestic firms. Specifically, we use micro data on over 11,500 firms in 27 transition economies to test predictions that are derived from recent theoretical models by Sutton (2007a), Aghion et al. (2005a, 2005b and 2006) and others.

## 1.1 Theoretical Literature and Predictions

Whereas considerable attention has been paid to the effects of globalization on productivity of firms in emerging market economies, the literature has only recently begun to be concerned with the effects of globalization on innovation by the local firms.[1] Yet, innovation is the presumed conduit through which globalization affects productivity. There are two broad mechanisms that can affect the level of innovation: knowledge transfers and product market competition. A recent model by Sutton (2007a) focuses on the first mechanism, while papers from Schumpeter (1943) to Aghion et al. (2005a, 2005b and 2006) focus on the second one.

Sutton (2007a) develops a model where 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." Consumers choose to buy on the basis of price-quality combinations and if a firm has a product whose quality is superior to that of its rivals, the firm will retain some level of market share even when the number of low quality rivals becomes arbitrarily large. Moreover, there is a lower bound on quality that any firm has to maintain in order to survive, thus creating a range ("window") of quality

[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 Gorg and Greenaway (2004); for a review of the trade literature, see Wagner (2007).

levels in which firms can operate. What matters is relative quality at both the firm and country levels, and with globalization (liberalization of trade and entry of foreign firms) the lower bound on the window of opportunity rises for local firms that were previously shielded from the competition of higher quality firms in advanced economies.

An important prediction of the Sutton (2007a) 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 that is also present in the international business literature on FDI that we discuss below. 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 globalisation, 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, pp. 27-28)

In parallel to Sutton's work there is a large literature asking whether exporting and importing activities of domestic firms raises their efficiency – presumably through innovation that is induced by the exposure of the domestic firms to more advanced practices and technologies.[3] 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 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 (e.g., Arrow(1962) and Gilbert and Newbery (1982)). On the other hand, Schumpeter (1943) argued that large firms operating in concentrated

[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 Melitz (2003) and 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 hence examine the importance of adjustment on the intensive margin.

[3] See Wagner (2007) for a survey.

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, Salop (1977), Dixit and Stiglitz (1977), Romer (1990), and Aghion and Howitt (1992) among others stress that that product market competition reduces monopoly rents that induce innovation. Recently, Aghion et al. (2004 and 2005a) have shown that competition can have different effects on firms/industries' willingness to innovate depending on their level of efficiency (technology). In particular, firms close to the efficiency frontier (those with highest efficiency) are expected to be spurred by competition to innovate and increase their efficiency, while firms that are far from the frontier (near the lower bound of efficiency) are expected to be discouraged by competition from innovating. In Aghion et al. (2004) the prediction comes from a Schumpeterian model where incumbent firms that are closer to the frontier have an incentive to innovate when faced with 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.

In Aghion et al. (2005a) the argument is developed further by emphasizing pre- and post-innovation rents. Firms close to the efficiency frontier are expected to be spurred by competition to innovate and increase their efficiency because competition reduces their pre-innovation rents (rents obtained if the firms were not to innovate). Innovation enables these efficient firms to escape competition and thus increase their post-innovation rents. In contrast, firms that are far from the frontier are expected to be discouraged by competition from innovating because competition affects negatively their post-innovation rents – innovation does not help these laggard firms escape competition. 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 effect of competition on innovation is likely to dominate. The balance between the opposing effects of competition on the two types of firms enables Aghion et al. (2004, 2005a) 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 -- a prediction that is in line with the earlier empirical findings by Kamien and Schwartz (1972) and Scherer (1967).[4] The model also predicts that the inverted U curve is steeper for the more efficient firms than for the laggards, a result that is brought about by a positive interaction between the escape-competition effect and the proximity of the firm to the efficiency frontier.

Finally, in a related model Aghion et al., (2005b) derive the prediction that firms located in more pro-business environments are more likely to respond to competition (threat of entry) by innovating. This is because the business-friendly environment enables these firms to be more efficient than firms in restrictive regulatory environments, and more efficient (as opposed to laggard) firms respond to competition by innovating.

In the remainder of the paper, we test the following *ceteris paribus* predictions derived from the models described above:

i. Globalization increases product market competition in emerging markets and the predicted effect of 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.
   e. The inverted U relationship between competition and innovation is steeper among firms that are closer to the efficiency 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.

[4] Strictly speaking, the theory does not directly predict an inverted U relationship but it does exclude the possibility of a U shaped relationship.

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.

iii. Firms in regions with a more-business friendly environment are more likely to respond to competition with more innovation than firms in less-business friendly environments.

### 1.2 Relevant Empirical Literature

These opposing theoretical views on the relationship between competition and innovation have spawned an empirical literature, whose findings have been mixed. Following Schumpeter (1943), the early empirical literature identified a negative linear relationship, while Scherer (1967) and Kamien and Schwartz (1972) discovered an inverted U relationship between competition and innovation; Cohen and Levin (1989) in their review of this earlier literature conclude that the effect of concentration on innovation is sensitive to industry conditions, particularly in terms of technological opportunity and appropriability. In the 1990s empirical tests again focused on a linear relationship, with Geroski (1995), Nickell (1996) and Blundell, Griffith and Van Reenen (1999) presenting evidence that competition spurs innovation. More recently, research has focused on the inverted U and heterogeneous effects of competition on innovation.

The tests of the inverted U hypothesis have yielded mostly but not completely supporting evidence. Whereas two studies using US and UK data provide some favorable evidence, one study using data from transition economies does not find support. Using the price cost margin (markup) as the competition indicator and citation-weighted patents as a measure of innovation, Aghion et al. (2005a) find an inverted U effect of competition on patents among 311 firms listed on the London Stock Exchange between 1973 and 1994.[5] Aghion et al. (2006) find that technologically advanced entry by foreign firms has a positive effect on innovation in sectors initially close to the frontier and that the effect of entry on total factor productivity growth interacts negatively with the distance to the frontier. These findings are based on a much larger data set of over 23,000 establishments in 180 4-digit manufacturing industries in the US and UK and a data set of patents in over 1,000 incumbent UK firms.

Carlin, Schaeffer and Seabright (2004) also test the inverted U hypothesis using data on transition economies (1999 Business Environment and Enterprise Performance

[5] They construct a two-digit SIC industry panel of 354 industry-year observations on these 311 firms.

Survey, BEEPs). They examine the effect of product competition (defined as the number of competitors in the firm's main product line) on innovation (defined as the number of innovative activities undertaken in introducing a new product or upgrading an existing one) and growth. Using different variables and an earlier data set than we use, they reach one of the findings as we do, namely that innovation is higher in monopolistic industries. We build on these findings by using additional (2002 and 2005) BEEPS data, analyzing the effect of FDI on innovation, examining the effect of competition in greater depth, and integrating the effects of FDI and competition in a unified framework.

The tests for the relationship between competition, firm heterogeneity (in terms of distance from the frontier) and firm performance yield fairly consistent results. Aghion et al. (2005b) analyze a three-digit-industry data available for all the states in India for the period 1980-97 and find that entry liberalization (de-licensing) led to an increase in within-industry inequality in output, labor productivity and total factor productivity, which is consistent with differential responses of firms in terms of innovation. Sabirianova, Svejnar and Terrell (2005a, 2005b) also find support for heterogeneous effects of firm entry on firm performance in Russian and Czech industrial firms. They find that entry by foreign firms in a given industry has a positive effect on the productivity of incumbent foreign firms (which are likely to be at or close to the frontier) but a negative effect on the productivity of incumbent domestic firms (which are likely to be laggards compared with foreign firms).

Whereas no studies have as yet tested for the direct impact of foreign direct investment (FDI) on domestic firms' innovation, the 'FDI spillover' literature has tested for efficiency gains that domestic firms might obtain from the presence of foreign firms in upstream or downstream activities.[6] In general, the variable capturing 'foreign firm presence' has been constructed as the share of output in an industry produced by firms with foreign ownership; the upstream and downstream relationships between the domestic and foreign firms has typically been deduced from the backward and forward linkages in input-output tables. The literature finds no positive efficiency effects in domestic firms that are in upstream relationships with foreign firms, but it detects large

[6] See e.g., Gorg and Greenaway (2004) for a review of the FDI spillover literature.

positive efficiency gains in domestic firms that engage in downstream activities with (selling to) foreign firms.[7]

As mentioned earlier, there is considerable literature on the effects of exports and imports on productivity (Wagner 2007), but relatively little direct measurement of the effect of trade on innovation. This literature tends to find that exporting firms tend to have higher efficiency, but question which way the causality goes. Finally, we know of no firm level evidence on differences in the business environment on level of innovation, although several theorists have raised questions regarding issues such as property rights and innovative activity (see e.g., Grossman and Helpman, 1991).

### 1.3 Our Contribution

Building on the literature that examines the effects of various channels of globalization on innovation and efficiency ("capability"), we make several contributions. First, we focus on innovation, which has not been much studied in emerging markets, rather than 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 directly about the productivity effect (a derived effect). Second, our analysis nests various channels of globalization and thus we can assess the relative importance of different aspects of globalization for innovative activity of firms in emerging markets. Importantly, in contrast to previous literature we utilize information on direct connections of domestic firms with foreign firms (e.g., whether a domestic firm is a supplier to foreign firms) instead of the typical measures of foreign presence at the industry level. 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 carry out comparative analysis to shed light on the significance of various institutional factors (e.g., pro-business environment) in promoting innovations.

Briefly, our main findings are that (i) supplying multinationals as well as exporting and importing (vertical relationships) induce innovation by domestic firms, (ii) firms that have market power tend to innovate more, but greater pressure from foreign competition also stimulates innovation; (iii) there is no evidence for an inverted U relationship between innovation and competition in either the more efficient or laggard

[7] See e.g., Blalock and Gertler (2008), Gorodnichenko, Svejnar and Terrell (2007) and Javorcik (2004).

firms, and (iv) the relationship between globalization and innovation does not vary across the manufacturing and service sectors or with differences in the business environment.

## 2. 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. The surveys relied on the same sampling frames and identical questionnaires in all countries. To ensure that the samples cover adequately most types of firms, the surveys used stratified random sampling.[8] For example, in each country, the sectoral composition of the sample in terms of manufacturing[9] versus services[10] was determined by their relative contribution to 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, and an important feature is the inclusion of firms in the service sector, which is the new dynamic (yet understudied) sector in these economies.

In addition, the data set contains a panel component, where 1,443 firms that were surveyed in 2002 were surveyed again in 2005.[11] We use these panel data for robustness checks, where we verify that the timing of the variables in our baseline econometric specifications does not affect our results. However, our analysis relies primarily on the

[8] In both years the surveys were administered to Turkey, 15 countries from Central and Eastern Europe (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Former Yugoslavia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia) and 11 countries from the former Soviet Union (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine and Uzbekistan). In neither year could the survey be administered in Turkmenistan.

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

[10] Services includes: Transportation, storage and communications; wholesale, retail, repairs; real estate, business services; hotels and restaurants; other community, social and personal activities; and commerce.

[11] 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% (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%) and inability to reach eligible responders within firms (25%).

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. Most studies on innovation use patent data or R&D expenditures, which are regarded as problematic. Patents are generally viewed as having three weaknesses: 1) they measure inventions rather than innovations; 2) the tendency to patent varies across countries, industries and processes; and 3) firms often use methods other than patents to protect their innovations (such as 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 (they are an input rather than an output), and formal R&D measures are biased against small firms (Michie, 1998; Archibugi and Sirilli, 2001).[12] Perhaps most important for the purposes of this paper is the fact that in emerging market economies these types of innovations are less likely to be observed as firms are expected to engage more in imitation and adaptation of already created and tested innovations, rather than in generating new inventions and are less likely to expend resources on R&D.

In this study, we define innovation broadly as the development and upgrading of new products, adoption of new technologies or obtaining quality certifications. 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:

- Developed successfully 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 9000, 9002 or 14000, AGCCP, etc.) -- hereafter *New Accreditation*.

[12] While many firms are reluctant to report the level of R&D expenditures, most are willing to indicate whether they have positive expenditures on R&D. Using a dummy variable for positive R&D expenditures as the dependent variable in our econometric specification (discussed below), we find similar results to those based on our survey measures. We are hence relatively confident that our survey-based measures of innovations are sensible indicators of innovative activity of firms.

As noted above, since we are studying emerging market economies, it is expected that these three measures of innovation may have some element of imitation or adoption rather than "in house development." We know for example, that the new technology used in the firm can be acquired in a number of ways. It can be developed by the firm (17% who answered that they acquired a new technology gave this as the way it was acquired) or it can be acquired by hiring new personnel (5%) or transferred from elsewhere (universities, business associations, etc., 3%). However, the vast majority acquired new technology embodied in new machinery or equipment that was purchased or licensed from other sources (75%).[13]

Given that the respondent's determination of whether a new product[14] 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.[15] However, in order to ensure the quality of a product, the standards monitor the process by which a product is manufactured or delivered.[16] Hence *New Accreditation* captures "process innovation" as well as "product/service innovation."

The BEEPS data also permit us to capture in various ways the degree of competition faced by each firm. A key variable, which is comparable with the one used by Aghion et al. (2005a) and Nickell (1996), is *markup*, or the price to cost ratio.[17] Firms that are able to charge a larger markup are deemed to have less competition. The

[13] 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.

[14] Note that the variable "New Product" includes also a new service.

[15] 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 vocabulary, can mean a physical object, or services.

[16] For example, the requirements in ISO 9001 (one of the standards in the ISO 9000 family) include: a) a set of procedures that cover all key processes in the business; b) monitoring processes to ensure they are effective; c) keeping adequate records; d) checking output for defects, with appropriate corrective action where necessary; e) regularly reviewing individual processes and the quality system itself for effectiveness; and f) facilitating continual improvement.

[17] Note that we do not compute markup using price and cost information provided by firms. If there are measurement errors in prices, costs and quantities, the constructed markup may be correlated with measured productivity, which is not desirable. Fortunately, markup is self-reported by firms in the survey and therefore it is less likely that we have spurious correlation between markup and productivity.

advantage of this indicator over a market share or Herfindahl index is that it does not require precise definition of geographic and product markets, which is difficult to obtain in emerging market economies that vary considerably by size and geographic reach of firms.[18] We are also able to capture the effects of *pressure from foreign competition* by using two dummy variables: "low" (slightly important) and "medium-high" (fairly and very important), with "not important" as the base response. (See a description of the variables in appendix Table A1.)

Foreign firms can spur innovation among domestic firms through competition but they can also directly transfer capabilities. BEEPS also permits us to capture the extent of vertical linkages between domestic and foreign firms, which allow for transfer of capabilities or "spillovers." We use three variables for vertical linkages: *SMNE*, the share of a firm's sales to multinational enterprises;[19] *Exports*, share of sales exported; and *Imports*, share of inputs imported.

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) and then calculate each domestically-owned firm's distance from the frontier. We would like to use total factor productivity (TFP or the Solow residual) to measure the distance from the frontier because it is the most intuitive measure.[20] 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.

Specifically, we draw on the literature on matching (e.g., Rosembaum, 2002) and measure the distance between a domestically-owned firm and the leading foreign-owned firms in an industry and country with the Mahalanobis distance, 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

[18] The BEEPS data also supply self-reported information on the number of competitors that a firm faces locally and nationally. 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] An MNE is defined as a firm with 50% or more foreign ownership.

[20] See equation (2) for more details on how we compute the Solow residual.

the best foreign-owned firms, the domestic firms are likely to be less efficient than the best foreign-owned firms. One may hence interpret this difference as the distance from the best business practice of foreign-owned firms. The Mahalanobis distance of domestic firm *i* to a foreign firm is equal to:

$$distance_i = \min_{j \in F} \left\{ \left(x_i^D - x_j^F\right)' S_x^{-1} \left(x_i^D - x_j^F\right) \right\}$$

Where superscript *F* denotes the best foreign-owned firms and superscript *D* denotes domestic companies. $S_x$ is the covariance matrix of the vector of observed characteristics *x*. The inverse of the covariance matrix of observable characteristics *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 *x* irrelevant. For example, if *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 $distance_i = \frac{\left(CU_i - CU^F\right)^2}{\mathrm{var}(CU)} + \frac{\left(L_i - L^F\right)^2}{\mathrm{var}(L)}$ where $CU^F$ is capacity utilization of the foreign firm, $L^F$ is employment of the foreign firm, and var(*CU*) and 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 *x* contains the size of the firm in terms of the logarithm of number of employees and number of establishments; the structure of employment in terms of educational attainment (share with, vocational school, secondary school, college; skill level 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); growth rates (of sales and capital); a dummy for paying for security. We match firms exactly by industry, country and year, i.e., 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.

We find that 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,[21] 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):

$$I_{isct} = \Phi\{\alpha_0 Markup_{isct} + \alpha_1 ForComp_{isct}$$

$$+\beta_0 SMNE_{isct} + \beta_1 Export_{isct} + \beta_2 Import_{isct} + \delta_1 \log(1 + distance_{isct})$$

$$+\gamma_0 lnL_{isc,t-3} + \gamma_1 \left(lnL_{isc,t-3}\right)^2 + \gamma_2 Edu_{isc,t-3} + \gamma_3 Skill_{isc,t-3} + \gamma_5 Age_{isct}$$

$$+\gamma_6 CMN_{isct} + \gamma_8 SOE_{isct} + \psi Loc_{isct} + \lambda_s + \vartheta_c + \omega_t + error\} \qquad (1)$$

where $I$ is a dummy variable equal to one if the firm reported an innovation, and zero otherwise; $\Phi$ denotes c.d.f. of a standard normal random variable; *i, s, c,* and *t* index firms, sector, country, 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 two variables capture our measures of competition: *Markup,* and *ForComp* (pressure from foreign competition). We also estimate a specification with Markup squared. 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.[22] The variable *distance* is the (Mahalanobis) distance from the technological frontier. The following set of variables control for a number of firm-specific factors deemed to be important in the literature:[23]

$L$ (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.[24]

[21] Admittedly, the similarity of observed characteristics does not always imply that firms have the same level of productivity. See Clark (1987), Baily and Gersbasch (1995) and Schmitz (2005) for examples.
[22] Note that in contrast to previous literature we have firm-level variables describing linkages instead of industry-level variables (e.g., Bertschek 1995).
[23] See Becheikh, Landry and Amara (2006) and Cohen (2005) for reviews of literature on innovation.
[24] 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.

*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. We expect *CNM* to have a positive effect on innovation, given that the firm operates in a larger market.

*SOE* (State Owned Enterprise) is a dummy variable equal to one if the government owns 50% 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.

Finally, location (*Loc*) is a set of dummies for size of population where the firm is operating and $\{\lambda_s, \vartheta_c, \omega_t\}$ is a set of industry, country, and time fixed effects. 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.

We report in appendix Table A1 a detailed description of the variables and in appendix Table A2 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 Table A2, there is considerable variation in the key variables.

## 3. Main Findings

We begin in Section 3.1 by presenting estimates of equation (1), which tests the main hypotheses (i.a-c and ii.a-c) of Section 1. In Section 3.2 we confront issues of

endogeneity and carry out robustness checks. Once these issues are resolved, we proceed with testing the more-nuanced hypotheses (i.d, i.e. and iii.) in Section 4.

### 3.1 Baseline Specification

Our baseline specification for each of the three types of innovation, estimated with over 11,500 firm-level observations in the 27 countries, using location, country, industry and time fixed effects is reported in Table 1. The first finding is that product market competition, as proxied by *markup,* has a negative effect on innovation. In particular, the larger the markup (implying less competition), the greater the probability that a firm develops a new product or acquires new technology. The corresponding marginal effect of increasing markup by 10 percentage points, which is approximately one 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 good or a new technology (see appendix Table A3 for marginal effects). This is a substantial increase given that unconditional probabilities of reporting a new product and a new technology are 56 and 30 percent, respectively. In other words, a one standard deviation increase in the markup increases innovative activity by 4.1 to 7.7 percent. On the other hand, product market competition does not have an effect on the third dimension of innovation, namely obtaining a new accreditation.

As shown in Table 1, we have also tested for the inverted U hypothesis by estimating a specification with *markup* and $markup^2$. The estimated coefficient on $markup^2$ is not significantly different from zero and we hence do not find support for the inverted U shaped relationship between competition and innovation. Our baseline specification supports the basic Schumpeterian view that monopolistic market structures boost innovative activity, providing support to hypothesis i.a and rejecting hypotheses i.b and i.c.

Recall that in addition to markup, we include among the explanatory variables pressure from foreign competition. In Table 1 we find that greater pressure from foreign competition has a positive effect on innovation, holding constant markup and vertical linkages with foreign firms. Firms feeling that pressure from foreign competition is "medium and high" are more likely to upgrade their product, acquire a new technology

and obtain new accreditation than firms that feel this pressure is "not at all important." Firms that feel that the pressure is "low" have coefficient estimates that are about or slightly more than one-half of those for "medium-high" pressure. (These smaller coefficients are statistically significant at the 5 percent test levels for "new technology," at the 10 percent level for "new product," and not significant for "new accreditation.") The economic significance of competitive pressure from foreign firms is also important for innovations in products and technology: converted to marginal effects, the estimated coefficients in Table 1 (marginal effects are in Appendix Table A3) indicate that reporting low pressure is associated with approximately 2.5 percentage point higher innovative activity, while reporting medium-high pressure is associated with 5.0 percentage point higher innovative activity. However, medium-high pressure from foreign firms only increases new accreditation by 1.4 percentage points. We conclude that the processes of developing or upgrading a new product and acquiring a new technology are influenced by the forces of product market or foreign competition, while the process of obtaining a new accreditation is affected only by medium-high pressure from foreign companies.

Vertical transfer of capability from foreign to domestic firms -- stressed by Sutton (2007a) and the FDI spillover literature -- is significant. 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. A one percentage point increase in a domestic firm's share of sales to MNEs or to exports has a very similar impact on the first two types of innovation and a larger positive impact on acquiring a new accreditation. Holding everything else constant, increasing the share of sales to MNEs or foreign markets as well as the share of imported inputs by one standard deviation is associated with increasing innovation by roughly 2 to 5 percentage points, which is approximately a 5 to 10% increase in the innovative success. A firm's share of inputs imported is a bit less influential in obtaining a new accreditation than it is 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. While this is not one of our hypotheses related to competition, 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 one percentage point, which is a relatively modest amount. As with markup, *distance* is not significantly related to obtaining a new quality accreditation, although the sign and point estimate of the coefficient is similar to those for the other two types of innovation.

There are a number of other interesting findings with respect to the control variables reported in Table 1. First, larger firms tend to innovate more than smaller firms, which is consistent with the finding in the vast majority of the 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 for new accreditation it is increasing at a decreasing rate. 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. The finding that having a higher share of labor force with university education is more conducive to innovation than having a higher share of skilled labor, stresses 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% of its employee having a university degree would be a 6 to 10 percentage points more innovative than a firm with no university-educated employees. Third, older (more mature) firms are not as 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 ten year old firm has a 2 percentage points lower innovative output relative to a newly born firm. Fourth, state-owned firms are 10 percentage points less likely to innovate than privately owned firms in terms of product or technology but are not different with respect to acquiring a new accreditation. Finally, 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.

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. These results suggest that something particular is driving the process of accreditation. We conjecture that because 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, accreditation may be obtained as a precondition for selling to MNEs and exporting. It also appears to be stimulated by medium-high pressure from competition by foreign firms but not by product market competition.

### 3.2 Econometric Issues and Robustness Checks

The baseline specification potentially has issues of endogeneity of our firm-level measures of competition, transfer of capabilities and distance to the frontier. We first tackle these issues and then carry out a robustness checks for our Mahalanobis measure of the distance to the frontier.

*Endogeneity of Markup*

Is the innovative activity being spurred by the market structure or is the market structure the result of the innovative activity? If, for example, firms successfully innovate, they may be able to gain a higher share of the market and prevent entry of new firms into the market (as noted for example by Aghion et al., 2005a, and Blundell, Griffith and Van Reenen, 1999). Unfortunately, economic theory does not make clear predictions about the sign of the bias. Both positive and negative feedbacks between markup and innovation are possible. Another source of endogeneity 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 markup since they affect entry of new firms but not necessarily innovative activity. BEEPS provides 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., 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.

The aforementioned questions provide many potential instruments because a firm's response to each sub-question in Q1 and Q2 is a possible instrument that varies on a scale from one to four or one to six. However, any given question may be a weak instrument when taken individually because these questions capture different facets of barriers to entry and one may need to look at the holistic picture rather than any individual aspect to understand impediments to entry. To address this issue, 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.[25] This index provides a simple 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 have regressed measures of firm profitability (from BEEPS) as well as industry level entry, survival and firm turnover (from Bartelsman, Haltiwanger and Scarpetta, 2004) on the index. The results, reported in Table 2, suggest that a larger value of our index is

[25] We also explored an alternative strategy when we choose instruments using formal statistical selection criteria developed by Andrews (1999) and Hall and Peixe (2003). These criteria select correctly excluded variables with strong predictive power as instruments. The results with this alternative strategy are qualitatively similar to those that we present in the paper.

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 indeed captures barriers to entry and, hence, we may expect it to serve as a reasonable instrumental variable for *markup*.

The IV results are presented in Table 3. We find that our instrument has a strong first stage fit. For example, the first-stage F-statistic suggests that excluded variables have strong predictive power for the markup. Likewise Anderson's canonical correlation test rejects the null that the instruments are irrelevant. Although the point estimates in the IV specification are greater than the point estimates in the standard probit,[26] both sets of estimates convey the same message: greater market power spurs innovation in introducing new products and adopting new technologies, and it has no effect on the acquisition of new accreditation. These results are similar to those of Aghion et al. (2005a) who also find that corrections for the endogeneity of markup do not change the qualitative results.

Although some questions about barriers to entry are phrased to ask about "firms like yours," one could be concerned that the firm's own answer may be correlated with some unobserved characteristics of the firm. We address this problem by instrumenting *markup* with an alternative index of barriers to entry, which is the average over all other firms' answers in a given industry, country and year. With this alternative instrument, the point estimates are smaller but the qualitative results are the same: larger markups are associated with more innovation.[27,28]

Because the IV estimates have relatively large confidence intervals and in many cases we cannot reject the equality of the estimates from IV and the standard probit, we proceed with the standard probit estimates in the rest of the paper.

[26] If our IV is correcting for measurement error in markup, it should remove attenuation bias and result in a larger coefficient.

[27] We find similar qualitative results when we use a linear probability model; hence, our results are not driven by non-linearities.

[28] Own survey responses about markup may be correlated with some characteristics of firms or may contain measurement errors. To assess the importance of these concerns, we experimented with the average markup of all other firms in the industry/country/year as a measure of competition. Our results are broadly similar to the baseline estimates, although the point estimates based on this alternative measure of market power are somewhat larger (which is consistent with smaller measurement errors in the alternative indicator of competition).

*Robustness of the Distance Measure*

To test the robustness of the Mahalanobis distance measure, we re-estimate the baseline equation with a measure that captures differences in efficiency using the Solow residual or total factor productivity (TFP). We compute the Solow residual with 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):

$$Solow_{isct} \equiv TFP_{isct} = logY_{isct} - \bar{s}_{sc}^{L} logL_{isct} - \bar{s}_{sc}^{M} logM_{isct} - \bar{s}_{sc}^{K} logK_{isct} - logCU_{isct}, \quad (2)$$

where *i*, *s*, *c*, and *t* index firms, industries, countries and time, $\bar{s}_{sc}^{L}, \bar{s}_{sc}^{M}, \bar{s}_{sc}^{K}$ 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 Solow 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.[29]

Using the Solow measure is problematic in our data since only about one-half of the firms report sales revenue and even fewer report capital. Yet with only 5,548 firm observations, we find that the coefficients on Solow distance measure 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 to alternative measures of the distance from the frontier. Because we lose so many observations with the TFP-based measure of distance, we continue to use the Mahalanobis distance in the rest of the paper.

*Reverse Causality (Endogeneity) due to 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 (*sales to MNEs, export, import, foreign competition, and markup*)

[29] Similar to computing the Mahalanobis distance, the top third of foreign firms is defined as the set of firms with TFP above the 66$^{th}$ percentile.

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 hence 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. The *foreign competition* variables are dummy variables and the probability of reporting the same value (staying in the same group) is around 50%. The only variable that has a relatively low correlation between 2002 and 2005 values is *markup* (0.2). All but one of these coefficients hence 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. 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 the competition variables one at a time. Finally, because of the small sample size and the fact that 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%), we convert these variables from shares into dummy variables, where 0 = no share of 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) hence 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 just the more recent half of the panel data observations. Finally, the results in (d) represent the ideal specification, which explains innovation over the 2002-05 period with the lagged (2002) values of the explanatory variables.[30] Comparing the results in (c) and (d) enables us to assess the difference in the estimated coefficients between the specification using the current v. 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 columns (a) 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, 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 columns (a) with columns (b) 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 the significance of the key coefficients. The only significant change in sign occurs for the coefficient on *markup* for new technology.

[30] 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.

Comparing columns (b) and (c) in each of the three panels of Table 5 demonstrates that going from the 2,000 pooled panel observations for 2002 and 2005 to just 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. Finally, moving from columns (c) to (d), 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 three of the twenty four coefficients. Interestingly, in the three cases where the coefficients become significant (*markup* for new technology and *SMNE* for New Product and New Technology), they also become similar to the corresponding coefficients in the full sample estimates in column (a) of Table 5 and the corresponding coefficients in the base model in Table 1.

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.[31]

## 4. Additional Findings

In this section we proceed with testing the remaining predictions outlined in Section 1, namely whether the effects of competition and vertical transfer of capabilities on innovation vary with the efficiency level of firms and the business environment. 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.

### 4.1 Firm Heterogeneity and Innovation

The key predictions from the Aghion et al. (2004, 2005a) models are that (a) firms closer to the frontier are spurred by competition to innovate, while those far from the frontier

[31] 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. We report results for this measure in appendix Table A4. The estimated coefficients are nearly identical to the results reported in the baseline specification. However, we do not use this measure in our analysis because many firms are reluctant to report the level of sales and hence the sample size for the regressions based on export share dated at $t-3$ shrinks to about 6,000 observations.

are discouraged from innovating (prediction i.d), and (b) the inverted U relationship between competition and innovation is steeper among firms that are closer to the frontier (prediction i.e). In order to test these predictions, 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 *markup* and *pressure from foreign competition* in the Close, Middle and Far columns of Table 6, we find no systematic support for either of these hypotheses. Firms with higher markup are actually more likely to develop new products if they are not close to the frontier, more likely to acquire new technology if they are either close or far from the frontier (but not in the middle), not more or less likely to obtain accreditation irrespective where they are relative to the frontier.[32] Medium and high *pressure from foreign competition* spurs product and technology innovation among firms that are 'close to' as well as 'far from' the frontier. Interestingly, firms that are far from the frontier are the only ones to register a statistically positive effect of medium-high pressure from foreign competition on the probability of obtaining accreditation, but one cannot reject the hypothesis that the effect is the same for firms that are close to the frontier.

A key hypothesis with respect to the relationship between vertical transfer of capabilities and innovation found in the FDI 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 (2007) 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

[32] We have also estimated this equation with *markup* and $markup^2$ (results shown in the first panel of appendix Table A5) and found that the coefficients on $markup^2$ are not significantly different from zero in any category.

frontier are discouraged from innovating by competition while firms close to the frontier are spurred by competition to innovate.

### 4.2 Business Environment

With respect to the business environment, we have carried out two tests. First, we check whether overall differences in levels of development of markets and institutions, captured by stratifying the sample by economically and institutionally different regions, result in different effects of competition and transfer of capability on innovation. Second we use a firm-level measure of business environment, bribery (corruption), and test whether differences in this indicator matter.

In Table 7, we present the coefficients from separate estimates of equation (1) for countries in the Commonwealth of Independent States (CIS), Central Europe and the Baltic (CEB) and South Eastern Europe, including Turkey (SEE). Since markets and market oriented institutions are widely viewed as functioning better in the CEB region than in the CIS and SEE regions,[33] one may expect that the dispersion of firms in terms of efficiency would be smaller and firms in CEB would operate more at a neck-and-neck level and closer to the frontier than firms in CIS and SEE. The Aghion et al. (2005b) model would hence predict a stronger positive relationship between competition and innovation in the CEB region than in the two other regions. (One could even expect a negative relationship between competition and innovation in CIS and SEE countries if their firms were to be sufficiently far from the frontier.)

Our estimates in Table 7 do not support this prediction. Whereas the CEB coefficients on *markup* are positive and significant for the first two types of innovation, the corresponding coefficients for the CIS and SEE are also positive and of similar magnitude. We have also tested for an inverted U relationship and find that the coefficients on $markup^2$ are not significant except in the case of the SEE region for new technology (Panel B of appendix Table A5). If anything, the positive coefficient on the first derivative and negative coefficient on the second derivative point to a U (not an inverted U) relationship between competition and innovation in the SEE. The estimates in Table 7 also indicate that selling to MNEs and importing brings about greater

[33] The CEB scores higher than either of the other two regions in all of the transition indicators published annually by the European Bank for Reconstruction and Development, in the EBRD *Transition Report*, from 2002 to 2007.

innovation in all regions,[34] and that exporting induces firms in CIS and SEE, but not in CEB, to engage in all three types of innovation. Overall, we detect no evidence that firms in a more pro-business environment are more likely to display a positive or inverted U relationship between competition and innovation, or that they are more sensitive to foreign presence.

We next present complementary tests of whether a more pro-business environment in terms of lower level of bribery (corruption) induces firms to respond to competition by investing more in innovation (Aghion et al., 2005b). We argue that an environment free of corruption is pro-business because it is transparent, less costly and enables new players to enter the market with clear-cut rules. Hence, the question that we examine is whether firms exhibit stronger sensitivity of innovation to competition in less corrupt environments.

To test this hypothesis, we classify firms as being in low, medium and high corruption environments on the basis of the distribution of answers to the question: "What percentage of annual sales does a firm like yours pay in unofficial payments to public officials?" We estimate equation (1) separately for firms in each of the three bribery categories and compare the estimated coefficients on *markup* across these categories. We note that the three categories have highly statistically different mean values of bribery -- 0.005, 0.011 and 0.021, respectively – but on the whole we do not find systematic differences between the estimated coefficients of firms in the low, medium and high categories of corruption (Table 8).[35] We also test for the inverted U hypothesis in the Panel C of appendix Table A5 and find that there is no support for this hypothesis either. Similarly, there are no systematic differences between the significantly positive coefficients on "pressure from foreign competition" for the first two types of innovation. In acquiring a new technology and obtaining accreditation, firms in low and high bribery environments are similarly responsive to vertical transfers of capability through sales to MNEs and importing. Firms in the low bribery category have lower sensitivity of product innovation to sales to MNEs and greater sensitivity to exporting than firms in medium and high bribery environments.

[34] Two exceptions are SEE in product innovation and CEB in importing, which generate correctly signed but insignificant coefficients.

[35] The only difference is in developing a new product where the coefficient on markup is statistically significant for the high and low corruption categories but insignificant for the medium corruption category of firms.

### 4.3 Manufacturing v. 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 non-tradables. 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 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 9 indicate that there is not much difference in the innovation effect of competition, vertical transfer of capabilities and distance to the frontier between firms in manufacturing and services. The coefficients are for the most part similar. Moreover, the estimates of the coefficients on *markup* and $markup^2$ in the fourth panel of appendix Table A5 show that the relationship is not necessarily steeper in one sector or another. The results hence indicate that the effect of globalization, as captured by our three sets of variables, is broad-based and relatively similar in firms that produce goods as opposed to services.

## 5. Conclusion

Motivated by the growing theoretical literature on globalization and innovation, together with the limited and contradictory empirical evidence in this area, we use rich firm-level data from the 27 emerging market economies of the post-communist countries to test predictions about the effects of product market competition and linkages with foreign firms on domestic firms' innovative activities. Our focus on innovation is motivated by the fact that (a) innovation is a key channel through which local firms try to stay competitive and (b) existing literature focuses primarily on productivity effects, assuming (but not showing) that the mechanism underlying these effects is innovation.

Our main findings are that (i) supplying multinationals as well as exporting and importing (vertical relationships) induce innovation by domestic firms, (ii) firms that have market power tend to innovate more, but greater pressure from foreign competition also stimulates innovation; (iii) there is no evidence for an inverted U relationship between innovation and competition in either the more efficient or laggard firms, and (iv) the relationship between globalization and innovation does not vary across the manufacturing and service sectors or with differences in the business environment.

Our first finding supports 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. The policy implication of this finding is that policy measures that facilitate foreign direct investment and international trade enhance domestic welfare through greater innovative activities of domestic firms.

Our second set of findings provides clear-cut evidence in an area that has seen conflicting theoretical conjectures and empirical analyses. The Schumpeterian view is that market power promotes innovation by providing a stable platform to fund these investments and by making it easier for the firm to capture the benefits. Moreover, innovation is spurred in order to maintain existing rents in the face of competitive threat. This is in contrast to the view that market power reduces innovation by protecting entrepreneurs who fail to innovate. Aghion et al.'s (2004, 2005a, 2005b) theory reconciles these opposing views by predicting that the Schumpeterian effect dominates in industries with laggard firms, while competition spurs investment among high performing firms. Our second set of findings is that (a) firms with market power tend to be the innovators in terms of developing new products and acquiring new technologies, but less so in obtaining formal accreditations, (b) there is no strong differential effect of product market competition on the laggard v. the high performance firms and hence, the inverted U relationship generated by the balance of these two, (c) firms further away from the frontier (laggard firms) are less likely to innovate, (d) greater pressure from foreign competition stimulates innovation, and (e) larger firms are more likely to innovate. Combining these results suggests that it is the larger firms with market power that innovate, spurred in part by the need to escape foreign competition. One possible reason for these results is that undeveloped financial markets in the emerging market economies force firms to rely on their own profits to finance their innovation. If so, our findings have policy implications not only for direct stimuli of innovation, but also indirect ones via development of financial markets.

Finally, our third set of findings indicates that (a) the effects of competition, vertical linkages with foreign firms and distance to the frontier are broad-based and

relatively similar in manufacturing and services and (b) firms in a more pro-business environment do not invest more in innovation and are not more likely to display the inverted U relationship between competition and innovation. The fact that the effects are uniform across sectors is welcome in that relevant policies may not have to be geared differentially toward manufacturing and the service sector. The lack of differential effect across varying institutional (business environment) settings suggests that researchers and policy makers need to invest more in understanding better the effect of environment on business behavior

Taken in their entirety, our results are both encouraging and sobering. Whereas the advocates of globalization and market oriented institutions may be disappointed by the finding that greater product market competition and better business environment do not foster innovation, they will be cheered by the finding that foreign direct investment and foreign competition promote innovation among domestic firms and that firms in more market oriented economies tend to innovate more.

## References


Aghion, Philippe, Richard Blundell, Rachel Griffith, Peter, Howett and Susanne Prantl (2004) "Entry and Productivity Growth: Evidence from Microlevel Panel Data," *Journal of the European Economic Association*, Papers and proceedings 2(2-3): 265-276.

Aghion, Philippe, Nick Bloom, Richard Blundell, Rachel Griffith, and Peter Howitt (2005a) "Competition and Innovation: an Inverted U Relationship," *Quarterly Journal of Economics* 20(2): 701-728.

Aghion, Philippe, Robin Burgess, Stephen Redding and Fabrizio Zilibotti (2005b) "Entry Liberalization and Inequality in Industrial Performance," *Journal of the European Economic Association*, Papers and proceedings, 3(2-3): 291-302.

Aghion, Philippe, Richard Blundell, Rachel Griffith, Peter Howitt and Susanne Prantl (2006) "Entry and Productivity Growth: Evidence from Micro-level Panel Data" *Journal of European Economic Association*, Papers and Proceedings 2(2-3): 265-276.

Aghion, Philippe and Peter Howitt (1992) "A Model of Growth through Creative Destruction," *Econometrica* 60(2): 323-251.

Andrews, Donald W. K. (1999) "Consistent Moment Selection Procedures for Generalized Method of Moments Estimation," *Econometrica* 67(3): 543-564.

Archibugi, D. and G. Sirilli (2001) "The Direct Measurement of Technological Innovation in Business," in *Innovation and Enterprise Creation: Statistics and Indicators*. European Commission.

Arrow, Kenneth (1962) "Economic Welfare and the Allocation of Resources for Invention," in R. Nelson (ed.) *The Rate and Direction of Inventive Activity* Princeton University Press, 609-625.

Baily, Martin N., and Hans Gersbach (1995) "Efficiency in Manufacturing and the Need for Global Competition," Brookings Papers on Economic Activity – Microeconomics: 307-358.

Blalock, Garrick and Paul J. Gertler (2008) "Welfare Gains from Foreign Direct Investment Through Technology Transfer to Local Suppliers," *Journal of International Economics* 74(2): 402-421.

Business Environment and Enterprise Performance Survey (1999) (2002) (2005) The World Bank, Washington, D.C.

Bartelsman, Eric, John Haltiwanger, and Stefano Scarpetta (2004) **"**Microeconomic Evidence of Creative Destruction in Industrial and Developing Countries," IZA Discussion Paper 1374.

Becheikh, Nizar, Rejean Landry and Nabil Amara (2006) "Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993-2003," *Technovation* 26: 644-664.

Bertrand, Marianne (2004) "From the invisible handshake to the invisible hand? How import competition changes the employment relationship," *Journal of Labor Economics* 22(4):723 -765.

Bertschek, Irene (1995) "Product and Process Innovation as a Response to Increasing Imports and Foreign Direct Investment," *The Journal of Industrial Economics* 43(4): 341-357.

Blundell, Richard, Rachel Griffith and John Van Reenen (1999) "Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms," *The Review of Economic Studies* 66 (3): 529-554.

Carlin, Wendy, Mark E. Schaffer and Paul Seabright (2004) "A Minimum of Rivalry: Evidence from Transition Economies on the Importance of Competition for Innovation and Growth," *Contributions to Economic Analysis & Policy* 3(1): Berkeley Electronic Press.

Clark, Gregory (1987) "Why Isn't the Whole World Developed? Lessons from the Cotton Mills," *Journal of Economic History* 47(1): 141-173.

Cohen, Wesley (2005) "Empirical Studies of Innovative Activity," pp. 182-264 in Stoneman, P. (ed.), *Economics of Innovation and Technological Change Handbook,* Oxford: Blackwell Publishers Ltd.

Cohen, Wesley and Richard C. Levin (1989) "Empirical Studies of Innovation and Market Structure," ch. 18 in *Handbook of Industrial Organization*, MIT, 2: 1059-1107.

Dixit, Avinash and Joseph Stiglitz (1977) "Monopolistic Competition and Optimum Product Diversity," *American Economic Review* 67(3): 297-308.

Geroski, Paul (1995) *Market Structure, Corporate Performance and Innovative Activity*. Oxford University Press, Oxford, U.K.

Gilbert, Richard and David Newbery (1982) "Preemptive Patenting and the Persistence of Monoploy," *American Economic Review* 72(3): 514-526.

Gorg, Holger and David Greenaway (2004) "Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?" *World Bank Research Observer* 19(2): 171-197.

Gorodnichenko, Yuriy, Jan Svejnar and Katherine Terrell (2007) "When Does FDI Have Positive Spillovers? Evidence from 17 Transition Economies," IZA Discussion Paper No. 3079.

Grossman, Gene and Elhanan Helpman (1991) *Innovation and Growth in the Global Economy*. MIT Press.

Hall, Alastair R. and Fernanda P. M. Peixe, 2003. "A Consistent Method for the Selection of Relevant Instruments," *Econometric Reviews* 22: 269-288.

Javorcik, Beata (2004) "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In search of spillovers through backward linkages," *American Economic Review* 94(3): 605-627.

Kamien, M.I. and Schwartz, N.L. (1972) “Market Structure, Rivals' Response, and the Firm's Rate of Product Improvement,” *The Journal of Industrial Economics* 20(2): 159-172.

Melitz, Marc J. (2003) “The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity,” *Econometrica* 71(6): 1695-1725.

Michie, J. (1998) “Introduction: The Internationalisation of the Innovation Process,” *International Journal of the Economics of Business* 5(3): 261–277.

Nickell, Stephen (1996) “Competition and Corporate Performance,” *Journal of Political Economy* 104(4): 724-746.

Newey, Whitney K. (1987) “Efficient estimation of limited dependent variable models with endogenous explanatory variables,” *Journal of Econometrics* 36(3): 231-250.

Pavcnik, Nina (2002) “Trade Liberalization, Exit, and Productivity Improvements: Eveidence from Chilean Plants,” *The Review of Economic Studies* 69(1): 245-276.

Romer, Paul (1990) “Endogenous Technological Change,” *Journal of Political Economy* 98(5): S71-S102.

Rosembaum, Paul R. (2002) *Observational Studies*. Springer-Verlag.

Sabirianova, Klara, Jan Svejnar and Katherine Terrell (2005a) “Foreign Investment, Corporate Ownership and Development: Are firms in emerging markets catching up to the world standard?” IZA and CEPR Discussion Papers.

Sabirianova, Klara, Jan Svejnar and Katherine Terrell (2005b) “Distance to the Efficiency Frontier and FDI Spillovers,” *Journal of the European Economic Association,* Papers and Proceedings, 3(2-3): 576-586.

Salop, Steven (1977) “The Noisy Monopolist: Imperfect Information, Price Dispersion, and Price Discrimination,” *Review of Economic Studies* 44(3): 393-406.

Scherer, F. M. (1967) “Market Structure and the Employment of Scientists and Engineers,” *American Economic Review* 57(3):524-531.

Schmitz, Jr., James A. (2005) “What Determines Productivity? Lessons from the Dramatic Recovery of the US and Canadian Iron Ore Industries Following Their Early 1980s,” *Journal of Political Economy* 133(3): 582-625.

Schumpeter, Joseph A. (1943) *Capitalism, Socialism, and Democracy*. New York: Harper.

Sutton, John (2007a) “Quality, Trade and the Moving Window: The Globalization Process,” manuscript.

_____ (2007b) “Market Structure - Theory and Evidence,” Ch. 35 in Robert Porter and Mark Armstrong (eds.) *Handbook of Industrial Organisation*, 3(1): 2301-2368.

Wagner, Joachim (2007) “Exports and Productivity: A Survey of the Evidence from Firm-level Data,” *World Economy* 30 (1): 60-82.

Table 1: Baseline Specification for All Firms

| | New Product | | New Technology | | New Accreditation | |
|---|---|---|---|---|---|---|
| **Competition** | | | | | | |
| Markup | 0.588*** | 0.874** | 0.636*** | 1.091*** | -0.018 | -0.434 |
| | (0.109) | (0.344) | (0.111) | (0.357) | (0.149) | (0.456) |
| $Markup^2$ | | -0.489 | | -0.774 | | 0.706 |
| | | (0.556) | | (0.577) | | (0.745) |
| Pressure from foreign competition | | | | | | |
| Low | 0.061* | 0.061* | 0.080** | 0.081** | 0.053 | 0.052 |
| | (0.035) | (0.035) | (0.037) | (0.037) | (0.047) | (0.047) |
| Medium & High | 0.123*** | 0.123*** | 0.151*** | 0.151*** | 0.087** | 0.087** |
| | (0.032) | (0.032) | (0.033) | (0.033) | (0.041) | (0.041) |
| **Vertical Transfer of Capability** | | | | | | |
| Share of sales to MNEs | 0.243*** | 0.244*** | 0.223*** | 0.223*** | 0.413*** | 0.413*** |
| | (0.067) | (0.067) | (0.066) | (0.066) | (0.074) | (0.073) |
| Export share | 0.297*** | 0.296*** | 0.243*** | 0.242*** | 0.464*** | 0.465*** |
| | (0.079) | (0.079) | (0.074) | (0.074) | (0.081) | (0.081) |
| Import share | 0.385*** | 0.384*** | 0.288*** | 0.287*** | 0.210*** | 0.211*** |
| | (0.038) | (0.038) | (0.038) | (0.038) | (0.050) | (0.050) |
| **Ability** | | | | | | |
| Distance (Mahalanobis) | -0.041* | -0.038* | -0.040* | -0.037* | -0.017 | -0.020 |
| | (0.022) | (0.022) | (0.022) | (0.023) | (0.028) | (0.028) |
| **Controls** | | | | | | |
| lnL, t-3 | 0.129*** | 0.129*** | 0.134*** | 0.135*** | 0.271*** | 0.270*** |
| | (0.031) | (0.031) | (0.033) | (0.033) | (0.047) | (0.047) |
| $(lnL)^2$, t-3 | -0.005 | -0.005 | -0.005 | -0.005 | -0.011* | -0.011* |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.006) | (0.006) |
| Share of skilled workers, t-3 | 0.038 | 0.038 | -0.012 | -0.012 | -0.095 | -0.095 |
| | (0.044) | (0.044) | (0.047) | (0.047) | (0.062) | (0.062) |
| Share of workers with Univ. Ed. t-3 | 0.232*** | 0.232*** | 0.185*** | 0.185*** | 0.212*** | 0.212*** |
| | (0.050) | (0.050) | (0.053) | (0.053) | (0.069) | (0.069) |
| Firm's age | -0.054*** | -0.054*** | -0.041** | -0.040** | 0.026 | 0.026 |
| | (0.019) | (0.019) | (0.020) | (0.020) | (0.024) | (0.024) |
| State owned dummy | -0.231*** | -0.231*** | -0.105** | -0.104** | 0.016 | 0.015 |
| | (0.045) | (0.045) | (0.047) | (0.047) | (0.055) | (0.055) |
| Compete in national markets | 0.229*** | 0.229*** | 0.216*** | 0.216*** | 0.256*** | 0.257*** |
| | (0.033) | (0.033) | (0.034) | (0.034) | (0.045) | (0.045) |
| No. of Observations | 11,665 | 11,665 | 11,562 | 11,562 | 11,643 | 11,643 |

Notes: The table reports estimates of equation (1). Definitions of the variables are in Appendix Table A1. Location, time, country and industry fixed effects are included but not reported. Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2. Barriers to entry and firm turnover

| | Incidence of zero profits<br>Probit | Turnover rate<br>OLS | Survival rate<br>OLS | Entry rate<br>OLS |
|---|---|---|---|---|
| Index of Barriers to Entry | -0.010***<br>(0.003) | -0.953***<br>(0.181) | 0.904**<br>(0.440) | -0.190**<br>(0.081) |
| N observations | 8,248 | 59 | 62 | 60 |

Notes:

The table reports separate correlations of our "index of barriers to entry" (described in Section 3.2) 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 10%; ** significant at 5%; *** significant at 1%.

Table 3: Instrumented vs Non-Instrumented Estimates on Markup

| | New Product | | New Technology | | New Accreditation | |
|---|---|---|---|---|---|---|
| | **Baseline estimates** | | | | | |
| | **Probit** | **Linear** | **Probit** | **Linear** | **Probit** | **Linear** |
| Markup | 0.588*** | 0.202*** | 0.636*** | 0.209*** | -0.018 | -0.009 |
| | (0.109) | (0.037) | (0.111) | (0.036) | (0.149) | (0 .025) |
| | **Instrumental Variables (IV)** | | | | | |
| | **Probit** | **Linear** | **Probit** | **Linear** | **Probit** | **Linear** |
| Own response | | | | | | |
| Markup | 7.716*** | 2.504*** | 10.898*** | 3.782*** | 2.037 | 0.056 |
| | (2.236) | (0.714) | (1.716) | (0.591) | (2.708) | (0.457) |
| First stage fit: | | | | | | |
| F-test | 38.91*** | | 34.84*** | | 33.40*** | |
| No. of Obs. | 11,606 | | 11,503 | | 11,584 | |
| Other firms' response | | | | | | |
| Markup | 4.185* | 2.527* | 7.827* | 2.764* | 1.335 | 0.058 |
| | (2.462) | (1.543) | (4.195) | (1.458) | (5.564) | (0.937) |
| First stage fit: | | | | | | |
| F-test | 8.07*** | | 10.07*** | | 7.67*** | |
| No. of Obs. | 10,714 | | 10,616 | | 10,696 | |

Notes: The table reports estimates of equation (1). IV probit is implemented as in Newey (1987). Location, time, country and industry fixed effects are included but not reported. Linear means standard linear least-squares or instrumental-variables estimator. In the specification that uses other firms' responses about barriers to entry, we consider industries with at least five firms in a given year, industry and country, which helps to reduce the noise in other firms' answers.

Robust standard errors are in parentheses; *significant at 10%; **significant at 5%; ***significant at 1%. The asterisks at the 1st stage F-statistic show the significance of the Anderson canonical correlation LM statistic for the null hypothesis that instruments are weak.

Table 4: Baseline Specification for All Firms using Solow distance

| | New Product | | New Technology | | New Accreditation | |
|---|---|---|---|---|---|---|
| **Competition** | | | | | | |
| Markup | 0.562*** | 1.369*** | 0.255 | 0.898* | -0.283 | -0.118 |
| | (0.171) | (0.526) | (0.168) | (0.539) | (0.214) | (0.675) |
| $Markup^2$ | | -1.250 | | -1.107 | | -0.199 |
| | | (0.848) | | (0.882) | | (1.164) |
| Pressure from foreign competition | | | | | | |
| Low | 0.057 | 0.062 | 0.093* | 0.094* | 0.095 | 0.097 |
| | (0.054) | (0.054) | (0.055) | (0.055) | (0.068) | (0.068) |
| Medium&High | 0.138*** | 0.137*** | 0.171*** | 0.171*** | 0.109* | 0.108* |
| | (0.049) | (0.049) | (0.049) | (0.049) | (0.061) | (0.061) |
| **Vertical Transfer of Capability** | | | | | | |
| Share of sales to MNEs | 0.418*** | 0.418*** | 0.276*** | 0.274*** | 0.357*** | 0.357*** |
| | (0.107) | (0.108) | (0.097) | (0.097) | (0.108) | (0.108) |
| Export share | 0.270** | 0.256** | 0.186* | 0.183* | 0.345*** | 0.338*** |
| | (0.115) | (0.115) | (0.104) | (0.104) | (0.114) | (0.115) |
| Import share | 0.421*** | 0.425*** | 0.260*** | 0.260*** | 0.120* | 0.125* |
| | (0.059) | (0.059) | (0.058) | (0.058) | (0.072) | (0.072) |
| **Ability** | | | | | | |
| Distance (Solow) | -0.033** | -0.035** | -0.019 | -0.020 | -0.041** | -0.046*** |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.017) | (0.017) |
| **Controls** | | | | | | |
| lnL, 3yrs ago | 0.143*** | 0.146*** | 0.126** | 0.127** | 0.274*** | 0.276*** |
| | (0.048) | (0.048) | (0.050) | (0.050) | (0.068) | (0.068) |
| $(lnL)^2$, 3yrs ago | -0.009 | -0.009 | -0.007 | -0.007 | -0.008 | -0.009 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.009) | (0.009) |
| Share of skilled workers, 3yrs ago | 0.046 | 0.048 | 0.028 | 0.028 | -0.098 | -0.089 |
| | (0.071) | (0.071) | (0.073) | (0.073) | (0.092) | (0.092) |
| Share of workers with higher education, 3yrs ago | 0.179** | 0.175** | 0.099 | 0.099 | 0.141 | 0.148 |
| | (0.085) | (0.085) | (0.086) | (0.086) | (0.107) | (0.107) |
| Firm's age | -0.030 | -0.027 | -0.039 | -0.038 | 0.046 | 0.049 |
| | (0.031) | (0.031) | (0.030) | (0.030) | (0.035) | (0.035) |
| State owned | -0.334*** | -0.326*** | -0.163** | -0.162** | -0.106 | -0.097 |
| | (0.072) | (0.072) | (0.072) | (0.072) | (0.084) | (0.084) |
| Compete in national markets | 0.269*** | 0.274*** | 0.233*** | 0.233*** | 0.255*** | 0.256*** |
| | (0.051) | (0.051) | (0.053) | (0.053) | (0.068) | (0.068) |
| No. of Observations | 5,020 | 5,020 | 4,985 | 4,985 | 5,011 | 5,011 |

Note: 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. The Solow residual is calculated using equation (2). Solow residual distance is the log difference between the average of the top third within a given country/industry/year cell foreign firms' Solow residual and that of a domestic firm. Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Testing for Endogeneity due to the Timing of the Variables

| | New Product | | | | New Technology | | | | New License | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full Sample (current) | 2002 & 2005 Panel (current) | 2005 Panel (current) | 2005 Panel (lagged) | Full Sample (current) | 2002 & 2005 Panel (current) | 2005 Panel (current) | 2005 Panel (lagged) | Full Sample (current) | 2002 & 2005 Panel (current) | 2005 Panel (current) | 2005 Panel (lagged) |
| | (a) | (b) | (c) | (d) | (a) | (b) | (c) | (d) | (a) | (b) | (c) | (d) |
| **Competition** | | | | | | | | | | | | |
| Markup | 0.593*** | 0.557** | 0.497* | 0.310 | 0.460*** | -0.050 | -0.524 | 0.654* | -0.006 | 0.031 | 0.011 | -0.170 |
| | (0.098) | (0.237) | (0.300) | (0.367) | (0.100) | (0.243) | (0.328) | (0.375) | (0.105) | (0.250) | (0.346) | (0.394) |
| **Pressure from foreign competition** | | | | | | | | | | | | |
| Low | 0.159*** | 0.297*** | 0.331*** | 0.250** | 0.154*** | 0.186** | 0.395*** | 0.342*** | 0.153*** | 0.244*** | 0.227* | 0.097 |
| | (0.032) | (0.078) | (0.112) | (0.101) | (0.033) | (0.079) | (0.112) | (0.109) | (0.035) | (0.082) | (0.117) | (0.116) |
| Medium&High | 0.276*** | 0.123* | 0.084 | 0.263 ** | 0.261*** | 0.176** | 0.351*** | 0.168* | 0.286*** | 0.189*** | 0.158 | 0.065 |
| | (0.027) | (0.069) | (0.098) | (0.087) | (0.028) | (0.070) | (0.102) | (0.097) | (0.030) | (0.072) | (0.106) | (0.097) |
| **Vertical Transfer** | | | | | | | | | | | | |
| Sales to MNEs | 0.308*** | 0.356*** | 0.191 | 0.305*** | 0.213*** | 0.158** | 0.065 | 0.264** | 0.344*** | 0.374*** | 0.294** | 0.366*** |
| | (0.033) | (0.083) | (0.120) | (0.108) | (0.032) | (0.079) | (0.119) | (0.108) | (0.033) | (0.079) | (0.122) | (0.109) |
| Export share | 0.296*** | 0.463*** | 0.444*** | 0.371*** | 0.213*** | 0.204*** | 0.315*** | 0.189* | 0.423*** | 0.494*** | 0.466*** | 0.442*** |
| | (0.032) | (0.084) | (0.115) | (0.116) | (0.031) | (0.076) | (0.109) | (0.110) | (0.033) | (0.079) | (0.112) | (0.114) |
| Import share | 0.368*** | 0.338*** | 0.319*** | 0.182** | 0.307*** | 0.255*** | 0.283*** | 0.146 | 0.212*** | 0.190*** | 0.298*** | 0.125 |
| | (0.025) | (0.061) | (0.088) | (0.086) | (0.026) | (0.064) | (0.092) | (0.091) | (0.028) | (0.067) | (0.098) | (0.094) |
| **Distance** | | | | | | | | | | | | |
| Distance | -0.075** | -0.129** | -0.121* | -0.117 | -0.076*** | -0.044 | -0.051 | -0.054 | -0.095*** | -0.046 | -0.036 | -0.026 |
| (Mahalanobis) | (0.020) | (0.053) | (0.072) | (0.075) | (0.021) | (0.052) | (0.073) | (0.073) | (0.025) | (0.066) | (0.096) | (0.096) |
| Distance | -0.039*** | -0.092*** | -0.064* | -0.072* | -0.035*** | -0.069** | -0.062* | -0.067* | -0.060*** | -0.026 | -0.002 | -0.005 |
| (Solow) | (0.012) | (0.027) | (0.041) | (0.041) | (0.012) | (0.025) | (0.037) | (0.038) | (0.014) | (0.030) | (0.043) | (0.044) |

Notes: *Markup* and *Pressure from Foreign Competition* each enter the regressions separately. Vertical Transfer of Capability (*sales to MNEs*, *Export*, *Import*), *Mahalanobis Distance* and *Solow Residual 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&2005 Panel is with current RHS values; 2005 Panel is with both current and lagged RHS values. The coefficients in columns (a) differ 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 10%; ** significant at 5%; *** significant at 1%.

Table 6: Testing for the Interaction between Distance and Competition.

| | **New Good** Distance to the Frontier | | | **New Technology** Distance to the Frontier | | | **New Accreditation** Distance to the Frontier | | |
|---|---|---|---|---|---|---|---|---|---|
| | Close | Middle | Far | Close | Middle | Far | Close | Middle | Far |
| **Competition** | | | | | | | | | |
| Markup | 0.359 | 0.334* | 0.957*** | 0.998*** | 0.319 | 0.725*** | -0.142 | -0.254 | 0.229 |
| | (0.230) | (0.189) | (0.171) | (0.236) | (0.198) | (0.167) | (0.307) | (0.264) | (0.229) |
| Pressure from foreign competition | | | | | | | | | |
| Low | 0.139** | -0.046 | 0.089 | 0.039 | 0.123* | 0.080 | -0.032 | 0.112 | 0.106 |
| | (0.060) | (0.061) | (0.062) | (0.064) | (0.065) | (0.064) | (0.080) | (0.086) | (0.084) |
| Medium & High | 0.170*** | 0.049 | 0.147** | 0.142** | 0.167*** | 0.145** | 0.084 | -0.012 | 0.174** |
| | (0.054) | (0.054) | (0.057) | (0.056) | (0.057) | (0.058) | (0.069) | (0.075) | (0.074) |
| **Vertical Transfer of Capability** | | | | | | | | | |
| Share of sales to MNEs | 0.186 | 0.312** | 0.221* | 0.278** | 0.203* | 0.178* | 0.383*** | 0.573*** | 0.310** |
| | (0.117) | (0.124) | (0.113) | (0.118) | (0.121) | (0.107) | (0.126) | (0.139) | (0.121) |
| Export share | 0.301** | 0.163 | 0.363*** | 0.293** | 0.105 | 0.318** | 0.372*** | 0.485*** | 0.596*** |
| | (0.138) | (0.141) | (0.137) | (0.128) | (0.133) | (0.127) | (0.140) | (0.147) | (0.145) |
| Import share | 0.432*** | 0.280*** | 0.438*** | 0.242*** | 0.328*** | 0.295*** | 0.234*** | 0.182* | 0.213** |
| | (0.069) | (0.066) | (0.067) | (0.069) | (0.070) | (0.065) | (0.087) | (0.093) | (0.088) |
| No. of observations | 3,945 | 3,890 | 3,830 | 3,904 | 3,859 | 3,799 | 3,933 | 3,882 | 3,820 |

Notes: The table reports estimates of equation (1). 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 10%; ** significant at 5%; *** significant at 1%.

Table 7: Testing for Business Environment: Regional Differences

| | New Product | | | New Technology | | | New Accreditation | | |
|---|---|---|---|---|---|---|---|---|---|
| | CIS | CEB | SEE | CIS | CEB | SEE | CIS | CEB | SEE |
| **Competition** | | | | | | | | | |
| Markup | 0.673*** | 0.519** | 0.559*** | 0.770*** | 0.728*** | 0.442** | 0.239 | -0.371 | -0.041 |
| | (0.170) | (0.210) | (0.201) | (0.168) | (0.228) | (0.198) | (0.226) | (0.311) | (0.270) |
| Pressure from foreign competition | | | | | | | | | |
| Low | 0.112** | 0.162** | -0.131* | 0.057 | 0.239*** | 0.004 | 0.024 | 0.051 | 0.065 |
| | (0.053) | (0.067) | (0.067) | (0.054) | (0.075) | (0.070) | (0.073) | (0.094) | (0.089) |
| Medium & High | 0.149*** | 0.261*** | -0.035 | 0.138*** | 0.237*** | 0.141** | 0.089 | 0.094 | 0.039 |
| | (0.052) | (0.059) | (0.056) | (0.052) | (0.067) | (0.057) | (0.068) | (0.084) | (0.073) |
| **Vertical Transfer of Capability** | | | | | | | | | |
| Share of sales to MNEs | 0.320*** | 0.236* | 0.137 | 0.204* | 0.367*** | 0.181* | 0.341*** | 0.677*** | 0.289** |
| | (0.116) | (0.132) | (0.107) | (0.112) | (0.132) | (0.105) | (0.130) | (0.139) | (0.126) |
| Export share | 0.371** | 0.106 | 0.481*** | 0.400*** | 0.047 | 0.302** | 0.611*** | 0.166 | 0.597*** |
| | (0.148) | (0.145) | (0.132) | (0.127) | (0.145) | (0.123) | (0.142) | (0.171) | (0.136) |
| Import share | 0.441*** | 0.370*** | 0.314*** | 0.352*** | 0.182** | 0.263*** | 0.191** | 0.125 | 0.342*** |
| | (0.059) | (0.073) | (0.071) | (0.058) | (0.080) | (0.071) | (0.077) | (0.104) | (0.090) |
| **Ability** | | | | | | | | | |
| Distance (Mahalanobis) | -0.002 | -0.160*** | -0.040 | -0.052 | -0.043 | -0.064 | 0.078* | -0.057 | -0.091* |
| | (0.033) | (0.045) | (0.043) | (0.034) | (0.048) | (0.042) | (0.045) | (0.058) | (0.052) |
| Observations | 5,010 | 3,154 | 3,500 | 4,964 | 3,133 | 3,464 | 5,006 | 3,146 | 3,490 |

Notes: The table reports estimates of equation (1). Definitions of the variables are in Appendix Table A1. CIS stands for Commonwealth Independent States; CEB stands for Central Europe and Baltic; SEE stands for South East Europe. Location, time, country and industry fixed effects are included but not reported.
Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Testing for Business Environment: Bribery

| | New Product | | | New Technology | | | New Accreditation | | |
|---|---|---|---|---|---|---|---|---|---|
| | Bribery | | | Bribery | | | Bribery | | |
| | Low | Medium | High | Low | Medium | High | Low | Medium | High |
| **Competition** | | | | | | | | | |
| Markup | 0.516*** | 0.281 | 0.891*** | 0.835*** | 0.469** | 0.568*** | -0.085 | -0.013 | -0.052 |
| | (0.198) | (0.189) | (0.190) | (0.203) | (0.195) | (0.188) | (0.269) | (0.264) | (0.254) |
| Pressure from foreign competition | | | | | | | | | |
| Low | 0.004 | 0.082 | 0.068 | 0.150** | 0.008 | 0.102* | 0.067 | 0.076 | 0.044 |
| | (0.063) | (0.061) | (0.060) | (0.067) | (0.066) | (0.061) | (0.087) | (0.083) | (0.082) |
| Medium & High | 0.097* | 0.153*** | 0.097* | 0.224*** | 0.095* | 0.151*** | 0.162** | 0.037 | 0.095 |
| | (0.056) | (0.054) | (0.056) | (0.059) | (0.056) | (0.057) | (0.075) | (0.072) | (0.073) |
| **Vertical Transfer of Capability** | | | | | | | | | |
| Share of sales to MNEs | 0.088 | 0.382*** | 0.310*** | 0.294*** | 0.174 | 0.217* | 0.637*** | 0.168 | 0.360** |
| | (0.103) | (0.133) | (0.120) | (0.102) | (0.127) | (0.118) | (0.113) | (0.142) | (0.141) |
| Export share | 0.459*** | 0.028 | 0.241 | 0.207* | 0.267* | 0.192 | 0.328** | 0.539*** | 0.549*** |
| | (0.127) | (0.144) | (0.152) | (0.117) | (0.141) | (0.136) | (0.128) | (0.158) | (0.155) |
| Import share | 0.331*** | 0.432*** | 0.393*** | 0.206*** | 0.335*** | 0.360*** | 0.257*** | 0.118 | 0.313*** |
| | (0.066) | (0.068) | (0.068) | (0.068) | (0.068) | (0.068) | (0.087) | (0.092) | (0.090) |
| **Ability** | | | | | | | | | |
| Distance (Mahalanobis) | -0.106*** | -0.043 | 0.002 | -0.035 | -0.054 | -0.021 | -0.072 | -0.061 | 0.087* |
| | (0.040) | (0.040) | (0.038) | (0.041) | (0.041) | (0.039) | (0.048) | (0.052) | (0.051) |
| Observations | 3,753 | 3,974 | 3,930 | 3,722 | 3,938 | 3,900 | 3,739 | 3,966 | 3924 |

Notes: The table reports estimates of equation (1). Definitions of the variables are in Appendix Table A1. Location, time, country and industry fixed effects are included but not reported. Low denotes the lowest third quantity in terms of bribery made. Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Testing for Response in Manufacturing v. Services

| | New Product | | New Technology | | New Accreditation | |
|---|---|---|---|---|---|---|
| | MNFR | SERV | MNFR | SERV | MNFR | SERV |
| **Competition** | | | | | | |
| Markup | 0.579*** | 0.598*** | 0.649*** | 0.593*** | 0.079 | 0.083 |
| | (0.202) | (0.153) | (0.186) | (0.168) | (0.230) | (0.242) |
| Pressure from foreign competition | | | | | | |
| Low | 0.096 | 0.034 | 0.008 | 0.131** | -0.068 | 0.093 |
| | (0.064) | (0.051) | (0.062) | (0.056) | (0.079) | (0.076) |
| Medium & High | 0.143*** | 0.145*** | 0.095* | 0.183*** | 0.039 | 0.098 |
| | (0.055) | (0.045) | (0.052) | (0.051) | (0.065) | (0.067) |
| **Vertical Transfer of Capability** | | | | | | |
| Share of sales to MNEs | 0.235** | 0.196* | 0.270*** | 0.237** | 0.429*** | 0.486*** |
| | (0.114) | (0.102) | (0.103) | (0.105) | (0.110) | (0.128) |
| Export share | 0.273** | 0.258** | 0.277*** | 0.224* | 0.379*** | 0.732*** |
| | (0.119) | (0.122) | (0.103) | (0.125) | (0.112) | (0.141) |
| Import share | 0.458*** | 0.302*** | 0.254*** | 0.274*** | 0.271*** | 0.104 |
| | (0.071) | (0.053) | (0.064) | (0.058) | (0.078) | (0.080) |
| **Ability** | | | | | | |
| Distance (Mahalanobis) | -0.087** | -0.037 | -0.052 | -0.041 | -0.037 | -0.059 |
| | (0.038) | (0.034) | (0.036) | (0.037) | (0.042) | (0.051) |
| No. of Observations | 3,892 | 5,624 | 3,855 | 5,580 | 3,884 | 5,615 |

Notes: The table reports estimates of equation (1). Definitions of the variables are in Appendix Table A1. *MNFR* is Manufacturing, *SERV* is services. Location, time, country and industry fixed effects are included but not reported. Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

# 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:<br>- Developed successfully a major new product line<br>- 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:<br>Has your company Obtained a new quality accreditation (ISO 9000, 9002 or 14,000, AGCCP, etc) over the last 36 months? Dummy variable is equal to one if 'yes' to any of the two questions |
| 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)? |
| 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":<br>None — Not important<br>Low — Slightly important<br>Medium — Fairly important<br>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 |
| SKILL | Share of skilled workers, 3 yrs ago | What share of your current permanent, full-time workers are skilled workers 36 months ago? |
| EDU | Share of workers with higher education, 3yrs ago | What share of the workforce at your firm has some university education in 36 months ago? |
| Age | Log (Firm's age ) | Year of survey minus the year when the firm was established. For the year established: In what year did your firm begin operations in this country? |
| SOE | State owned | Government is the major shareholder (50%+) |
| 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)? 1= yes. |
| 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 |
| BR | Bribes | On average, what percent of total annual sales do firm's like yours typically pay in unofficial payments/gifts to public officials? |

Table A2: Summary Statistics.

| | Mean | St.Dev. |
|---|---|---|
| **Innovation Variables** | | |
| New Product | 0.562 | 0.496 |
| New Technology | 0.302 | 0.459 |
| New Accreditation | 0.129 | 0.335 |
| **Competition** | | |
| Markup | 0.209 | 0.118 |
| Pressure from foreign competition | | |
| Low | 0.173 | 0.378 |
| Medium &High | 0.297 | 0.457 |
| **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(Solow) | 0.364 | 0.377 |
| **Controls** | | |
| lnL, 3yrs ago | 3.000 | 1.604 |
| $(lnL)^2$, 3yrs ago | 11.577 | 11.530 |
| Share of skilled workers, 3yrs ago | 0.487 | 0.309 |
| Share of workers with higher education, 3yr 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 |
| **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.

| | New Product | New Technology | New Accreditation |
|---|---|---|---|
| **Competition** | | | |
| Markup | 0.231*** | 0.215*** | -0.003 |
| | (0.043) | (0.038) | (0.023) |
| Pressure from foreign competition | | | |
| Low | 0.024* | 0.028** | 0.008 |
| | (0.014) | (0.013) | (0.008) |
| Medium & High | 0.048*** | 0.052*** | 0.014** |
| | (0.012) | (0.011) | (0.007) |
| **Vertical Transfer of Capability** | | | |
| Share of sales to MNEs | 0.096*** | 0.075*** | 0.063*** |
| | (0.026) | (0.022) | (0.011) |
| Export share | 0.116*** | 0.082*** | 0.071*** |
| | (0.031) | (0.025) | (0.013) |
| Import share | 0.151*** | 0.098*** | 0.032*** |
| | (0.015) | (0.013) | (0.008) |
| **Ability** | | | |
| Distance (Mahalanobis) | -0.016* | -0.014* | -0.003 |
| | (0.009) | (0.008) | (0.004) |
| **Controls** | | | |
| lnL, t-3 | 0.051*** | 0.045*** | 0.041*** |
| | (0.012) | (0.011) | (0.007) |
| $(lnL)^2$, t-3 | -0.002 | -0.002 | -0.002* |
| | (0.002) | (0.001) | (0.001) |
| Share of skilled workers, t-3 | 0.015 | -0.004 | -0.014 |
| | (0.017) | (0.016) | (0.009) |
| Share of workers with Univ. Ed. t-3 | 0.091*** | 0.063*** | 0.032*** |
| | (0.020) | (0.018) | (0.011) |
| Firm's age | -0.021*** | -0.014** | 0.004 |
| | (0.008) | (0.007) | (0.004) |
| State owned dummy | -0.091*** | -0.035** | 0.002 |
| | (0.018) | (0.015) | (0.009) |
| Compete in national markets | 0.090*** | 0.071*** | 0.037*** |
| | (0.013) | (0.011) | (0.006) |
| No. of Observations | 11,665 | 11,562 | 11,643 |

Note: The table reports estimates of equation (1). Definitions of the variables are in Appendix Table A1. Location, time, country and industry fixed effects are included but not reported. Robust standard errors are in parentheses and the number of observations is in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A4: Baseline Specification for All Firms

| | **New Product** | **New Technology** | **New Accreditation** |
|---|---|---|---|
| Export share, t-3 | 0.311*** | 0.257*** | 0.450*** |
| | (0.118) | (0.107) | (0.135) |
| No. of Observations | 5,374 | 6,151 | 6,107 |

Note: The table reports estimates of equation (1) where *export share* is constructed using retrospective questions about growth rate of sales revenue and exports as well as the current year information on the share of exports in total sales and the level of total sales. Other variables as defined are in the specification reported in Table 1 are included but not reported. Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A5: Testing for inverted-U relationship between innovation and competition.

| | **New Product** | | | **New Technology** | | | **New Accreditation** | | |
|---|---|---|---|---|---|---|---|---|---|
| Panel A: | | | | Distance to the Frontier | | | | | |
| | Close | Middle | Far | Close | Middle | Far | Close | Middle | Far |
| Markup | 1.211 | 1.248** | 0.902 | 1.687** | 0.492 | 1.244** | -0.516 | -0.534 | -0.207 |
| | (0.740) | (0.604) | (0.562) | (0.799) | (0.642) | (0.563) | (0.984) | (0.835) | (0.729) |
| $Markup^2$ | -1.678 | -1.585 | 0.086 | -1.352 | -0.301 | -0.811 | 0.734 | 0.485 | 0.674 |
| | (1.382) | (0.997) | (0.845) | (1.507) | (1.064) | (0.837) | (1.901) | (1.404) | (1.087) |
| Panel B: | | | | Regional development | | | | | |
| | CIS | CEB | SEE | CIS | CEB | SEE | CIS | CEB | SEE |
| Markup | 1.175** | 0.770 | 0.709 | 1.037* | 1.097 | 1.967*** | 0.048 | -0.514 | -0.536 |
| | (0.541) | (0.645) | (0.641) | (0.554) | (0.704) | (0.648) | (0.745) | (0.900) | (0.830) |
| $Markup^2$ | -0.853 | -0.434 | -0.255 | -0.452 | -0.635 | -2.565** | 0.317 | 0.256 | 0.829 |
| | (0.875) | (1.053) | (1.027) | (0.895) | (1.165) | (1.033) | (1.196) | (1.591) | (1.380) |
| Panel C: | | | | Bribery | | | | | |
| | Low | Medium | High | Low | Medium | High | Low | Medium | High |
| Markup | 1.505** | 0.656 | 0.352 | 2.665*** | 0.709 | 0.117 | -0.216 | -1.276 | 0.039 |
| | (0.647) | (0.602) | (0.594) | (0.666) | (0.632) | (0.595) | (0.818) | (0.807) | (0.790) |
| $Markup^2$ | -1.556 | -0.637 | 0.917 | -3.126*** | -0.406 | 0.761 | 0.226 | 2.127 | -0.154 |
| | (1.081) | (0.983) | (0.957) | (1.081) | (1.028) | (0.949) | (1.397) | (1.300) | (1.259) |
| Panel D: | | | | Sectors | | | | | |
| | MNFR | | SERV | MNFR | | SERV | MNFR | | SERV |
| Markup | 1.485** | | 0.633 | 1.575*** | | 0.651 | 0.753 | | -0.824 |
| | (0.646) | | (0.481) | (0.624) | | (0.536) | (0.750) | | (0.726) |
| $Markup^2$ | -1.561 | | -0.059 | -1.540 | | -0.097 | -1.166 | | 1.492 |
| | (1.047) | | (0.766) | (1.032) | | (0.846) | (1.227) | | (1.141) |

Notes: The table reports estimates of equation (1). 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. *MNFR* is Manufacturing, *SERV* is services. *CIS* stands for Commonwealth Independent States; *CEB* stands for Central Europe and Baltic; *SEE* stands for South East Europe. *Low* denotes the lowest third quantity in terms of bribery made. Location, time, country and industry fixed effects are included but not reported. Robust standard errors are in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.