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Authors
Gorodnichenko, Yuriy
Svejnar, Jan
Terrell, Katherine

Publication Date
2020

DOI
10.1016/j.euroecorev.2019.103343

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DO FOREIGN INVESTMENT AND TRADE SPUR INNOVATION?

Yuriy Gorodnichenko
University of
California – Berkeley

Jan Svejnar
Columbia University
and CERGE-EI

Katherine Terrell

This Draft: November 2019

Abstract

Using large firm-level and industry-level data sets from eighteen countries, we find that foreign direct investment (FDI) and trade have positive spillover effects on product and technology innovation by domestic firms in emerging markets. The FDI effect is more pronounced for firms from advanced economies. However, while we detect the spillover effects with micro data at the firm-level, when we use linkage variables computed from input-output tables at the industry level we find much weaker, and usually insignificant, effects. These patterns are important for policy, suggesting that spillovers are localized to firms engaged directly with multinationals and in trade, rather than affecting all domestic firms in industries with FDI presence.

Key Words: Innovation, FDI, trade, spillovers, horizontal and vertical linkages, emerging markets, foreign competition, entry.

JEL: F23, M16, O16, P23

Acknowledgements: Yuriy Gorodnichenko and Jan Svejnar would like to dedicate this paper to Katherine Terrell, who passed away while the authors were working on the paper. They would like to thank Michael Olabisi, Aaron Baum, and Yury Yatsynovich for valuable research assistance. In carrying out this research, they benefitted from grant no. P402-15-24642S of the Grant Agency of the Czech Republic. Yuriy Gorodnichenko also thanks National Science Foundation for financial support.

1. Introduction

A major question that has arisen in the last few decades is whether domestic firms have become stronger or weaker with the opening up of most economies to foreign trade and investment. More specifically, has the efficiency of firms in emerging market economies improved with the growing presence of foreign direct investment (FDI) within their borders and the opening of these economies to trade? While there is substantial evidence that multinational enterprises (MNEs)[1] are more productive than domestic firms,[2] the evidence on productivity spillovers of FDI and trade remains mixed.[3]

The mixed evidence points to the need to understand better the mechanisms through which horizontal and vertical relationships with foreign firms and international trade improve or hamper efficiency of domestic firms. Innovation is the presumed conduit through which globalization affects productivity, yet there has been little research testing the relationship between globalization and innovation. In this paper, we provide the first analysis based on industry-level ("indirect") and firm-level ("micro") data to address this question.

Foreign firms may have efficiency and other "spillover" effects on local competitors (horizontal spillovers) as well as on upstream and downstream domestic firms (vertical spillovers).[4] Most studies

[1] In this paper the term MNEs refers to foreign-owned firms, although we recognize that domestically owned firms can also be multinational in their production and sourcing.

[2] See e.g., the seminal work of Caves (1974) and the more recent work of Djankov and Hoekman (2000), Haskel, Pereira and Slaughter (2007) and Sabirianova, Svejnar and Terrell (2005).

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

[4] The spillover (broadly defined as a transfer of managerial practices, production methods, marketing techniques or any other knowledge embodied in a product or service) may occur through a number of channels. Local firms may for instance learn to imitate a new process or improve the quality of their products or services through observation, or find out about better processes or marketing methods through interaction with foreign managers in business chambers and from former employees of MNEs. Local firms may also benefit from the entry of new professional services or suppliers as a result of the MNE entry. Foreign firms may act as catalysts for domestic suppliers to improve quality or time efficiency by demanding higher standards. On the other hand, foreign firms may have a negative effect on domestic firms' output and efficiency if they "steal" their market or best human capital. If domestic firms cut back production in the face of foreign competition, they may experience a higher average cost as fixed costs are spread over a smaller scale of production (Aitken and Harrison, 1999). Similarly, if the best employees leave for foreign firms, efficiency declines.

examine "horizontal spillovers" and do so at the industry level within a production function framework.[5] The effect of foreign presence on the productivity of domestic firms in a given industry is captured by the coefficient on the share of foreign firms' output or employment in that industry. The evidence from this research is mixed. Most studies of developing countries suggest that the horizontal spillover effect is nil or negative.[6] On the other hand, several studies find positive horizontal spillovers in the more developed economies such as the UK.[7] Hence, there is a puzzle that is of considerable interest.

While studies of horizontal productivity spillovers are numerous, until recently there were few empirical studies on vertical spillovers. This is surprising given the early analysis by Lall (1980) of the positive backward linkage effects of foreign firms on the Indian trucking industry.[8] Moreover, vertical spillovers are more likely to be positive than horizontal spillovers since MNEs have an incentive to improve the productivity of their suppliers rather than that of their competitors.[9] The empirical papers that have appeared more recently do indeed find evidence that is consistent with the view of technology transfer through backward linkages in the manufacturing sectors of for example, Hungary (Schoors and van der Tol, 2001), Indonesia (Blalock and Gertler, 2005), Lithuania (Javorcik, 2004), Czech Republic (Stancik, 2007) and the United Kingdom (Girma, Gorg and Pisu, 2008). However, these studies rely only on a variable that is constructed from input-output (I-O) tables at the industry level, rather than a direct

[5] The literature on FDI spillovers has been burgeoning in recent years. We do not attempt to summarize the large and rapidly growing literature, but simply highlight the work that has motivated the analysis in this paper. We refer the interested reader to a survey by Gorg and Greenaway (2004).

[6] See for example studies of Morocco by Haddad and Harrison (1993); Venezuela by Aitken and Harrison (1999); Bulgaria and Romania by Konings (2000); Russia by Yudaeva et al. (2003); the Czech Republic by Kosova (2004); and China by Abraham, Konings and Slootmaekers (2006). In the Chinese case, Abraham, Konings and Slootmaekers (2006) find positive horizontal spillovers for certain types of firms. More recently, using firm-level data from ten transition economies, Damijan et al. (2012) find that horizontal spillovers tend to be positive in more productive firms and negative in less productive and smaller ones. Moreover, Davies, Lamla, and Schiffbauer (2016) find that spillovers tend to be temporary in that they depend on MNEs continuous presence.

[7] See e.g., Haskel et al. (2007) and Keller and Yeaple (2003).

[8] On the other hand, there are numerous case studies which provide specific examples of how MNEs provide training and assistance to their suppliers. See for example, Moran (2001).

[9] Blalock and Gertler (2005) point out that MNEs may establish a relationship with multiple suppliers to reduce dependency on a single supplier and that this will then benefit all firms that purchase these vendors' output. Consistent with this view, Lin and Saggi (2007) show theoretically how exclusivity in the contractual relationship between a multinational and its local supplier reduces the competition among local suppliers and can lower backward linkages and local welfare relative to autarky.

firm-specific measure. More recently, Gorodnichenko, Svejnar and Terrell (2010, 2014) use firm-specific linkage variables to examine the productivity effects of the share of sales to multinationals, share of exports in total sales and share of imported inputs in total input cost in the Business Environment and Enterprise Performance Surveys (BEEPS) data. Moreover, Vacek (2007) uses a firm-specific linkage variable to examine the productivity effects of share of sales to multinationals within a small sample of large firms in four two-digit NACE manufacturing sectors in the Czech Republic. Finally, Barrioso et al. (2011) find evidence of positive backward linkages using plant level data from Ireland, while Di Ubaldo, Lawless and Siedschlag (2018) find a nil or negative effect using firm-level Irish data.

There has thus been considerable advancement within the productivity spillover literature, but the mixed results suggest that one needs to (a) examine directly the effect of FDI and trade on innovation and (b) assess whether the widely used industry-level linkage measures (e.g., Javorcik, 2004) provide an adequate approach or whether it is preferable to employ firm-level linkage measures in addressing these issues. The direct examination of the effect of FDI and trade on innovation is desirable because theories usually make predictions about the effects on innovation by firms rather than about the (derived) productivity effect. Furthermore, as argued by Gorodnichenko (2008) and others, measured productivity captures the revenue generating ability of firms (which includes both market power and technology level) rather than the technology level of firms. The comparison of the *indirect* effects based on (aggregate) industry-level linkages and *direct* effect based on firm-level (micro) linkages is highly desirable because it is not clear that the typical measures of vertical linkages at the industry level, which rely on I-O tables (e.g., Javorcik, 2004) provide a sufficiently precise measure of the linkage. In particular, studies based on I-O tables cannot identify whether the spillover effects are broad-based, affecting all firms in a given industry, or whether they are specific to firms engaged with multinationals.

In this paper we carry out this analysis by combining the rich ORBIS™ data base of firms with the 2002 and 2005 BEEPS of firms in 18 emerging market (transition) economies and Turkey. We use these

firm-level data together with industry-level input-output data that we have collected individually from national statistical offices and international organizations. The combined data set enables us to provide the first study of innovation effects of both industry-level (input-output) and firm-level (micro) measures of horizontal, backward and forward linkages of local firms to MNEs. As mentioned earlier, we also include in the analysis of vertical spillovers the concept of selling to or buying from firms outside of the country, i.e., importing and exporting, since vertical spillovers need not be constrained to linkages with foreign firms within the host country alone. In doing so, we recognize that others have analyzed the link between firm-level innovation and imports or exports.[10] The advantage of our approach derives from the fact that we analyze vertical linkages as sales to multinationals, as well as exports and imports, and that unlike other studies we carry out our analysis on many countries.

Second, we are able to provide much larger comparative evidence on more heterogeneous firms than has been possible in this area to date.[11] Our analysis covers firms in both the service and manufacturing sectors, while existing studies focus on manufacturing. This is important because most of the recent FDI is in services. We are also able to estimate the effects separately for small firms, while much of the existing evidence is for medium and large firms. Being able to cover smaller firms is important because smaller firms tend to be the new entrepreneurs and engines of growth in many emerging market economies. Finally, we also test for differences in spillovers among new and old firms – in our case firms that existed prior to 1990 (before the fall of the communist regime) and those that started afterwards.

[10] These include Bustos (2011), who uses a theoretical model and evidence from Argentine firm-level data to show that firms update technology when faced with the opportunities presented by trade liberalization. Long, Raff and Stahler (2011) also use a theoretical model to show that trade liberalization increases firm-level innovation in a set-up with heterogeneous firms (although they describe innovation in terms of cost-saving R&D). Fernandes and Paunov (2010) use Chilean firm-level data to evidence product innovation or quality upgrades by firms faced with import competition. One other paper examines both directions of causality between innovation and exporting -- Damijan, Kostevc and Polanec (2010) use Slovenian firm-level data to show that exporting leads to productivity improvements, especially for firms that report changes to their production process.

[11] Our analysis includes firm level data from Albania, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Georgia, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Turkey, and Ukraine.

Third, we check the robustness of our base results using a control function approach and find that the base results are quite robust.

We find that FDI and trade have strong positive spillover effects on innovation by domestic firms. However, our results indicate that the spillover effects can be detected with micro data at the firm-level, but using linkage variables computed from I-O tables at the industry level yields much weaker, and usually insignificant, estimated effects. Furthermore, whether we use input-output matrices to calculate immediate linkages to industries with strong foreign presence or to calculate total linkages across industries (based on the inverse of input-output matrices) appears to make relatively little difference for the estimates of the industry-level effects. Thus, the spillover effects on innovation appear to be *localized,* reflecting effect on firms that are directly engaged with multinationals, rather than being *broad-based*, reflecting an effect on all firms in a given industry. Moreover, the strength of estimated spillovers is heterogeneous. For example, spillovers of FDI from more advanced countries (OECD or high productivity countries) are more tangible than spillovers of FDI from less advanced (non-OECD or lower productivity) countries.

The rest of the paper is organized as follows. In Section 2 we describe our data and analytical methodology. In Section 3 we present our findings and we interpret them in the concluding Section 4.

2. Data and Methodology

We use firm-level data from the ORBIS™ and BEEPS data bases.[12] The BEEPs survey was first undertaken in 1999–2000, when it was administered to approximately 4,000 enterprises in 26 countries of Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS) to assess the environment for private enterprise and business development. The second and third rounds of the

[12]The description of the data draws heavily from Synovate (2005), the report from the firm that implemented the BEEPS instrument and provided the EBRD and World Bank with electronic data sets.

BEEPS were implemented in 2002 and 2005 on approximately 6,500 and 9,500 enterprises, respectively, in the same CIS and CEE countries, and expanded to include Turkey from the second round and Turkmenistan from the third round. The 2005 BEEPS survey instrument approximates the coverage, sampling frames and specific questionnaire items of the second round of the BEEPS.[13] For all countries, the BEEPS survey is representative of the private sector at the national level; for some countries it is also representative at the subnational level.[14] Examining individual variables such as markups, one observes that the values reported in BEEPS are largely consistent with values estimated for emerging market economies by De Loecker and Eeckout (2018).

In this paper we use primarily the 2002 and 2005 BEEPS surveys as they contains data on the variables of interest.[15] The original 2005 data base contains a total of 9,655 firms, with 200 – 975 firms per country. The share of firms in services ranges from 50% to 65% across the 28 countries. Between two-thirds and three-quarters of the firms have less than 50 employees. Approximately 10% of the firms are foreign owned and another 10% are state owned. The share of firms that export more than 20% of their output varies widely across countries: from 5% in Kazakhstan to 30% in Slovenia. The 2002 BEEPS has a similar structure and composition.

To construct measures of foreign presence in an industry in a given country, we use information on foreign ownership from the ORBIS database – a global firm-level database constructed by Bureau van Dijk.[16] The ownership data include owner's country of origin (not only whether a firm is foreign-owned), allowing us to identify whether or not foreign ownership is from an OECD economy.

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[13] In order to obtain more detailed information about the data set and the relevant questionnaires, see http://www.ebrd.com/pages/research/analysis/surveys/beeps.shtml.

[14] See http://www.enterprisesurveys.org/methodology or https://ebrd-beeps.com/methodology/.

[15] The reference year for the 2005 BEEPS is actually 2004 and for the 2002 BEEPS it is 2001. However, for ease of exposition, we simply refer to the year of the survey.

[16] http://www.bvdinfo.com/Products/Company-Information/International/ORBIS.aspx. Bureau van Dijk is also responsible for the AMADEUS database, which business and economics scholars have used for more than a decade for Europe-focused firm-level studies. ORBIS is the global superset of AMADEUS. It is arguably the world's largest database of public and private companies, and it distinguishes itself by being the only global dataset that comprehensively identifies parent-subsidiary relationships between firms. (Bureau van Dijk aggregates ownership and financial information from official sources worldwide – primarily using sources like national registers of companies like the United Kingdom's Company

In addition to the ORBIS™ and BEEPS data, we rely on data from I-O tables to construct the industry-wide spillover variables. We are only able to obtain recent I-O tables for 18 of the economies covered by the survey, therefore we focus our analysis on these countries and we pool the 2002 and 2005 survey data.[17] We take the I-O tables from GTAP 7.[18]

The BEEPS sample includes a variety of firms, from very small firms with as few as two employees to larger firms with up to 10,000 employees. Moreover, the data include firms in the rural areas as well as large cities, and firms in industry as well as firms in the service sector, which is the new dynamic (yet understudied) sector in these economies.[19] Hence the data enable us to analyze diverse firms in a large number of countries.

In addition, the data set contains a panel component, where several hundred firms that were surveyed in 2002 were surveyed again in 2005.[20] However, our analysis relies primarily on the pooled 2002 and 2005 data since many variables of interest have a retrospective component in each survey and because it is hard to detect robust relationships with a small panel of heterogeneous firms, especially when we use a number of 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 have well-known limitations as measures of innovation. 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

House, private information services like FAME™, credit analysts like D&B, and the public records of listed companies. By 2010, it covered more than 80 million firms from 180 countries and territories). ORBIS firm-level data coverage overlaps with all the years for which we have BEEPS data –its scope similarly extends to firms of all sizes and industry sectors.

[17] We have attempted to impute values for countries with missing input-output tables by using the average values from the two closest neighboring countries but we have found that such imputation introduced too much noise in the data.

[18] https://www.gtap.agecon.purdue.edu/

[19] According to Fernandes (2009), "During the 1997-2004 period, services represent an increasing share of value-added … in the [Eastern European] region, averaging 46% … remarkable given the underdevelopment of the services sector … during the communist period".

[20] 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%).

processes; and 3) firms often protect their innovations by using methods other than patents (maintaining technological complexity, industrial secrecy, and lead time over competitors). Using R&D expenditures may also be inappropriate because not all innovations are generated by R&D expenditures (Santamaria et al, 2008), R&D does not necessarily lead to innovation (it is an input rather than an output), and formal R&D measures are biased against small firms (Michie, 1998; Archibugi and Sirilli, 2001; Lin et al, 2010). 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 technologies, 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 and adoption of new technologies. Specifically, we use binary variables based on top managers' answers to the question about whether a firm has undertaken any of the following two 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*).

As noted above, since we are studying emerging market economies, it is expected that these two measures of innovation may have some element of imitation or adoption rather than "in house development." From the survey, 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 said this was the way the technology was introduced) or it can be acquired by hiring new personnel (5%) or transferred from elsewhere (universities, business associations, etc., 3%). However, the vast majority (75%) of acquired new technology was embodied in new machinery or equipment that was purchased or licensed from other sources.[21]

[21] 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 similar effects.

The BEEPS data also permit us to control at the firm level for the effects of pressure from foreign and domestic competition. In particular, we use as a control variable each firm's markup, a "sufficient statistic" for the degree of competition.[22]

In addition to providing competition, foreign firms may also transfer capabilities. The BEEPS data permit us to capture the extent of vertical linkages between domestic and foreign firms, which allow transfer of capabilities or "knowledge spillovers." We use three variables for vertical linkages: *SMNE*, the share of a firm's sales to multinational enterprises;[23] *Exports*, the share of sales exported; and *Imports*, the share of "material inputs and supplies" imported.[24] Whereas *SMNE* can be construed as capturing downstream relationships with foreign firms within the country, *Exports* can be viewed as capturing downstream relationships with foreign firms outside the country.

Our estimated specification is

$$
\begin{aligned}
I_{isct} = \Phi\{&\alpha_1 Horizontal_{sct} + \alpha_2 Backward_{sct} + \alpha_3 Forward_{sct} \\
&+\beta_1 SMNE_{isct} + \beta_2 Export_{isct} + \beta_3 Import_{isct} \\
&+\phi_0 FOREIGN_{isct} + \phi_1 SOE_{isct} \\
&+\gamma_0 lnL_{isc,t-3} + \gamma_1 \left(lnL_{isc,t-3}\right)^2 + \gamma_2 Edu_{isc,t-3} \\
&+\gamma_3 Skill_{isc,t-3} + \gamma_5 \log(Age_{isct}) + \gamma_6 CMN_{isct} + \gamma_7 Markup_{isct} \\
&+\gamma_8 CU_{isc,t-3} + \gamma_9 Lopt_{isct} \\
&+ \psi Loc_{isct} + \lambda_s + \vartheta_c + \omega_t + error\} , \qquad (1)
\end{aligned}
$$

where I is a dummy variable equal to one if the firm reported an innovation, and zero otherwise; Φ denotes the cumulative density function of a standard normal random variable; *i, s, c,* and *t* index

[22] Mayer et al. (2014) explore the use of markup as an indicator of competition and justify its use as a sufficient statistic.
[23] A multinational enterprise is defined as a firm with 50% or more foreign ownership.
[24] Note that *Imports* refer to material inputs and supplies rather than imports of machinery and equipment, which could introduce a mechanical correlation between import share and the dependent variable. In fact, in our data the correlation between import share and a dummy variable equal to one if a firm reports machine-embodied innovation is only 0.08.

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 three variables capture industry-level, foreign linkage variables: horizontal, backward and forward. These linkages are common across firms in a given industry, time, and country. We compute them as *direct linkages* and *total linkages*. With A being an I-O matrix, total linkages include direct and indirect effects and are based on the $(I-A)^{-1}$ matrix, while direct linkages do not take into account the indirect multiplier effects and are based only on A. The existing literature uses only the direct linkages. Specifically, we compute the linkages for industry *j* as follows:

$$Forward_j^{total} = \sum_{h \neq j} FP_h \frac{FT_{hj}}{\sum_{k \neq j} FT_{hj}},$$

$$Backward_j^{total} = \sum_{h \neq j} FP_h \frac{BT_{hj}}{\sum_{k \neq j} BT_{hj}},$$

$$FP_j \equiv Horizontal_j^{total} = Horizontal_j^{direct} = \frac{\sum_i Y_i \times ForeignShare_i \times \mathbf{1}(i \in industry_j)}{\sum_i Y_i \times \mathbf{1}(i \in industry_j)},$$

$$Forward_j^{direct} = \sum_{h \neq j} FP_h \frac{A_{hj}}{\sum_{k \neq j} A_{kj}},$$

$$Backward_j^{direct} = \sum_{h \neq j} FP_h \frac{A_{jh}}{\sum_{k \neq j} A_{jk}},$$

where Y_i is a measure of size for firm *i* (we use sales), BT is the Leontief inverse of the I-O matrix A, FT is the Ghosh inverse of the I-O matrix A, $ForeignShare_i$ is the share of foreign ownership in firm *i*, $\mathbf{1}(i \in industry_j)$ is the indicator variable equal to one if firm *i* is in industry *j* and zero otherwise. The key difference between the Leontief and Ghosh inverse matrices is that the former is estimated from an I-O matrix's input coefficients, while the latter uses the output coefficients. Thus, they represent the linkages suggested by a demand-driven and supply-driven model of the economy, respectively.

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).

In addition to sector (λ_s), country (ϑ_c) and year (ω_t) fixed effects, we include the following variables to control for firm-specific factors deemed to be important in the literature:[25]

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.[26]

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

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

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

State Owned Enterprise (*SOE*) is a dummy variable equal to one if the government owns 50% or more of the firm and zero otherwise. This variable is expected to be negatively correlated with

[25] See Becheikh, Landry and Amara (2006) for a review of the literature on innovation.
[26] This variable is probably one of the most studied firm characteristics determining innovation, in part because it also captures one of Schumpeter's (1943) hypotheses.

innovation for a variety of reasons, including a poor system of rewards for innovative activities in these enterprises.

FOREIGN is a dummy variable equal to one if foreigners own 50% or more of the firm and zero otherwise.

CU is capacity utilization. Adding this variable allows us to adjust the effects of the firm size variable(s) with an index of factor-intensity.

Lopt is the optimal size of employment relative to the current employment. (This information was collected from managers as part of the survey). Like *CU*, *Lopt* can be interpreted as a measure of capacity utilization. The expected coefficient sign for *CU* and *Lopt* is ambiguous.

Location (*Loc*) is a set of dummies for size of population where the firm is operating or headquartered. This will control for potential differences in knowledge available in larger v. smaller cities. Appendix Table A1 contains a more detailed description of our variables.

To assess the extent to which the estimated effects are specific to particular settings or nonlinear in key variables, we also separately estimate the basic specification for each of the following subsamples:

Sector: manufacturing, services;

Ownership: private domestic, foreign, and state;

Employment size: 1= 2-10 employees, 2 = 11- 49, 3 = 50-99, 4 = 100+;

Regions: CIS (Commonwealth of Independent States -- Ukraine, Belarus, Armenia, Kazakhstan, Russia), EU (European Union -- Slovenia, Poland, Hungary, Czech Republic, Slovakia, Latvia, Lithuania, Estonia), and SEE (South-Eastern Europe -- Albania, Croatia, Romania, Bulgaria, and Turkey);

Red tape: firms are grouped into three bins based on manager's time spent with official. (1= least time, 3 = most time).

Age: new (founded after 1991), old (founded before 1991), and de-novo (founded after 1991 as a private firms).

3. Empirical Results

In Tables 1 and 2 below, we report the summary statistics. As may be seen from Table 1, our sample covers 18 emerging market economies in the EU, SEE (including Turkey) and the CIS. The sample contains several hundred firms in each country, with larger countries (Kazakhstan, Poland, Romania, Russia, Turkey, and Ukraine) each having more than 800 firms. Croatia has the smallest sample with 291 firms. The mean and standard deviation statistics in Table 2 suggest that the values taken on by the variables used in our analysis are reasonable and display considerable variation. About 38% of the firms report that they introduced a new product, while about 30% have introduced a new technology. Both the total and direct horizontal, forward and backward linkages (common across firms in a given industry, time, and country) take on values in the 0.3 - 0.5 range, while the corresponding linkages with respect to OECD fall in the 0.2 – 0.3 range. The share of sales going to multinational firms averages 0.07, the share of sales exported averages 0.09 and the share of imported inputs in the value of all inputs averages 0.29. The average share of skilled workers is 0.49, while workers with a university education average 27% of the firms' total labor force. About 10% of the firms have majority state ownership, while about 12% have majority foreign ownership. Finally, about 70% of the firms report competing in the national as opposed to only the local market.

3.1 Baseline Estimates

In Tables 3-6, we report the estimated coefficients on the industry-level linkages α and firm-level (micro) linkages β. In these tables we report estimates based on total linkages (using the $(I-A)^{-1}$ matrix), while in the appendix tables we report the corresponding estimates based on direct linkages (using the A matrix). As may be seen from the first row of Table 3, the estimated product innovation

spillovers based on the entire data set for the usual industry-level, input-output linkage variables are all statistically insignificant. This finding is consistent with much of the literature that finds insignificant spillover effects on productivity. In contrast, the corresponding product innovation spillovers based on the firm-level data are all positive and statistically highly significant. Quantitatively these estimates are also substantial. When converted to marginal effects at means, our point estimates on $SMNE, Export$ and $Import$ range from 0.07 to 0.09 and the standard deviations of these variables are between 0.2 and 0.4. Thus, a one standard deviation increase in $SMNE, Export, Import$ can raise our measures of innovation by about 0.015 to 0.030, or approximately 4 to 7 percent, given that the unconditional means of the dependent variables are about 0.3 to 0.4. Our estimates based on both the firm-level and industry-level approaches hence indicate that the industry-level data do not capture the positive innovation spillover effects that can be detected with firm-level data. The two sets of estimates hence suggest that spillovers are isolated to firms engaged with multinational firms rather than affecting all firms in industries with multinationals.

The uniformly positive and statistically significant firm-level spillover effects are also found in Table 3 when we carry out the estimation on the following subsamples of firms: service sector firms, old firms, new firms, state-owned firms, domestic privately-owned firms, firms located in EU countries, and firms in which officials spend considerable time with local officials (i.e., considerable red tape). Moreover, there are several categories of firms in which we find the effect of the share of sales to MNEs to be insignificant, but the effects of the share of sales exported and share of inputs imported to be positive and significant: manufacturing firms, de-novo firms, small and medium-sized firms, MNEs, firms located in SEE, and firms in which officials spend little or only moderate amount of time with officials (low red tape). The positive effect of interacting with foreign firms is hence positive for most types of firms, with manufacturing being the only sector (about one-third of the sampled firms) where a greater share of sales going to MNEs is not associated with greater product innovation. Interestingly,

as may be seen from all the rows of Table 3, when we carry out estimations for the various subsamples of firms, the estimated industry-level linkages are virtually all statistically insignificant,[27] again suggesting that the aggregate analysis based on input-output tables does not capture the effects found with firm-level data. Finally, as may be seen from the Appendix Table A2, the estimates based on direct linkages are similar to those based on total linkages.

The finding that industry-level estimates of product innovation spillovers are statistically insignificant has led us to explore this interesting issue further. In particular, in Table 3A we present estimates from specifications where we exclude the firm-level linkage variables from the regressions. We find that excluding the firm-level linkages leaves the estimated industry-level linkages virtually unaffected. Moreover, when we leave out the firm-level linkages and aggregate the innovation variable to the industry level (i.e., when we estimate with industry-level data) in Table 3B, we again find similar results. The results could also be affected by not including capital stock and purchases of intermediate inputs as control variables. We do not include these regressors in the base specification because approximately one-half of the firms in the sample do not report values for these variables. However, when we include these control variables, the results (reported in Appendix Table A6) are similar to those obtained with the full sample. Finally, the question arises as to whether a "horse race" between the industry- and firm-level linkages is fair, given that at the industry level we use only one piece of information (ownership share of foreign firms), while at the firm level we use three pieces (MNE sales, export and import shares). We agree that the amount of variation for industry-level linkages may be smaller than for firm-level linkages, but this is a key reason why firm-level, cross-country analyses like ours are important -- they may exploit more variation in the data and lead to more precise estimates. We also note that while the three variables at the industry level are not perfectly correlated (because the I-O tables are not symmetric), we agree that one may be concerned that the comparison is unfair as long as the correlation across industry-level linkages is

[27] Of the many estimated coefficients in the first three columns of Table 3, only 8 are significant and two of these are negative.

higher than across firm-level linkages. We address this issue by reporting in columns (8) and (10) of Table 3 F-tests of the hypothesis that coefficients on a given type of linkages are jointly equal to zero.[28] As may be seen from the table, even these tests do not overturn our conclusion that statistically the firm-level linkages are much stronger predictors of product innovation than industry-level linkages. Hence, our results are quite robust.

Our findings with respect to the adoption of new technology are similar to those obtained for developing a new product. Using the total linkage method, we find in Table 4 that the estimated spillovers based on the firm-level micro data are all positive and statistically highly significant for the sample of all firms, as well as for the subsamples of manufacturing firms, service sector firms, old firms, domestic private firms, and firms whose managers do not spend much time with officials. Our firm-level technology innovation findings are hence even stronger than our corresponding findings with respect to product innovation in that manufacturing firms register a positive spillover effect not only with respect to exporting and importing, but also with respect to supplying the locally based MNEs. Firms in a number of other subsamples generate significant positive effects with respect to exporting and importing, but insignificant effects with respect to sales to MNEs: new firms, de-novo firms, firms that spend a moderate amount of time with officials, and firms operating in SEE and CIS. In contrast, large firms, state-owned firms and firms operating the EU countries benefit from selling to MNEs and exporting, but not from linkages derived from importing inputs. As before, spillovers based on industry-level variables are mostly insignificant.[29] This finding is again consistent with much of the literature that finds insignificant spillover effects on productivity. Finally, the estimates based on direct linkages, reported in Table A3, are similar.

As we did with product innovation, we have also estimated the technology innovation regressions with the firm-level linkage variables excluded from the regressions. As may be seen from

[28] Intuitively, a high correlation between regressors may make individual coefficients on these regressors statistically insignificant (because of collinearity) but the F-test is immune to this issue because it tests the joint predictive power of regressors.
[29] Of the few that are statistically significant, most are negative.

Table 4A, excluding the firm-level linkages leaves the estimates of industry-level linkages virtually unaffected. Moreover, when we leave out the firm-level linkages and aggregate the technology innovation variable to the industry level (i.e., when we estimate with industry-level data) in Table 4B, we again find similar results. When we estimate on a smaller sample of firms by including in the regression capital stock and purchases of intermediate inputs as control variables, we obtain estimates (reported in Appendix Table A7) that are similar to those recorded with the full sample. Finally, when we report in columns (8) and (10) of Table 4 F-tests of the hypothesis that coefficients on a given type of linkages are jointly equal to zero, we again find that these tests do not overturn our conclusion that statistically the firm-level linkages are much stronger predictors of product innovation than the industry-level linkages.

Overall, our findings in Tables 3, 3A-3B, 4, and 4A-4B indicate that firm-level linkages are better predictors of innovation than industry-level linkages, suggesting that spillovers are limited to local firms that are engaged with MNEs and trade. Our findings also suggest that some of the earlier studies reporting significant industry-level relationships for a given country may have identified specific cases that do not necessarily generalize to other countries.

3.2 Spillovers by the Source of FDI

One may hypothesize that the potential for spillovers differs depending on whether FDI comes from a similar or very different country in terms of development and hence productivity. In Table 5 we present the estimated product innovation spillovers when we distinguish whether foreign presence is from OECD or non-OECD countries. As may be seen from the table, the firm-level micro linkage effects, which cannot distinguish OECD vs. non-OECD FDI effects, are virtually identical to those found earlier. The industry-level estimates may be split by OECD vs. non-OECD origin and they suggest that the presence of OECD firms, as compared to non-OECD firms, has a positive horizontal linkage effect in the sample

of all firms, as well as in subsamples of firms that operate in the service sector or are new, large, in domestic private ownership, or in CIS. The backward OECD linkages are all insignificant except for the service sector firms where one finds a significant positive linkage effect of OECD as well as non-OECD firms, and the backward OECD linkage effect of firms in the EU countries, where one finds a surprisingly negative effect. The forward OECD linkage effects are all insignificant except for a positive effect in firms operating in the European Union. It is notable that the presence of non-OECD firms has a negative horizontal linkage effect on very small firms and a positive backward linkage effect on firms in the service sector and on large firms. The corresponding direct linkage effects, reported in Appendix Table A4, are similar for OECD horizontal linkages but they suggest that a number of OECD backward linkages and forward non-OECD linkages are positive and few are also negative. These findings suggest that relying on the direct linkage effects may provide an incomplete picture.

The corresponding estimated technology innovation spillovers that distinguish between foreign presence from OECD and non-OECD countries are reported in Table 6. The firm-level linkage effects that cannot be split between OECD and non-OECD FDI presence are again strong and similar to those found for technology innovation earlier. Unlike in the case of product innovation, the estimated technology innovation spillovers at the industry-level suggest that the presence of non-OECD firms has a negative horizontal linkage effect in the sample of all firms, as well as in several specific subsamples of firms: firms operating in the service sector, firms that are old, medium-sized firms, SOEs, foreign owned firms, privately owned firms, firms that spend moderate amount of time with officials, and firms in SEE. The difference is that there are now more subsamples of firms where one detects a positive horizontal spillover effect of OECD presence: firms that operate in the service sector, are small, have domestic private ownership, and spend moderate amount of time with officials. We also find a positive backward linkage effect associated with the presence of OECD firms in the sample of all firms, as well as the subsamples of firms in the service sector, old firms, micro, medium-sized and large firms,

SOEs, and firms that spend moderate amount of time with officials. In all these cases except for the medium-sized firms, the base effect of non-OECD foreign presence is insignificant rather than negative. Finally, the forward linkages associated with both OECD and non-OECD firms' presence are mostly insignificant or negative, with the exception of a positive non-OECD linkage of firms in SEE. In terms of direct technology innovation spillovers, we show in Appendix Table A5 that these estimates are somewhat similar to those based on total linkages in the case of horizontal spillovers, but they differ considerably from total linkage effects with respect to forward and backward spillovers. This result strengthens our earlier finding that firm-level spillover effects are more consistent than the partial or direct industry-level effects common in the literature.

In order to check the robustness of the above results we have also used country-level TFP from Penn World Tables to group linkages into those relating to countries that are close vs. far apart in terms of TFP. For example, we normalize TFP=1 in the US and find that it is 0.36 for Russia and 0.23 for Ukraine. Accordingly, we classify American FDI into Ukraine as being long-distance and FDI from Russia into Ukraine as being short-distance. Using this approach, we split source countries into long- and short- distance, making the approach comparable to the OECD vs. non-OECD split. We find that this alternative approach does not have a material effect on the estimates, the reason being that the classification of FDI is similar, with low productivity OECD countries (e.g., Portugal) having relatively little FDI in the transition economies.

3.3 Further Robustness Tests – A Control Function Approach

In the previous sections, we have documented an interesting set of patterns for the sample as a whole and for a number of subsamples. However, these patterns do not necessarily imply causal relationships, which

are difficult to establish in observational studies. A major concern in our context is that we may be omitting factors that potentially limit the growth of firms and thus also their incentives to innovate.[30]

To address this concern, we employ the control function approach in which we use proxies to control for potentially omitted factors that might bias the estimated linkage effects. The main advantage of using this approach is that BEEPS provides a rich set of proxies that enable us to rule out a number of alternative explanations. In particular, we use each firm's self-reported assessment of a large number of potentially limiting factors, ranging from constraints imposed on the firms by corruption to regulation, taxes, and electricity problems. Our approach is to add to our basic specification an additional regressor capturing a particular omitted factor. Ideally, we would like to include all of these potentially important controls simultaneously. However, since many variables have missing observations or are collected only in one of the BEEPS waves, including all variables would shrink the sample size dramatically. As a result, we include variables one at a time. However, even if we include many controls simultaneously, our results do not change materially.

The estimated coefficients of the augmented specification for a new product innovation are reported in Table 7, while those for a new technology innovation are reported in Table 8. We first explore if factors related to problems with various aspects of infrastructure (telecommunications, electricity, transportation, access to land, and title or leasing of land) lower the firm's ability to innovate via its industry-level and firm-specific linkages. We find that these factors have no effect in that the estimated linkages are very similar to those found in our original specification. We obtain the same result when we construct an index of limiting factors (*average score*). We next estimate augmented specifications that

[30] In the absence of an exogenous shock that we could use for identification, we spent considerable amount of time trying to find valid instrumental variables. In doing so, we considered three candidates for instrumental variables. The first two instruments were (i) self-reported constraints imposed by transportation difficulties and (ii) custom and trade regulations. Both of these constraints are likely to limit long distance trade, thus making it more likely that MNEs wishing to sell in the country will open plants in the country and domestic firms will supply and purchase from the MNEs, as well as compete with them. The third instrumental variable was based on how important business associations and chambers are in finding suppliers. It may be expected that if firms use business associations and chambers, they are more likely to find a foreign firm than if they use more proximate channels (friends, family, government, and former employees). We found using these instrumental variables yields the same qualitative conclusions although the effects are imprecisely estimated.

control, alternatively, for tax rates and tax administration, various forms of regulation, skills and education of the labor force, economic uncertainty and instability, corruption and crime, anti-competitive practices and contract violations, education of a manager, indebtedness, productivity, access to and cost of finance, quality of courts, information about suppliers and customers, unofficial payments and tax reporting, various forms of competitive and customer pressures, and experience with lost electric power, water, and phone connection, as well as lost products due to breakage, spoilage or theft while in transit.[31] Each of these factors may arguably co-vary with the linkages and including these factors as regressors could in principle reduce the significance of our estimated effects of linkages on innovation. We show that controlling for each of these factors has no effect on our baseline results. Only in three of the forty two regressions that we estimate in Table 7 and in one of the forty two regressions that we estimate in Table 8 does the coefficient on the share of sales to MNEs become marginally insignificant. All the other 249 firm-specific linkage coefficients remain significant. Hence, the robustness of the baseline estimates to this large battery of control function tests is remarkable and it suggests that we could be indeed identifying a causal relationship.

4. Conclusions

Using large firm-level and industry-level data sets from 18 countries, we find that FDI and trade have strong positive spillover effects on innovation by domestic firms in emerging markets. However, we find that the spillover effects can be detected with micro data at the firm-level, but that using linkage variables computed from input-output tables at the industry level yields much weaker, and usually insignificant, estimated effects. Furthermore, there is generally little difference in whether the industry-level spillover effect is computed as a direct effect based on the input-output matrix (the usual approach in the literature) or as a total effect based on the inverses of input-output matrices.

[31] Lost power, phone and water are measured in days. Lost product is measured as percent of sales.

These patterns are consistent with spillover effects being rather proximate. In other words, spillover effects on innovation from foreign firms to domestic firms appear to be limited to domestic firms immediately connected to foreign firms. Simply being in an industry populated by foreign firms or an industry buying from or selling to industries with strong foreign presence generally has a weak, if any, effect on innovation. An immediate policy implication of these findings is that local government requirements that foreign firms have significant local content (i.e., a certain fraction of value added or inputs having to be local) may make sense.

We also document heterogeneity in the strength of the effect across sources of foreign presence. Our firm-level data do not permit us to distinguish between the effects of FDI from more advanced (OECD) and less advanced (non-OECD) countries, but we are able to do so at the level of the industry (input-output) linkages. Our estimates suggest that the presence of OECD firms, as compared to non-OECD firms, has a positive horizontal linkage effect on product innovation in the sample of all firms, as well as in subsamples of various types of firms. The backward OECD linkages are all insignificant except for the service sector firms where one finds a significant positive linkage effect of OECD as well as non-OECD firms, and the backward OECD linkage effect of firms in the EU countries, where one finds a surprisingly negative effect. The forward OECD linkage effects are all insignificant except for a positive effect in firms operating in EU. It is notable that the presence of non-OECD firms has a negative horizontal linkage effect on very small firms and a positive backward linkage effect on firms in the service sector and on large firms. Unlike in the case of product innovation, the estimated technology innovation spillovers at the industry-level suggest that the presence of non-OECD firms has a negative horizontal linkage effect in the sample of all firms, as well as in several specific subsamples of firms.

Our results have important implications for interpreting the existing literature, which has focused on the effects of FDI and trade on (total factor) productivity rather than on innovation, has tended to use the industry-level rather than firm-level measures of horizontal and vertical linkages, and usually used

data from a single country. Since measured productivity (a) captures the effects of both market power and efficiency (rather than just efficiency) of firms, (b) is a noisy outcome variable, and (c) suffers from endogeneity problems in estimation, our focus on innovation provides potentially more direct estimates of the true effects of foreign presence on the performance of local firms.

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Table 1: Distribution of observations by country

Country	N. obs.	Percent
Albania	318	2.85
Armenia	495	4.43
Belarus	542	4.85
Bulgaria	514	4.60
Croatia	291	2.60
Czech Republic	512	4.58
Estonia	311	2.78
Hungary	805	7.20
Kazakhstan	804	7.19
Latvia	330	2.95
Lithuania	350	3.13
Poland	1,386	12.40
Romania	789	7.06
Russia	1,014	9.07
Slovakia	346	3.10
Slovenia	375	3.36
Turkey	975	8.72
Ukraine	1,018	9.11
Total	11,175	100.00

Table 2: Descriptive statistics

Variable	Mean	St.Dev.
New good	0.379	0.485
New technology	0.302	0.459
Horizontal linkage (direct)	0.384	0.299
Backward linkage (direct)	0.394	0.237
Forward linkage (direct)	0.378	0.231
Horizontal linkage (total)	0.384	0.299
Backward linkage (total)	0.424	0.245
Forward linkage (total)	0.376	0.227
Horizontal linkage (direct, OECD)	0.203	0.213
Backward linkage (direct, OECD)	0.214	0.167
Forward linkage (direct, OECD)	0.203	0.156
Horizontal linkage (total, OECD)	0.203	0.213
Backward linkage (total, OECD)	0.231	0.170
Forward linkage (total, OECD)	0.199	0.149
Share of sales to MNES	0.073	0.201
IMPORT	0.290	0.370
EXPORT	0.091	0.216
LnL	3.194	1.632
Share of skilled workers	0.489	0.310
Share of workers with a university education	0.274	0.293
Markup	0.214	0.134
Age (log years)	2.367	0.770
Optimal size of employment relative to the current employment	107.328	30.135
Capacity utilization	0.798	0.204
State ownership (dummy)	0.104	0.305
Foreign ownership (dummy)	0.128	0.334
Compete in national markets (dummy)	0.705	0.456

Table 3: New Product (total linkages)

Sample	Industry-level linkages			Firm-level linkages				Industry-level linkages		Firm-level linkages	
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	Number of observations	F-test	p-value	F-test	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
All Firms	0.098	0.459	-0.134	0.191***	0.246***	0.235***	11,651	6.658	0.084	76.215	0.000
	(0.095)	(0.407)	(0.494)	(0.067)	(0.034)	(0.066)					
Manufacturing	0.105	-0.491	1.049**	0.073	0.259***	0.214***	3,915	7.442	0.059	25.593	0.000
	(0.138)	(0.438)	(0.482)	(0.106)	(0.063)	(0.090)					
Services	0.116	1.882***	-1.775**	0.314***	0.206***	0.237**	6,299	9.040	0.029	39.441	0.000
	(0.133)	(0.670)	(0.851)	(0.097)	(0.042)	(0.110)					
New firms	0.052	0.534	-0.227	0.148*	0.176***	0.184***	8,539	3.507	0.320	33.748	0.000
	(0.103)	(0.508)	(0.612)	(0.081)	(0.039)	(0.078)					
Old firms	0.185	0.518	-0.190	0.302***	0.445***	0.347***	3,110	3.917	0.271	44.355	0.000
	(0.189)	(0.573)	(0.657)	(0.115)	(0.082)	(0.116)					
De-novo firms	0.120	0.652	-0.347	0.108	0.160***	0.261***	6,341	4.327	0.228	23.934	0.000
	(0.117)	(0.557)	(0.665)	(0.099)	(0.046)	(0.104)					
Labor size: 2-10 employees	-0.047	0.591	0.031	0.181	0.251***	0.509***	4,684	6.852	0.077	42.713	0.000
	(0.123)	(0.613)	(0.717)	(0.141)	(0.054)	(0.143)					
Labor size: 11-49 employees	0.197	-0.176	0.065	0.127	0.268***	0.205*	3,498	1.233	0.745	18.855	0.000
	(0.182)	(0.710)	(0.844)	(0.109)	(0.071)	(0.120)					
Labor size: 50-100 employees	-0.209	1.096	-0.710	0.292	-0.007	0.223	1,204	2.824	0.419	4.059	0.255
	(0.239)	(1.065)	(1.321)	(0.186)	(0.122)	(0.177)					
Labor size: 100+ employees	0.405***	1.012	-0.534	0.281***	0.345***	0.181	2,252	12.201	0.007	25.040	0.000
	(0.150)	(0.619)	(0.694)	(0.116)	(0.088)	(0.121)					
State owned only	-0.163	1.145	-0.446	0.452**	0.281**	0.415*	1,205	3.730	0.292	13.226	0.004
	(0.235)	(1.104)	(1.283)	(0.204)	(0.137)	(0.238)					
Foreign owned only	-0.096	-0.782	0.729	0.122	0.219***	0.241*	1,491	1.292	0.731	9.733	0.021
	(0.242)	(0.808)	(0.973)	(0.144)	(0.091)	(0.127)					
Priv. domestic owned only	0.189*	0.586	-0.246	0.173**	0.252***	0.247***	8,971	9.745	0.021	59.011	0.000
	(0.102)	(0.501)	(0.602)	(0.089)	(0.039)	(0.081)					
Time spent with officials: low	0.131	0.978	-1.078	0.158	0.218***	0.196*	4,311	2.978	0.395	21.001	0.000
	(0.164)	(0.686)	(0.831)	(0.112)	(0.057)	(0.112)					
Time spent with officials: med	0.015	0.141	0.435	0.095	0.239***	0.267***	3,791	6.029	0.110	27.140	0.000
	(0.128)	(0.552)	(0.658)	(0.111)	(0.062)	(0.098)					
Time spent with officials: high	0.030	-0.236	0.923	0.389***	0.227***	0.334***	2,836	3.569	0.312	28.612	0.000
	(0.162)	(0.646)	(0.819)	(0.134)	(0.070)	(0.129)					
CIS	0.343*	-0.041	0.157	0.109	0.312***	0.063	3,870	5.396	0.145	27.019	0.000
	(0.180)	(0.596)	(0.866)	(0.144)	(0.062)	(0.134)					
EU	-0.030	-0.631	1.475*	0.263***	0.163***	0.244***	4,411	15.962	0.001	23.097	0.000
	(0.151)	(0.781)	(0.788)	(0.100)	(0.051)	(0.095)					
SEE	-0.434*	1.581	-1.165	0.068	0.243***	0.374***	2,388	3.721	0.293	20.177	0.000
	(0.248)	(1.385)	(1.291)	(0.145)	(0.075)	(0.147)					

Notes: the table reports estimated coefficients for specification (1) with *New Product* indicator variable as the regressand. Standard errors clustered by industry × country × year are reported in parentheses. Columns (8)-(11) report F-stats and associated p-values for the hypothesis that coefficients on industry-level linkages (columns 1-3) or coefficients on firm-level linkages (columns 4-6) are jointly equal to zero. ***, **, * denote statistical significance at 1, 5 and 10 percent.

Table 3A: New Product (total linkages), exclude firm-level linkages

Sample	Industry-level linkages			Number of observations
	Horizontal	Backward	Forward	
	(1)	(2)	(3)	(4)
All Firms	0.086	0.453	-0.114	12,464
	(0.087)	(0.386)	(0.463)	
Manufacturing	0.117	-0.414	0.994**	4,150
	(0.132)	(0.414)	(0.462)	
Services	0.074	1.669***	-1.470*	6,814
	(0.120)	(0.628)	(0.786)	
New firms	0.044	0.656	-0.307	9,150
	(0.094)	(0.487)	(0.577)	
Old firms	0.161	0.127	0.161	3,312
	(0.171)	(0.551)	(0.628)	
De-novo firms	0.084	0.791	-0.450	6,770
	(0.108)	(0.536)	(0.635)	
Labor size: 2-10 employees	-0.084	0.480	0.053	4,995
	(0.117)	(0.587)	(0.687)	
Labor size: 11-49 employees	0.180	-0.115	0.115	3,707
	(0.191)	(0.680)	(0.806)	
Labor size: 50-100 employees	-0.160	0.672	-0.210	1,303
	(0.215)	(0.986)	(1.232)	
Labor size: 100+ employees	0.346***	1.114*	-0.506	2,449
	(0.138)	(0.581)	(0.647)	
State owned only	-0.182	0.884	-0.230	1,317
	(0.221)	(0.973)	(1.117)	
Foreign owned only	-0.220	-0.569	0.665	1,663
	(0.216)	(0.753)	(0.874)	
Priv. domestic owned only	0.193**	0.587	-0.251	9,501
	(0.095)	(0.493)	(0.588)	
Time spent with officials: low	0.075	0.805	-0.718	4,609
	(0.152)	(0.680)	(0.807)	
Time spent with officials: med	0.017	0.276	0.256	4,051
	(0.122)	(0.531)	(0.636)	
Time spent with officials: high	0.015	-0.354	1.049	3,030
	(0.152)	(0.596)	(0.755)	
CIS	0.246	-0.010	0.223	4,037
	(0.173)	(0.561)	(0.825)	
EU	-0.010	-0.852	1.629**	4,733
	(0.145)	(0.728)	(0.732)	
SEE	-0.220	1.471	-1.091	2,644
	(0.237)	(1.330)	(1.266)	

Notes: the table replicates Table 3 in the paper but the set of regressors excludes firm-level linkages.

Table 3B: New Product (total linkages), exclude firm-level linkages and aggregate to industry level

Sample	Industry-level linkages			Number of observations
	Horizontal	Backward	Forward	
	(1)	(2)	(3)	(4)
All Firms	-0.005	0.159	-0.013	740
	(0.028)	(0.133)	(0.156)	
Manufacturing	0.019	-0.170	0.413**	455
	(0.056)	(0.174)	(0.180)	
Services	-0.025	0.528***	-0.439	205
	(0.040)	(0.211)	(0.267)	
New firms	0.000	0.232*	-0.131	693
	(0.026)	(0.137)	(0.166)	
Old firms	0.017	0.184	-0.072	569
	(0.031)	(0.157)	(0.183)	
De-novo firms	0.006	0.334**	-0.271	605
	(0.027)	(0.145)	(0.178)	
Labor size: 2-10 employees	-0.022	0.400***	-0.356*	507
	(0.029)	(0.164)	(0.187)	
Labor size: 11-49 employees	-0.039	0.061	0.074	548
	(0.029)	(0.140)	(0.179)	
Labor size: 50-100 employees	0.010	-0.018	0.219	383
	(0.033)	(0.183)	(0.212)	
Labor size: 100+ employees	0.057*	0.297*	-0.113	594
	(0.034)	(0.160)	(0.197)	
State owned only	-0.017	-0.042	0.274	533
	(0.036)	(0.161)	(0.194)	
Foreign owned only	0.016	0.070	0.088	473
	(0.039)	(0.161)	(0.190)	
Priv. domestic owned only	0.000	0.198	-0.113	659
	(0.026)	(0.144)	(0.173)	
Time spent with officials: low	0.005	0.285*	-0.255	540
	(0.034)	(0.150)	(0.188)	
Time spent with officials: med	0.001	0.077	0.073	593
	(0.030)	(0.148)	(0.179)	
Time spent with officials: high	-0.026	0.189	0.006	511
	(0.034)	(0.162)	(0.197)	
CIS	0.077	0.034	0.052	200
	(0.071)	(0.236)	(0.351)	
EU	-0.040	-0.464**	0.641***	296
	(0.050)	(0.231)	(0.226)	
SEE	0.085	0.652	-0.709*	197
	(0.107)	(0.412)	(0.392)	

Notes: the table replicates Table 3 in the paper but the set of regressors excludes firm-level linkages and the unit of observation is country/industry/year cell.

Table 4: New technology (total linkages)

Sample	Industry-level linkages			Firm-level linkages				Industry-level linkages		Firm-level linkages	
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	Number of observations	F-test	p-value	F-test	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
All Firms	-0.046	0.341	-0.586	0.190***	0.272***	0.187***	11,570	3.258	0.354	73.898	0.000
	(0.108)	(0.328)	(0.415)	(0.065)	(0.041)	(0.064)					
Manufacturing	0.158	0.009	-0.063	0.182*	0.253***	0.210***	3,888	0.822	0.844	28.783	0.000
	(0.179)	(0.514)	(0.583)	(0.099)	(0.075)	(0.088)					
Services	-0.037	0.487	-0.833	0.186**	0.257***	0.179*	6,260	2.644	0.450	34.593	0.000
	(0.139)	(0.449)	(0.619)	(0.091)	(0.051)	(0.100)					
New firms	0.019	-0.018	-0.415	0.071	0.225***	0.194***	8,474	4.338	0.227	37.776	0.000
	(0.112)	(0.429)	(0.549)	(0.077)	(0.046)	(0.079)					
Old firms	-0.224	1.449***	-1.189*	0.452***	0.399***	0.225**	3,096	6.649	0.084	54.338	0.000
	(0.198)	(0.609)	(0.711)	(0.115)	(0.079)	(0.117)					
De-novo firms	0.040	-0.474	0.247	0.054	0.180***	0.173*	6,294	2.230	0.526	16.395	0.001
	(0.125)	(0.535)	(0.670)	(0.095)	(0.053)	(0.099)					
Labor size: 2-10 employees	0.100	-0.360	0.205	0.229*	0.243***	0.256	4,658	1.203	0.752	26.421	0.000
	(0.140)	(0.640)	(0.736)	(0.130)	(0.056)	(0.174)					
Labor size: 11-49 employees	0.048	-0.483	0.125	-0.087	0.219***	0.368***	3,482	2.460	0.483	19.337	0.000
	(0.193)	(0.600)	(0.770)	(0.120)	(0.079)	(0.118)					
Labor size: 50-100 employees	-0.131	3.055***	-2.771**	0.386**	0.248*	0.192	1,188	10.183	0.017	11.328	0.010
	(0.236)	(1.050)	(1.241)	(0.171)	(0.135)	(0.160)					
Labor size: 100+ employees	-0.132	1.466***	-1.818***	0.407***	0.448***	0.161	2,234	6.989	0.072	41.488	0.000
	(0.169)	(0.605)	(0.777)	(0.132)	(0.092)	(0.109)					
State owned only	-0.285	0.467	-0.700	0.434**	0.590***	0.180	1,200	2.688	0.442	25.515	0.000
	(0.218)	(0.974)	(1.189)	(0.201)	(0.134)	(0.223)					
Foreign owned only	-0.229	0.467	-1.168	0.083	0.370***	0.158	1,472	7.195	0.066	13.675	0.003
	(0.222)	(0.741)	(0.892)	(0.141)	(0.110)	(0.130)					
Priv. domestic owned only	0.097	0.250	-0.451	0.233***	0.225***	0.263***	8,917	1.252	0.741	47.710	0.000
	(0.114)	(0.431)	(0.530)	(0.079)	(0.047)	(0.082)					
Time spent with officials: low	-0.116	0.649	-1.188	0.250**	0.216***	0.281**	4,272	5.929	0.115	21.133	0.000
	(0.155)	(0.626)	(0.753)	(0.117)	(0.067)	(0.127)					
Time spent with officials: med	0.059	0.817	-0.753	0.133	0.371***	0.215**	3,771	2.499	0.475	40.607	0.000
	(0.147)	(0.602)	(0.747)	(0.114)	(0.065)	(0.112)					
Time spent with officials: high	-0.148	-0.805	0.519	0.169	0.252***	0.130	2,815	5.212	0.157	11.899	0.008
	(0.165)	(0.596)	(0.749)	(0.131)	(0.080)	(0.143)					
CIS	-0.390**	0.506	-0.822	0.028	0.371***	0.241**	3,848	9.157	0.027	38.636	0.000
	(0.173)	(0.545)	(0.831)	(0.134)	(0.069)	(0.120)					
EU	-0.141	-0.281	0.032	0.283***	0.190***	0.040	4,384	2.711	0.438	19.424	0.000
	(0.145)	(0.805)	(0.786)	(0.100)	(0.062)	(0.098)					
SEE	-0.803***	-1.293	1.601*	0.134	0.251***	0.339***	2,379	12.732	0.005	14.243	0.003
	(0.253)	(0.958)	(0.965)	(0.127)	(0.090)	(0.140)					

Notes: the table reports estimated coefficients for specification (1) with *New Technology* indicator variable as the regressand. Standard errors clustered by industry × country × year are reported in parentheses. Columns (8)-(11) report F-stats and associated p-values for the hypothesis that coefficients on industry-level linkages (columns 1-3) or coefficients on firm-level linkages (columns 4-6) are jointly equal to zero. ***, **, * denote statistical significance at 1, 5 and 10 percent.

Table 4A: New technology (total linkages), exclude firm-level linkages

Sample	Industry-level linkages			Number of observations
	Horizontal	Backward	Forward	
	(1)	(2)	(3)	(4)
All Firms	-0.031	0.309	-0.619	12,378
	(0.098)	(0.326)	(0.409)	
Manufacturing	0.165	0.003	-0.178	4,123
	(0.173)	(0.528)	(0.594)	
Services	-0.026	0.467	-0.884	6,770
	(0.132)	(0.430)	(0.582)	
New firms	0.046	-0.030	-0.474	9,082
	(0.103)	(0.417)	(0.529)	
Old firms	-0.245	1.299**	-1.126*	3,296
	(0.183)	(0.576)	(0.672)	
De-novo firms	0.080	-0.377	0.017	6,720
	(0.119)	(0.513)	(0.636)	
Labor size: 2-10 employees	0.108	-0.171	-0.070	4,967
	(0.126)	(0.606)	(0.707)	
Labor size: 11-49 employees	0.085	-0.634	0.202	3,687
	(0.187)	(0.589)	(0.761)	
Labor size: 50-100 employees	-0.156	2.557***	-2.210*	1,285
	(0.233)	(0.987)	(1.170)	
Labor size: 100+ employees	-0.117	1.289**	-1.680**	2,429
	(0.155)	(0.575)	(0.727)	
State owned only	-0.284	0.763	-0.921	1,310
	(0.218)	(0.916)	(1.106)	
Foreign owned only	-0.338*	0.340	-1.024	1,643
	(0.187)	(0.716)	(0.861)	
Priv. domestic owned only	0.137	0.207	-0.487	9,445
	(0.104)	(0.423)	(0.515)	
Time spent with officials: low	-0.095	0.611	-1.104	4,563
	(0.145)	(0.602)	(0.717)	
Time spent with officials: med	0.047	0.687	-0.714	4,028
	(0.132)	(0.571)	(0.706)	
Time spent with officials: high	-0.164	-0.837	0.492	3,007
	(0.154)	(0.577)	(0.721)	
CIS	-0.375**	0.502	-0.904	4,015
	(0.166)	(0.557)	(0.850)	
EU	-0.184	-0.729	0.404	4,702
	(0.138)	(0.795)	(0.788)	
SEE	-0.519**	-1.208	1.146	2,634
	(0.225)	(0.904)	(0.954)	

Notes: the table replicates Table 4 in the paper but the set of regressors excludes firm-level linkages.

Table 4B: New technology (total linkages), exclude firm-level linkages and aggregated to industry level

Sample	Industry-level linkages			Number of observations
	Horizontal	Backward	Forward	
	(1)	(2)	(3)	(4)
All Firms	-0.039	0.034	-0.092	739
	(0.029)	(0.116)	(0.142)	
Manufacturing	0.064	-0.119	0.080	454
	(0.080)	(0.223)	(0.228)	
Services	-0.031	0.071	-0.167	205
	(0.026)	(0.114)	(0.151)	
New firms	-0.025	0.034	-0.165	692
	(0.026)	(0.110)	(0.139)	
Old firms	-0.038	0.066	-0.148	568
	(0.029)	(0.126)	(0.149)	
De-novo firms	-0.027	0.024	-0.154	605
	(0.026)	(0.108)	(0.136)	
Labor size: 2-10 employees	-0.012	-0.010	-0.109	506
	(0.027)	(0.124)	(0.146)	
Labor size: 11-49 employees	-0.046	0.046	-0.136	548
	(0.032)	(0.120)	(0.154)	
Labor size: 50-100 employees	-0.030	-0.006	-0.102	383
	(0.037)	(0.161)	(0.197)	
Labor size: 100+ employees	-0.030	0.119	-0.193	593
	(0.034)	(0.130)	(0.169)	
State owned only	-0.096***	0.009	0.081	533
	(0.040)	(0.170)	(0.217)	
Foreign owned only	-0.010	0.033	-0.187	472
	(0.035)	(0.143)	(0.183)	
Priv. domestic owned only	-0.021	0.021	-0.142	658
	(0.026)	(0.111)	(0.136)	
Time spent with officials: low	-0.064**	-0.099	0.028	540
	(0.030)	(0.126)	(0.152)	
Time spent with officials: med	0.014	0.179	-0.344***	593
	(0.030)	(0.113)	(0.140)	
Time spent with officials: high	-0.071***	-0.061	-0.054	510
	(0.030)	(0.140)	(0.180)	
CIS	-0.083	0.096	-0.254	200
	(0.071)	(0.190)	(0.277)	
EU	-0.099**	-0.021	0.064	296
	(0.044)	(0.258)	(0.251)	
SEE	-0.021	-0.548	0.328	197
	(0.109)	(0.432)	(0.438)	

Notes: the table replicates Table 4 in the paper but the set of regressors excludes firm-level linkages and the unit of observation is country/industry/year cell.

Table 5. New Product – OECD vs. non-OECD foreign presence (total linkages)

Sample	Industry-level linkages						Firm-level linkages			Number of observations
	Non-OECD			OECD						
	Horizontal	Backward	Forward	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All Firms	-0.133	0.420	0.126	0.235**	0.679	-0.494	0.188***	0.246***	0.238***	11,651
	(0.135)	(0.508)	(0.673)	(0.112)	(0.539)	(0.675)	(0.067)	(0.034)	(0.066)	
Manufacturing	-0.022	-0.292	1.065*	0.154	-0.702	1.093	0.070	0.259***	0.214***	3,915
	(0.202)	(0.526)	(0.604)	(0.157)	(0.731)	(0.837)	(0.106)	(0.063)	(0.090)	
Services	-0.290	2.143***	-1.867	0.385***	1.932***	-1.767	0.308***	0.204***	0.245**	6,299
	(0.205)	(0.916)	(1.349)	(0.148)	(0.813)	(1.084)	(0.097)	(0.041)	(0.110)	
New firms	-0.252	0.572	-0.050	0.231*	0.710	-0.499	0.144*	0.176***	0.190***	8,539
	(0.174)	(0.663)	(0.875)	(0.126)	(0.616)	(0.799)	(0.081)	(0.039)	(0.078)	
Old firms	0.081	0.425	0.125	0.245	0.763	-0.645	0.301***	0.444***	0.346***	3,110
	(0.248)	(0.694)	(0.844)	(0.236)	(0.921)	(1.160)	(0.115)	(0.082)	(0.116)	
De-novo firms	-0.062	0.677	-0.310	0.227	0.759	-0.429	0.106	0.161***	0.262***	6,341
	(0.195)	(0.772)	(0.988)	(0.144)	(0.651)	(0.845)	(0.099)	(0.046)	(0.104)	
Labor size: 2-10 employees	-0.327*	0.350	0.134	0.140	1.128	-0.156	0.177	0.252***	0.511***	4,684
	(0.189)	(0.845)	(1.100)	(0.143)	(0.743)	(0.910)	(0.142)	(0.054)	(0.143)	
Labor size: 11-49 employees	-0.039	-0.210	0.063	0.350	0.176	-0.111	0.125	0.270***	0.211*	3,498
	(0.256)	(0.908)	(1.136)	(0.241)	(0.963)	(1.226)	(0.109)	(0.071)	(0.120)	
Labor size: 50-100 employees	-0.559	0.572	1.127	-0.116	1.242	-2.074	0.293	-0.022	0.209	1,204
	(0.398)	(1.367)	(1.828)	(0.302)	(1.405)	(1.792)	(0.186)	(0.122)	(0.176)	
Labor size: 100+ employees	0.033	1.455**	-0.184	0.597***	0.445	-0.633	0.267**	0.337***	0.187	2,252
	(0.252)	(0.712)	(0.850)	(0.189)	(1.068)	(1.299)	(0.117)	(0.089)	(0.121)	
State owned only	-0.278	1.718	-0.418	-0.197	-0.265	0.355	0.437**	0.279**	0.420*	1,205
	(0.366)	(1.404)	(1.770)	(0.306)	(1.562)	(2.049)	(0.204)	(0.138)	(0.238)	
Foreign owned only	-0.442	-1.221	1.235	0.146	0.352	-0.358	0.131	0.208**	0.253**	1,491
	(0.317)	(1.028)	(1.374)	(0.306)	(1.306)	(1.628)	(0.144)	(0.092)	(0.126)	
Priv. domestic owned only	-0.119	0.594	0.041	0.355***	0.742	-0.587	0.167*	0.253***	0.248***	8,971
	(0.156)	(0.659)	(0.854)	(0.121)	(0.596)	(0.739)	(0.089)	(0.039)	(0.081)	
Time spent with officials: low	0.025	1.302	-1.362	0.187	0.643	-0.697	0.155	0.220***	0.200*	4,311
	(0.267)	(1.033)	(1.237)	(0.202)	(0.897)	(1.144)	(0.112)	(0.057)	(0.112)	
Time spent with officials: med	-0.137	0.499	0.616	0.069	-0.389	0.443	0.086	0.236***	0.262***	3,791
	(0.218)	(0.576)	(0.768)	(0.166)	(1.023)	(1.132)	(0.112)	(0.062)	(0.099)	
Time spent with officials: high	-0.261	-0.413	0.899	0.335	0.673	0.342	0.382***	0.228***	0.338***	2,836
	(0.248)	(0.777)	(1.022)	(0.216)	(1.035)	(1.415)	(0.135)	(0.070)	(0.129)	
CIS	0.167	0.139	0.066	0.660***	0.258	-0.541	0.110	0.312***	0.072	3,870
	(0.224)	(0.677)	(0.951)	(0.245)	(1.433)	(2.366)	(0.145)	(0.062)	(0.134)	
EU	-0.157	0.852	0.746	0.107	-2.702***	2.797***	0.250***	0.164***	0.227***	4,411
	(0.168)	(0.883)	(0.910)	(0.196)	(1.110)	(1.113)	(0.099)	(0.051)	(0.096)	
SEE	-0.342	1.525	-1.125	-0.568	2.012	-1.751	0.068	0.243***	0.374***	2,388
	(0.313)	(1.431)	(1.307)	(0.413)	(1.904)	(2.348)	(0.145)	(0.076)	(0.149)	

Notes: the table reports estimated coefficients for specification (1) with *New Product* indicator variable as the regressand and linkage variables differentiated between OECD and non-OECD source countries. Standard errors clustered by industry × country × year are reported in parentheses. ***, **, * denote statistical significance at 1, 5 and 10 percent.

Table 6: New Technology – OECD vs. non-OECD foreign presence (total linkages)

Sample	Industry-level linkages						Firm-level linkages			Number of observations
	Non-OECD			OECD						
	Horizontal	Backward	Forward	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All Firms	-0.357***	-0.031	-0.562	0.190	1.373***	-1.017	0.190***	0.270***	0.196***	11,570
	(0.132)	(0.425)	(0.550)	(0.133)	(0.560)	(0.722)	(0.065)	(0.041)	(0.064)	
Manufacturing	-0.095	-0.310	-0.685	0.318	0.662	0.454	0.179*	0.256***	0.219***	3,888
	(0.266)	(0.629)	(0.624)	(0.213)	(0.962)	(1.134)	(0.100)	(0.076)	(0.086)	
Services	-0.623***	-0.002	-0.320	0.355**	1.822***	-1.596	0.186**	0.249***	0.197**	6,260
	(0.153)	(0.636)	(0.944)	(0.171)	(0.664)	(1.009)	(0.090)	(0.052)	(0.099)	
New firms	-0.257	-0.312	-0.375	0.218	0.800	-0.754	0.072	0.225***	0.201***	8,474
	(0.173)	(0.612)	(0.806)	(0.134)	(0.644)	(0.843)	(0.077)	(0.046)	(0.078)	
Old firms	-0.603**	0.841	-1.108	0.093	3.079***	-1.998*	0.454***	0.387***	0.243**	3,096
	(0.271)	(0.704)	(0.909)	(0.248)	(0.955)	(1.204)	(0.115)	(0.079)	(0.117)	
De-novo firms	-0.160	-0.740	0.264	0.181	0.171	0.041	0.053	0.182***	0.176*	6,294
	(0.214)	(0.751)	(0.955)	(0.147)	(0.783)	(0.995)	(0.095)	(0.053)	(0.100)	
Labor size: 2-10 employees	-0.110	-1.760**	1.381	0.261	1.595*	-1.378	0.230*	0.237***	0.261	4,658
	(0.206)	(0.859)	(1.008)	(0.179)	(0.852)	(1.078)	(0.130)	(0.057)	(0.175)	
Labor size: 11-49 employees	-0.540**	-0.160	-0.825	0.451**	-0.033	0.822	-0.091	0.225***	0.388***	3,482
	(0.263)	(0.850)	(1.084)	(0.232)	(0.849)	(1.109)	(0.120)	(0.078)	(0.118)	
Labor size: 50-100 employees	-0.788*	2.520*	-2.093	0.216	4.384***	-3.881**	0.387**	0.227*	0.210	1,188
	(0.469)	(1.418)	(1.809)	(0.292)	(1.458)	(1.773)	(0.170)	(0.136)	(0.160)	
Labor size: 100+ employees	-0.399	1.186	-1.649*	0.075	2.408**	-2.502	0.408***	0.443***	0.167	2,234
	(0.263)	(0.722)	(0.982)	(0.234)	(1.182)	(1.543)	(0.132)	(0.092)	(0.109)	
State owned only	-0.562*	-0.249	-0.899	0.205	3.482**	-2.064	0.458**	0.589***	0.161	1,200
	(0.334)	(1.218)	(1.629)	(0.303)	(1.524)	(1.919)	(0.203)	(0.134)	(0.225)	
Foreign owned only	-0.737**	0.663	-1.561	0.123	0.967	-1.181	0.087	0.358***	0.173	1,472
	(0.317)	(0.889)	(1.202)	(0.279)	(1.249)	(1.441)	(0.142)	(0.111)	(0.131)	
Priv. domestic owned only	-0.279*	-0.040	-0.349	0.335***	1.030	-0.805	0.227***	0.224***	0.270***	8,917
	(0.168)	(0.582)	(0.744)	(0.134)	(0.677)	(0.849)	(0.078)	(0.047)	(0.082)	
Time spent with officials: low	-0.263	0.340	-1.277	0.068	1.531	-1.509	0.250**	0.214***	0.283**	4,272
	(0.266)	(0.863)	(1.046)	(0.193)	(0.975)	(1.184)	(0.117)	(0.067)	(0.127)	
Time spent with officials: med	-0.554**	0.643	-0.186	0.418**	1.759*	-1.807	0.131	0.362***	0.229**	3,771
	(0.244)	(0.828)	(1.080)	(0.180)	(0.957)	(1.186)	(0.114)	(0.065)	(0.112)	
Time spent with officials: high	-0.131	-0.988	-0.100	-0.129	-0.045	0.847	0.175	0.252***	0.125	2,815
	(0.226)	(0.627)	(0.865)	(0.224)	(1.233)	(1.624)	(0.130)	(0.081)	(0.143)	
CIS	-0.193	0.186	-0.710	-0.722**	0.577	-0.210	0.032	0.371***	0.232**	3,848
	(0.197)	(0.568)	(0.815)	(0.335)	(1.418)	(2.355)	(0.133)	(0.069)	(0.119)	
EU	-0.332	0.567	-1.502	0.011	-0.977	1.488	0.277***	0.190***	0.038	4,384
	(0.211)	(0.935)	(1.068)	(0.207)	(1.220)	(1.318)	(0.099)	(0.063)	(0.097)	
SEE	-1.232***	-1.641*	1.661*	-0.273	-0.544	1.659	0.141	0.243***	0.351***	2,379
	(0.303)	(0.959)	(0.960)	(0.357)	(1.724)	(2.271)	(0.126)	(0.090)	(0.140)	

Notes: the table reports estimated coefficients for specification (1) with *New Technology* indicator variable as the regressand and linkage variables differentiated between OECD and non-OECD source countries. Standard errors clustered by industry × country × year are reported in parentheses. ***, **, * denote statistical significance at 1, 5 and 10 percent.

Table 7: New Product; additional controls.

Additional control	Industry-level linkages			Firm-specific linkages			Number of observations
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Problematic factors							
Telecommunications	0.097	0.475	-0.155	0.190***	0.245***	0.236***	11,650
	(0.095)	(0.407)	(0.494)	(0.067)	(0.034)	(0.066)	
Electricity	0.098	0.485	-0.170	0.191***	0.249***	0.235***	11,650
	(0.096)	(0.405)	(0.492)	(0.068)	(0.034)	(0.066)	
Transportation	0.098	0.467	-0.148	0.187***	0.245***	0.235***	11,649
	(0.095)	(0.407)	(0.494)	(0.067)	(0.034)	(0.067)	
Access to land	0.102	0.469	-0.159	0.189***	0.246***	0.236***	11,642
	(0.098)	(0.408)	(0.495)	(0.067)	(0.034)	(0.066)	
Title or leasing of land	0.101	0.437	-0.173	0.200***	0.245***	0.236***	11,646
	(0.097)	(0.406)	(0.493)	(0.068)	(0.034)	(0.066)	
Tax rates	0.096	0.439	-0.145	0.195***	0.243***	0.233***	11,642
	(0.097)	(0.411)	(0.498)	(0.067)	(0.033)	(0.066)	
Tax administration	0.105	0.457	-0.150	0.191***	0.233***	0.229***	11,622
	(0.097)	(0.410)	(0.495)	(0.068)	(0.033)	(0.067)	
Customs and trade regulations	0.114	0.445	-0.139	0.189***	0.237***	0.224***	11,637
	(0.099)	(0.408)	(0.495)	(0.068)	(0.033)	(0.066)	
Business licensing and permits	0.102	0.461	-0.194	0.194***	0.241***	0.230***	11,645
	(0.098)	(0.408)	(0.494)	(0.067)	(0.033)	(0.066)	
Labor regulations	0.103	0.480	-0.137	0.192***	0.241***	0.228***	11,647
	(0.097)	(0.411)	(0.498)	(0.067)	(0.033)	(0.066)	
Skills and education of available workers	0.100	0.421	-0.159	0.190***	0.237***	0.229***	11,647
	(0.097)	(0.411)	(0.493)	(0.068)	(0.033)	(0.066)	
Economic policy uncertainty	0.092	0.420	-0.126	0.193***	0.240***	0.225***	11,645
	(0.096)	(0.408)	(0.493)	(0.068)	(0.034)	(0.066)	
Macroeconomic instability	0.117	0.430	-0.150	0.190***	0.238***	0.223***	11,641
	(0.099)	(0.402)	(0.487)	(0.068)	(0.033)	(0.067)	
Functioning of the judiciary	0.104	0.468	-0.162	0.190***	0.243***	0.234***	11,644
	(0.098)	(0.409)	(0.495)	(0.068)	(0.033)	(0.066)	
Corruption	0.101	0.472	-0.147	0.193***	0.244***	0.234***	11,636
	(0.095)	(0.407)	(0.493)	(0.068)	(0.033)	(0.066)	
Street crime/theft/disorder	0.111	0.483	-0.174	0.193***	0.244***	0.234***	11,631
	(0.094)	(0.408)	(0.494)	(0.068)	(0.034)	(0.066)	
Organized crime/Mafia	0.102	0.451	-0.156	0.193***	0.245***	0.240***	11,646
	(0.095)	(0.408)	(0.495)	(0.067)	(0.033)	(0.067)	
Anti-competitive practices of other producers	0.087	0.438	-0.127	0.192***	0.239***	0.242***	11,643
	(0.095)	(0.410)	(0.495)	(0.068)	(0.033)	(0.067)	
Contract violations of by customers/suppliers	0.101	0.442	-0.124	0.189***	0.242***	0.235***	11,639
	(0.097)	(0.410)	(0.495)	(0.068)	(0.033)	(0.067)	
Average score	0.091	0.445	-0.170	0.189***	0.235***	0.230***	11,650
	(0.095)	(0.410)	(0.491)	(0.068)	(0.033)	(0.067)	
Education of manager	-0.166	-0.513	0.451	0.249***	0.274***	0.357***	4,517
	(0.152)	(0.679)	(0.845)	(0.097)	(0.053)	(0.114)	

$Debt_{i,t-3}/Y_{i,t-3}$	0.109	-1.867**	3.201***	0.243	0.277***	0.526***	1,729
	(0.203)	(0.960)	(1.179)	(0.160)	(0.102)	(0.158)	
$\log(Y_{i,t-3}/L_{i,t-3})$	0.077	0.550	-0.328	0.207***	0.288***	0.268***	8,428
	(0.104)	(0.444)	(0.547)	(0.079)	(0.042)	(0.080)	
Access to external finance	0.110	0.389	-0.068	0.192***	0.249***	0.214***	11,123
	(0.098)	(0.405)	(0.489)	(0.071)	(0.035)	(0.067)	
Cost of external finance	0.070	0.335	-0.001	0.208***	0.245***	0.233***	11,211
	(0.095)	(0.401)	(0.485)	(0.071)	(0.034)	(0.067)	
Quality of courts	0.088	0.513	-0.175	0.191***	0.256***	0.260***	10,960
	(0.098)	(0.410)	(0.496)	(0.069)	(0.035)	(0.070)	
Information about suppliers	0.151	0.375	-0.033	0.196***	0.255***	0.223***	10,528
	(0.098)	(0.411)	(0.505)	(0.075)	(0.036)	(0.071)	
Information about customers	0.137	-0.659	0.723	0.168*	0.210***	0.171**	6,440
	(0.108)	(0.551)	(0.611)	(0.100)	(0.051)	(0.089)	
Unofficial payments to public officials							
Own	0.052	0.178	0.314	0.197***	0.244***	0.246***	10,234
	(0.106)	(0.417)	(0.512)	(0.071)	(0.036)	(0.072)	
Other firms in the industry	-0.044	0.492	0.065	0.217***	0.239***	0.225***	9,642
	(0.100)	(0.433)	(0.519)	(0.073)	(0.037)	(0.073)	
Reported for tax purposes							
Sales	0.127	0.434	-0.065	0.195***	0.238***	0.259***	10,848
	(0.095)	(0.422)	(0.520)	(0.074)	(0.036)	(0.068)	
Workforce	0.105	-0.781	0.607	0.169*	0.237***	0.174**	6,830
	(0.105)	(0.579)	(0.646)	(0.099)	(0.047)	(0.085)	
Wage bill	0.104	-0.860	0.683	0.149	0.233***	0.172**	6,798
	(0.106)	(0.581)	(0.646)	(0.098)	(0.046)	(0.084)	
Pressure for developing new products, from:							
Domestic competitors	0.078	0.384	-0.048	0.210***	0.242***	0.271***	11,640
	(0.093)	(0.399)	(0.483)	(0.068)	(0.033)	(0.067)	
Foreign competitors	0.090	0.490	-0.185	0.180***	0.224***	0.186***	11,635
	(0.095)	(0.402)	(0.487)	(0.067)	(0.034)	(0.067)	
Customers	0.068	0.416	-0.049	0.199***	0.238***	0.242***	11,643
	(0.093)	(0.406)	(0.491)	(0.068)	(0.033)	(0.066)	
Pressure for reducing costs, from:							
Domestic competitors	0.080	0.423	-0.089	0.193***	0.242***	0.253***	11,647
	(0.093)	(0.403)	(0.487)	(0.068)	(0.033)	(0.067)	
Foreign competitors	0.087	0.487	-0.173	0.183***	0.227***	0.192***	11,643
	(0.094)	(0.404)	(0.489)	(0.068)	(0.034)	(0.067)	
Customers	0.075	0.410	-0.069	0.196***	0.239***	0.233***	11,648
	(0.094)	(0.406)	(0.491)	(0.068)	(0.033)	(0.066)	
Lost							
Power	0.087	0.437	-0.083	0.183***	0.247***	0.240***	11,435
	(0.097)	(0.411)	(0.497)	(0.068)	(0.034)	(0.068)	
Water	0.103	0.469	-0.111	0.187***	0.248***	0.239***	11,247
	(0.096)	(0.414)	(0.504)	(0.068)	(0.034)	(0.068)	
Phone	0.103	0.458	-0.069	0.181***	0.243***	0.226***	11,240
	(0.095)	(0.414)	(0.502)	(0.069)	(0.034)	(0.067)	
Product	0.090	-0.627	0.479	0.152	0.238***	0.164**	7,095
	(0.101)	(0.573)	(0.631)	(0.097)	(0.045)	(0.081)	

Table 8: New Technology; additional controls.

Additional control	Industry-level linkages			Firm-specific linkages			Number of observations
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Problematic factors							
Telecommunications	-0.047	0.364	-0.619	0.189***	0.270***	0.189***	11,569
	(0.109)	(0.328)	(0.415)	(0.065)	(0.041)	(0.064)	
Electricity	-0.046	0.366	-0.621	0.189***	0.274***	0.186***	11,569
	(0.109)	(0.328)	(0.416)	(0.065)	(0.041)	(0.064)	
Transportation	-0.047	0.357	-0.614	0.183***	0.270***	0.187***	11,568
	(0.108)	(0.328)	(0.415)	(0.065)	(0.041)	(0.065)	
Access to land	-0.037	0.336	-0.612	0.188***	0.272***	0.190***	11,561
	(0.114)	(0.329)	(0.417)	(0.065)	(0.041)	(0.065)	
Title or leasing of land	-0.038	0.313	-0.618	0.198***	0.270***	0.186***	11,565
	(0.113)	(0.329)	(0.418)	(0.065)	(0.040)	(0.064)	
Tax rates	-0.042	0.311	-0.582	0.192***	0.269***	0.183***	11,561
	(0.112)	(0.328)	(0.415)	(0.065)	(0.041)	(0.064)	
Tax administration	-0.033	0.308	-0.576	0.188***	0.262***	0.180***	11,541
	(0.115)	(0.327)	(0.415)	(0.065)	(0.041)	(0.065)	
Customs and trade regulations	-0.026	0.318	-0.583	0.187***	0.258***	0.168***	11,556
	(0.116)	(0.326)	(0.415)	(0.065)	(0.041)	(0.064)	
Business licensing and permits	-0.039	0.341	-0.643	0.191***	0.267***	0.181***	11,564
	(0.114)	(0.329)	(0.416)	(0.065)	(0.041)	(0.064)	
Labor regulations	-0.041	0.360	-0.593	0.191***	0.268***	0.181***	11,566
	(0.111)	(0.328)	(0.416)	(0.065)	(0.041)	(0.064)	
Skills and education of available workers	-0.041	0.314	-0.598	0.189***	0.266***	0.183***	11,566
	(0.111)	(0.328)	(0.417)	(0.065)	(0.041)	(0.065)	
Economic policy uncertainty	-0.048	0.307	-0.580	0.191***	0.267***	0.180***	11,564
	(0.110)	(0.329)	(0.417)	(0.065)	(0.041)	(0.065)	
Macroeconomic instability	-0.024	0.331	-0.610	0.191***	0.267***	0.182***	11,560
	(0.116)	(0.329)	(0.417)	(0.065)	(0.041)	(0.065)	
Functioning of the judiciary	-0.040	0.349	-0.616	0.189***	0.267***	0.186***	11,563
	(0.112)	(0.328)	(0.415)	(0.065)	(0.041)	(0.065)	
Corruption	-0.044	0.339	-0.607	0.190***	0.269***	0.186***	11,555
	(0.110)	(0.327)	(0.415)	(0.065)	(0.041)	(0.065)	
Street crime/theft/disorder	-0.044	0.335	-0.590	0.190***	0.272***	0.184***	11,550
	(0.111)	(0.327)	(0.415)	(0.065)	(0.041)	(0.064)	
Organised crime/Mafia	-0.043	0.322	-0.596	0.190***	0.270***	0.191***	11,565
	(0.110)	(0.328)	(0.415)	(0.065)	(0.041)	(0.064)	
Anti-competitive practices of other producers	-0.050	0.316	-0.578	0.189***	0.266***	0.193***	11,562
	(0.109)	(0.327)	(0.414)	(0.065)	(0.041)	(0.064)	
Contract violations of by customers/suppliers	-0.036	0.320	-0.582	0.191***	0.268***	0.188***	11,558
	(0.113)	(0.326)	(0.414)	(0.065)	(0.041)	(0.065)	
Average score	-0.053	0.324	-0.617	0.188***	0.260***	0.182***	11,569
	(0.107)	(0.328)	(0.415)	(0.065)	(0.041)	(0.064)	
Education of manager	-0.018	0.271	-0.040	0.223***	0.223***	0.224**	4,524
	(0.154)	(0.558)	(0.740)	(0.092)	(0.059)	(0.114)	

$Debt_{i,t-3}/Y_{i,t-3}$	0.367	2.390**	-1.777	0.121	0.199*	0.516***	1,726
	(0.237)	(1.044)	(1.252)	(0.148)	(0.113)	(0.172)	
$\log(Y_{i,t-3}/L_{i,t-3})$	0.043	0.182	-0.469	0.148*	0.265***	0.217***	8,379
	(0.105)	(0.404)	(0.502)	(0.079)	(0.050)	(0.075)	
Access to external finance	-0.061	0.304	-0.518	0.177***	0.268***	0.184***	11,055
	(0.114)	(0.330)	(0.421)	(0.067)	(0.041)	(0.064)	
Cost of external finance	-0.052	0.308	-0.577	0.175***	0.265***	0.181***	11,140
	(0.110)	(0.333)	(0.423)	(0.066)	(0.041)	(0.065)	
Quality of courts	-0.029	0.302	-0.608	0.230***	0.270***	0.195***	10,889
	(0.113)	(0.337)	(0.424)	(0.069)	(0.042)	(0.067)	
Information about suppliers	0.012	0.338	-0.581	0.197***	0.285***	0.216***	10,454
	(0.116)	(0.349)	(0.432)	(0.067)	(0.041)	(0.067)	
Information about customers	-0.040	0.289	0.340	0.210**	0.302***	0.207***	6,365
	(0.136)	(0.786)	(0.773)	(0.095)	(0.055)	(0.077)	
Unofficial payments to public officials							
Own	-0.110	0.127	-0.335	0.169***	0.278***	0.188***	10,175
	(0.114)	(0.341)	(0.430)	(0.069)	(0.043)	(0.070)	
Other firms in the industry	-0.212**	0.212	-0.301	0.211***	0.283***	0.200***	9,581
	(0.105)	(0.346)	(0.441)	(0.070)	(0.047)	(0.071)	
Reported for tax purposes							
Sales	-0.032	0.325	-0.478	0.180***	0.279***	0.212***	10,770
	(0.109)	(0.338)	(0.435)	(0.067)	(0.042)	(0.066)	
Workforce	-0.030	0.584	-0.108	0.171*	0.304***	0.203***	6,749
	(0.132)	(0.739)	(0.727)	(0.095)	(0.056)	(0.078)	
Wage bill	-0.019	0.402	0.091	0.154*	0.300***	0.199***	6,718
	(0.133)	(0.753)	(0.749)	(0.093)	(0.056)	(0.078)	
Pressure for developing new products, from:							
Domestic competitors	-0.046	0.304	-0.555	0.195***	0.270***	0.192***	11,559
	(0.108)	(0.330)	(0.420)	(0.065)	(0.041)	(0.065)	
Foreign competitors	-0.038	0.372	-0.655	0.179***	0.249***	0.139**	11,554
	(0.109)	(0.329)	(0.419)	(0.065)	(0.042)	(0.065)	
Customers	-0.057	0.293	-0.535	0.191***	0.267***	0.190***	11,562
	(0.106)	(0.329)	(0.417)	(0.064)	(0.041)	(0.065)	
Pressure for reducing costs, from:							
Domestic competitors	-0.053	0.335	-0.571	0.192***	0.271***	0.198***	11,566
	(0.107)	(0.329)	(0.418)	(0.065)	(0.040)	(0.065)	
Foreign competitors	-0.045	0.381	-0.643	0.178***	0.248***	0.139**	11,562
	(0.108)	(0.329)	(0.417)	(0.065)	(0.042)	(0.065)	
Customers	-0.061	0.314	-0.556	0.193***	0.266***	0.183***	11,567
	(0.107)	(0.331)	(0.418)	(0.065)	(0.040)	(0.064)	
Lost							
Power	-0.052	0.402	-0.628	0.186***	0.280***	0.203***	11,354
	(0.109)	(0.331)	(0.417)	(0.065)	(0.041)	(0.065)	
Water	-0.046	0.492	-0.710*	0.182***	0.276***	0.205***	11,166
	(0.106)	(0.329)	(0.417)	(0.066)	(0.042)	(0.066)	
Phone	-0.049	0.489	-0.704*	0.181***	0.279***	0.199***	11,159
	(0.108)	(0.326)	(0.411)	(0.066)	(0.042)	(0.065)	
Product	-0.031	0.652	-0.129	0.173*	0.302***	0.194***	7,011
	(0.134)	(0.732)	(0.721)	(0.093)	(0.055)	(0.076)	

Appendix

Table A1: Definition of Variables

Variable Name	Variable Definition	BEEPS question
Newproduct	New product or upgrade existing product	Dummy variable. Has your company undertaken any of the following initiatives over the last 36 months? Dummy variable is equal to one if 'yes' to any of the two questions: - Developed successfully a major new product line - Upgraded an existing product line
Newtech	New technology is implemented	Dummy variable = 1 if answer is affirmative to question: Has your firm acquired new production technology over the last 36 months?
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
SKILL	Share of skilled workers, 3 yrs ago	What share of your current permanent, full-time workers were skilled workers 36 months ago?
EDU	Share of workers with higher education, 3yrs ago	What share of the workforce at your firm had some university education 36 months ago?
Age	Log (Firm's age)	Year of survey minus the year when the firm was established (minimum age is two years). For the year established: In what year did your firm begin operations in this country?
SOE	State owned	Government is the major shareholder (50%+)
CNM	Compete in national markets	Does your firm compete in the national market (i.e. whole country) for its main product line or service or does it serve primarily the local market (i.e. region, city, or neighborhood)? Yes = 1
LOC	Location	Type of location: Capital; Other city over 1 million; Other 250,000-1,000,000; Other 50,000-250,000; Under 50,000
Markup	Markup	Considering your main product line or main line of services in the domestic market, by what margin does your sales price exceed your operating costs (i.e., the cost of material inputs plus wage costs but not overhead and depreciation)?

Table A2: New Product (direct linkages)

Sample	Industry-level linkages			Firm-level linkages			Number of observations
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All Firms	0.099	-0.012	0.323	0.191***	0.246***	0.237***	11,651
	(0.094)	(0.214)	(0.196)	(0.067)	(0.034)	(0.066)	
Manufacturing	0.131	-0.305	0.661***	0.068	0.262***	0.217***	3,915
	(0.140)	(0.257)	(0.247)	(0.106)	(0.062)	(0.089)	
Services	0.061	0.106	0.144	0.307***	0.203***	0.248**	6,299
	(0.137)	(0.398)	(0.436)	(0.098)	(0.041)	(0.109)	
New firms	0.051	-0.064	0.358	0.147*	0.175***	0.187***	8,539
	(0.105)	(0.237)	(0.242)	(0.081)	(0.039)	(0.078)	
Old firms	0.187	-0.052	0.347	0.304***	0.442***	0.351***	3,110
	(0.184)	(0.329)	(0.332)	(0.115)	(0.082)	(0.116)	
De-novo firms	0.107	-0.222	0.539**	0.104	0.161***	0.267***	6,341
	(0.118)	(0.244)	(0.259)	(0.099)	(0.046)	(0.104)	
Labor size: 2-10 employees	-0.051	0.015	0.564*	0.178	0.251***	0.511***	4,684
	(0.126)	(0.284)	(0.304)	(0.142)	(0.054)	(0.142)	
Labor size: 11-49 employees	0.181	-0.251	0.122	0.127	0.268***	0.210*	3,498
	(0.178)	(0.290)	(0.319)	(0.109)	(0.071)	(0.120)	
Labor size: 50-100 employees	-0.215	0.038	0.334	0.288	-0.011	0.222	1,204
	(0.233)	(0.499)	(0.516)	(0.186)	(0.121)	(0.178)	
Labor size: 100+ employees	0.410***	0.010	0.404	0.285***	0.340***	0.185	2,252
	(0.149)	(0.411)	(0.404)	(0.117)	(0.088)	(0.121)	
State owned only	-0.156	-0.434	0.945*	0.462**	0.285**	0.416*	1,205
	(0.230)	(0.545)	(0.529)	(0.205)	(0.136)	(0.238)	
Foreign owned only	-0.111	0.187	-0.232	0.118	0.220***	0.227*	1,491
	(0.246)	(0.465)	(0.449)	(0.144)	(0.091)	(0.127)	
Priv. domestic owned only	0.186*	0.024	0.326	0.173**	0.252***	0.246***	8,971
	(0.102)	(0.211)	(0.212)	(0.089)	(0.039)	(0.081)	
Time spent with officials: low	0.094	0.033	-0.002	0.158	0.214***	0.202*	4,311
	(0.166)	(0.396)	(0.417)	(0.111)	(0.057)	(0.111)	
Time spent with officials: med	0.020	0.390	0.233	0.096	0.237***	0.263***	3,791
	(0.127)	(0.272)	(0.307)	(0.111)	(0.062)	(0.098)	
Time spent with officials: high	0.051	0.116	0.443	0.390***	0.227***	0.335***	2,836
	(0.159)	(0.407)	(0.350)	(0.134)	(0.070)	(0.129)	
CIS	0.329*	0.444	-0.227	0.109	0.312***	0.046	3,870
	(0.181)	(0.327)	(0.378)	(0.145)	(0.063)	(0.136)	
EU	0.039	-0.353	0.967***	0.263***	0.163***	0.244***	4,411
	(0.151)	(0.422)	(0.377)	(0.100)	(0.051)	(0.095)	
SEE	-0.474*	-0.094	0.441	0.061	0.245***	0.376***	2,388
	(0.284)	(0.629)	(0.594)	(0.147)	(0.075)	(0.147)	

Table A3. New technology (direct linkages)

Sample	Industry-level linkages			Firm-level linkages			Number of observations
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All Firms	-0.064	0.090	-0.183	0.190***	0.271***	0.187***	11,570
	(0.110)	(0.198)	(0.216)	(0.065)	(0.041)	(0.065)	
Manufacturing	0.147	-0.007	0.014	0.182*	0.253***	0.211***	3,888
	(0.195)	(0.325)	(0.298)	(0.099)	(0.075)	(0.088)	
Services	-0.067	0.048	-0.234	0.185**	0.256***	0.181*	6,260
	(0.134)	(0.380)	(0.410)	(0.090)	(0.051)	(0.100)	
New firms	0.003	0.068	-0.373	0.072	0.225***	0.194***	8,474
	(0.112)	(0.240)	(0.282)	(0.077)	(0.046)	(0.079)	
Old firms	-0.236	0.185	0.231	0.460***	0.387***	0.221*	3,096
	(0.196)	(0.313)	(0.313)	(0.114)	(0.079)	(0.117)	
De-novo firms	0.026	-0.252	0.008	0.052	0.181***	0.174*	6,294
	(0.124)	(0.237)	(0.307)	(0.095)	(0.053)	(0.100)	
Labor size: 2-10 employees	0.094	0.102	-0.171	0.231*	0.243***	0.255	4,658
	(0.142)	(0.382)	(0.402)	(0.130)	(0.056)	(0.174)	
Labor size: 11-49 employees	0.022	-0.212	-0.132	-0.089	0.221***	0.372***	3,482
	(0.191)	(0.267)	(0.339)	(0.120)	(0.079)	(0.118)	
Labor size: 50-100 employees	-0.193	-0.085	0.690	0.375**	0.231*	0.199	1,188
	(0.233)	(0.473)	(0.504)	(0.171)	(0.135)	(0.161)	
Labor size: 100+ employees	-0.166	0.249	-0.322	0.410***	0.435***	0.162	2,234
	(0.169)	(0.357)	(0.349)	(0.132)	(0.092)	(0.110)	
State owned only	-0.298	0.519	-0.515	0.427**	0.587***	0.170	1,200
	(0.215)	(0.523)	(0.527)	(0.201)	(0.134)	(0.223)	
Foreign owned only	-0.233	0.006	-0.638	0.084	0.368***	0.162	1,472
	(0.225)	(0.384)	(0.412)	(0.140)	(0.110)	(0.130)	
Priv. domestic owned only	0.075	0.095	-0.127	0.234***	0.224***	0.262***	8,917
	(0.116)	(0.218)	(0.252)	(0.079)	(0.047)	(0.082)	
Time spent with officials: low	-0.169	0.397	-0.623*	0.249**	0.214***	0.277**	4,272
	(0.160)	(0.284)	(0.332)	(0.117)	(0.067)	(0.127)	
Time spent with officials: med	0.030	0.074	0.180	0.134	0.370***	0.218**	3,771
	(0.147)	(0.306)	(0.351)	(0.115)	(0.065)	(0.112)	
Time spent with officials: high	-0.160	0.441	-0.666*	0.171	0.252***	0.136	2,815
	(0.165)	(0.370)	(0.390)	(0.130)	(0.080)	(0.143)	
CIS	-0.403**	1.190***	-0.999***	0.024	0.369***	0.201	3,848
	(0.176)	(0.269)	(0.381)	(0.134)	(0.069)	(0.122)	
EU	-0.161	-0.051	-0.123	0.283***	0.191***	0.040	4,384
	(0.150)	(0.359)	(0.397)	(0.100)	(0.062)	(0.098)	
SEE	-0.777***	-0.458	0.831	0.135	0.250***	0.336***	2,379
	(0.271)	(0.513)	(0.519)	(0.128)	(0.090)	(0.140)	

Table A4: New Product – OECD vs. non-OECD foreign presence (direct linkages)

Sample	Industry-level linkages						Firm-level linkages			Number of observations
	Non-OECD			OECD						
	Horizontal	Backward	Forward	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All Firms	-0.089	-0.524	0.745***	0.258**	0.240	0.172	0.191***	0.244***	0.236***	11,651
	(0.140)	(0.365)	(0.286)	(0.115)	(0.251)	(0.250)	(0.067)	(0.034)	(0.066)	
Manufacturing	0.007	-0.821*	0.990***	0.192	-0.083	0.553*	0.068	0.260***	0.216***	3,915
	(0.203)	(0.459)	(0.349)	(0.161)	(0.313)	(0.326)	(0.106)	(0.062)	(0.089)	
Services	-0.301	-0.025	0.512	0.324**	0.335	-0.164	0.304***	0.201***	0.255***	6,299
	(0.214)	(0.660)	(0.608)	(0.164)	(0.466)	(0.552)	(0.098)	(0.041)	(0.108)	
New firms	-0.212	-0.451	0.773**	0.239*	0.150	0.188	0.146*	0.175***	0.189***	8,539
	(0.180)	(0.486)	(0.362)	(0.130)	(0.283)	(0.304)	(0.081)	(0.039)	(0.077)	
Old firms	0.152	-0.984	0.842	0.301	0.359	0.192	0.304***	0.437***	0.346***	3,110
	(0.244)	(0.640)	(0.543)	(0.237)	(0.414)	(0.483)	(0.115)	(0.082)	(0.116)	
De-novo firms	-0.026	-0.644	0.870**	0.222	-0.024	0.432	0.104	0.160***	0.265***	6,341
	(0.200)	(0.601)	(0.422)	(0.150)	(0.301)	(0.329)	(0.099)	(0.046)	(0.103)	
Labor size: 2-10 employees	-0.301	-0.221	0.612	0.139	0.216	0.698*	0.174	0.253***	0.510***	4,684
	(0.190)	(0.589)	(0.445)	(0.149)	(0.312)	(0.401)	(0.142)	(0.054)	(0.143)	
Labor size: 11-49 employees	-0.013	-1.516***	0.688	0.434*	0.359	0.130	0.129	0.270***	0.207*	3,498
	(0.253)	(0.589)	(0.509)	(0.251)	(0.364)	(0.420)	(0.109)	(0.071)	(0.120)	
Labor size: 50-100 employees	-0.468	0.182	1.069	-0.152	-0.114	-0.274	0.285	-0.019	0.212	1,204
	(0.402)	(0.837)	(0.821)	(0.297)	(0.640)	(0.660)	(0.186)	(0.122)	(0.178)	
Labor size: 100+ employees	0.103	-0.280	1.226**	0.614***	0.171	-0.254	0.280***	0.333***	0.188	2,252
	(0.251)	(0.647)	(0.542)	(0.185)	(0.493)	(0.588)	(0.117)	(0.088)	(0.121)	
State owned only	-0.179	-0.811	1.835**	-0.163	-0.196	-0.033	0.449**	0.280**	0.426*	1,205
	(0.369)	(1.007)	(0.833)	(0.289)	(0.726)	(0.811)	(0.206)	(0.137)	(0.240)	
Foreign owned only	-0.468	0.042	-0.358	0.136	0.408	0.060	0.125	0.212**	0.237*	1,491
	(0.321)	(0.868)	(0.749)	(0.313)	(0.533)	(0.672)	(0.144)	(0.092)	(0.126)	
Priv. domestic owned only	-0.073	-0.575	0.839***	0.386***	0.312	0.144	0.167*	0.251***	0.243***	8,971
	(0.162)	(0.458)	(0.347)	(0.126)	(0.232)	(0.259)	(0.089)	(0.039)	(0.081)	
Time spent with officials: low	0.065	-0.887	0.562	0.189	0.428	-0.149	0.160	0.215***	0.200*	4,311
	(0.283)	(0.615)	(0.569)	(0.195)	(0.446)	(0.520)	(0.111)	(0.057)	(0.111)	
Time spent with officials: med	-0.124	-0.361	1.072***	0.158	0.642**	-0.221	0.097	0.232***	0.260***	3,791
	(0.219)	(0.548)	(0.460)	(0.161)	(0.327)	(0.442)	(0.112)	(0.062)	(0.098)	
Time spent with officials: high	-0.224	-0.266	0.345	0.371*	0.416	0.797	0.384***	0.227***	0.331***	2,836
	(0.249)	(0.565)	(0.523)	(0.219)	(0.545)	(0.486)	(0.135)	(0.070)	(0.129)	
CIS	0.175	-0.344	0.389	0.663***	1.234***	-0.932	0.114	0.314***	0.045	3,870
	(0.236)	(0.564)	(0.415)	(0.223)	(0.494)	(0.843)	(0.145)	(0.063)	(0.132)	
EU	-0.139	0.492	1.014**	0.163	-0.734*	0.701*	0.254***	0.168***	0.244***	4,411
	(0.168)	(0.552)	(0.456)	(0.199)	(0.435)	(0.413)	(0.100)	(0.051)	(0.095)	
SEE	-0.470	-1.490*	0.735	-0.457	2.309*	-0.034	0.074	0.244***	0.365***	2,388
	(0.362)	(0.856)	(0.774)	(0.437)	(1.219)	(0.713)	(0.146)	(0.076)	(0.151)	

Table A5: New Technology – OECD vs. non-OECD foreign presence (direct linkages)

Sample	Industry-level linkages						Firm-level linkages			Number of observations
	Non-OECD			OECD						
	Horizontal	Backward	Forward	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All Firms	-0.385***	0.350	-0.670**	0.137	0.128	0.350	0.186***	0.270***	0.195***	11,570
	(0.133)	(0.341)	(0.326)	(0.134)	(0.242)	(0.319)	(0.065)	(0.041)	(0.065)	
Manufacturing	-0.200	1.124**	-1.037***	0.325	-0.512	0.860*	0.170*	0.260***	0.225***	3,888
	(0.258)	(0.498)	(0.378)	(0.216)	(0.404)	(0.457)	(0.100)	(0.076)	(0.087)	
Services	-0.598***	0.060	-0.475	0.292	0.367	0.244	0.179**	0.249***	0.196**	6,260
	(0.156)	(0.690)	(0.682)	(0.190)	(0.435)	(0.609)	(0.090)	(0.052)	(0.100)	
New firms	-0.300*	0.446	-0.839**	0.175	0.047	0.055	0.067	0.225***	0.204***	8,474
	(0.169)	(0.431)	(0.415)	(0.137)	(0.281)	(0.392)	(0.077)	(0.046)	(0.079)	
Old firms	-0.590**	0.243	-0.322	0.022	0.308	0.998**	0.455***	0.378***	0.228**	3,096
	(0.270)	(0.624)	(0.528)	(0.245)	(0.407)	(0.450)	(0.114)	(0.079)	(0.117)	
De-novo firms	-0.208	0.284	-0.500	0.134	-0.370	0.372	0.047	0.182***	0.181*	6,294
	(0.209)	(0.473)	(0.471)	(0.149)	(0.288)	(0.440)	(0.095)	(0.053)	(0.100)	
Labor size: 2-10 employees	-0.108	0.502	-0.586	0.206	0.030	0.142	0.228*	0.244***	0.259	4,658
	(0.206)	(0.697)	(0.634)	(0.191)	(0.462)	(0.548)	(0.130)	(0.057)	(0.176)	
Labor size: 11-49 employees	-0.581**	0.426	-1.076**	0.393*	-0.243	0.847*	-0.090	0.226***	0.393***	3,482
	(0.261)	(0.592)	(0.549)	(0.230)	(0.314)	(0.483)	(0.120)	(0.078)	(0.119)	
Labor size: 50-100 employees	-0.758	0.019	1.089	0.051	-0.058	0.494	0.372**	0.215	0.207	1,188
	(0.488)	(0.925)	(0.848)	(0.291)	(0.601)	(0.649)	(0.170)	(0.136)	(0.160)	
Labor size: 100+ employees	-0.370	-0.514	-0.126	0.041	0.696	-0.092	0.418***	0.427***	0.158	2,234
	(0.260)	(0.603)	(0.522)	(0.239)	(0.458)	(0.526)	(0.133)	(0.092)	(0.112)	
State owned only	-0.554*	-0.058	-1.198	0.070	0.872	1.045	0.452**	0.588***	0.128	1,200
	(0.335)	(0.917)	(0.793)	(0.291)	(0.664)	(0.751)	(0.203)	(0.136)	(0.227)	
Foreign owned only	-0.760***	1.545**	-1.721***	0.025	-0.398	-0.151	0.073	0.361***	0.184	1,472
	(0.312)	(0.711)	(0.664)	(0.270)	(0.467)	(0.599)	(0.143)	(0.110)	(0.130)	
Priv. domestic owned only	-0.323**	0.402	-0.472	0.293**	0.101	0.246	0.226***	0.224***	0.270***	8,917
	(0.167)	(0.424)	(0.424)	(0.137)	(0.263)	(0.352)	(0.079)	(0.047)	(0.082)	
Time spent with officials: low	-0.364	1.081*	-1.277***	-0.066	0.157	-0.108	0.244**	0.211***	0.287**	4,272
	(0.276)	(0.591)	(0.547)	(0.185)	(0.377)	(0.493)	(0.117)	(0.067)	(0.126)	
Time spent with officials: med	-0.547**	-0.583	0.874	0.408**	0.429	0.037	0.135	0.359***	0.225**	3,771
	(0.249)	(0.676)	(0.665)	(0.177)	(0.379)	(0.466)	(0.115)	(0.065)	(0.113)	
Time spent with officials: high	-0.182	0.826	-1.661***	-0.150	0.158	0.556	0.172	0.255***	0.132	2,815
	(0.221)	(0.577)	(0.557)	(0.225)	(0.490)	(0.630)	(0.130)	(0.080)	(0.143)	
CIS	-0.262	1.229***	-1.122**	-0.674**	1.065**	-0.745	0.023	0.369***	0.197	3,848
	(0.189)	(0.463)	(0.498)	(0.313)	(0.495)	(0.922)	(0.135)	(0.069)	(0.122)	
EU	-0.381*	0.034	-0.690	-0.004	-0.030	0.372	0.279***	0.191***	0.044	4,384
	(0.221)	(0.566)	(0.525)	(0.213)	(0.427)	(0.489)	(0.099)	(0.063)	(0.099)	
SEE	-1.205***	-0.978	1.014	-0.192	0.230	1.029	0.145	0.246***	0.335***	2,379
	(0.338)	(0.807)	(0.711)	(0.367)	(1.326)	(0.817)	(0.129)	(0.091)	(0.141)	

Table A6. New Product (total linkages), control for capital and cost share of materials

Sample	Industry-level linkages			Firm-level linkages			Number of observations
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All Firms	-0.086	-0.060	0.520	0.194**	0.253***	0.240***	5,546
	(0.123)	(0.487)	(0.580)	(0.091)	(0.058)	(0.088)	
Manufacturing	-0.012	-0.527	0.933	0.168	0.336***	0.144	2,142
	(0.195)	(0.635)	(0.678)	(0.130)	(0.101)	(0.125)	
Services	-0.203	1.329	-1.082	0.217	0.202***	0.353***	2,633
	(0.202)	(0.984)	(1.201)	(0.166)	(0.079)	(0.141)	
New firms	-0.141	-0.304	0.756	0.062	0.147**	0.225**	3,973
	(0.153)	(0.655)	(0.811)	(0.107)	(0.065)	(0.107)	
Old firms	0.012	0.352	0.203	0.609***	0.534***	0.352**	1,571
	(0.251)	(0.750)	(0.848)	(0.161)	(0.121)	(0.151)	
De-novo firms	-0.233	-0.606	1.192	-0.048	0.187***	0.303**	2,889
	(0.190)	(0.820)	(0.998)	(0.137)	(0.076)	(0.143)	
Labor size: 2-10 employees	-0.114	-0.892	1.746	0.228	0.246***	0.688***	2,019
	(0.230)	(1.035)	(1.295)	(0.180)	(0.089)	(0.233)	
Labor size: 11-49 employees	0.016	-0.784	0.971	0.076	0.331***	0.214	1,705
	(0.229)	(0.884)	(0.997)	(0.161)	(0.098)	(0.166)	
Labor size: 50-100 employees	0.149	0.729	-0.565	0.011	-0.042	0.313	654
	(0.345)	(1.550)	(1.875)	(0.226)	(0.180)	(0.245)	
Labor size: 100+ employees	0.071	1.070	-0.642	0.322*	0.329***	0.175	1,156
	(0.224)	(0.783)	(0.861)	(0.169)	(0.134)	(0.163)	
State owned only	-0.072	0.866	0.616	0.358	0.548***	0.096	537
	(0.359)	(1.546)	(1.783)	(0.361)	(0.204)	(0.321)	
Foreign owned only	-0.350	-0.857	1.101	0.197	0.152	0.324	688
	(0.334)	(1.087)	(1.200)	(0.195)	(0.139)	(0.197)	
Priv. domestic owned only	-0.017	0.017	0.342	0.204*	0.250***	0.307***	4,317
	(0.144)	(0.605)	(0.762)	(0.113)	(0.067)	(0.114)	
Time spent with officials: low	-0.035	0.414	0.163	0.323*	0.347***	0.202	1,883
	(0.254)	(1.024)	(1.184)	(0.171)	(0.091)	(0.145)	
Time spent with officials: med	0.026	-0.328	0.782	0.030	0.109	0.313***	1,962
	(0.184)	(0.673)	(0.837)	(0.129)	(0.091)	(0.134)	
Time spent with officials: high	-0.167	-0.532	1.103	0.276	0.332***	0.352**	1,460
	(0.213)	(0.806)	(0.999)	(0.219)	(0.114)	(0.173)	
CIS	0.138	-0.138	0.166	0.049	0.400***	0.060	1,460
	(0.278)	(0.705)	(1.105)	(0.230)	(0.117)	(0.197)	
EU	-0.116	-1.030	2.281**	0.287***	0.180**	0.238*	2,646
	(0.187)	(1.011)	(0.998)	(0.116)	(0.085)	(0.125)	
SEE	-0.738**	1.697	-2.153	0.074	0.185	0.425**	1,127
	(0.364)	(1.644)	(1.535)	(0.188)	(0.120)	(0.191)	

Notes: the table replicates Table 3 in the paper but the set of regressors also include log fixed assets and log materials. The sample used is smaller as many firms do not report data on fixed assets and/or material supplies.

Table A7: New technology (total linkages), control for capital and cost share of materials

Sample	Industry-level linkages			Firm-level linkages			Number of observations
	Horizontal	Backward	Forward	Share of sales to MNEs	Share of imported inputs	Share of exports in total sales	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
All Firms	-0.022	0.199	-0.574	0.126	0.229***	0.128	5,511
	(0.143)	(0.432)	(0.536)	(0.084)	(0.056)	(0.090)	
Manufacturing	-0.070	-0.546	0.359	0.197*	0.126	0.215*	2,130
	(0.217)	(0.605)	(0.696)	(0.113)	(0.084)	(0.116)	
Services	0.366*	0.582	-1.128	0.095	0.206***	0.015	2,618
	(0.204)	(0.751)	(0.934)	(0.146)	(0.084)	(0.158)	
New firms	0.047	-0.281	-0.310	0.001	0.201***	0.072	3,949
	(0.166)	(0.568)	(0.709)	(0.100)	(0.068)	(0.111)	
Old firms	-0.232	1.440*	-1.188	0.400***	0.337***	0.370***	1,556
	(0.244)	(0.780)	(0.917)	(0.165)	(0.105)	(0.158)	
De-novo firms	-0.088	-0.707	0.401	-0.125	0.170**	-0.029	2,870
	(0.201)	(0.759)	(0.950)	(0.128)	(0.076)	(0.138)	
Labor size: 2-10 employees	0.377	-1.342	1.013	0.001	0.323***	0.188	2,010
	(0.230)	(1.005)	(1.155)	(0.191)	(0.093)	(0.257)	
Labor size: 11-49 employees	-0.242	-0.676	0.281	0.022	0.162	0.276	1,694
	(0.253)	(0.745)	(0.914)	(0.181)	(0.106)	(0.171)	
Labor size: 50-100 employees	0.118	2.497*	-2.216	0.272	0.160	0.041	644
	(0.397)	(1.504)	(1.836)	(0.217)	(0.190)	(0.234)	
Labor size: 100+ employees	-0.255	1.727**	-1.771*	0.206	0.263*	0.234	1,144
	(0.273)	(0.755)	(0.942)	(0.178)	(0.139)	(0.161)	
State owned only	-0.294	0.727	-0.089	0.095	0.656***	0.069	523
	(0.352)	(1.295)	(1.643)	(0.345)	(0.206)	(0.327)	
Foreign owned only	-0.263	1.483	-3.177***	0.161	0.338**	0.105	678
	(0.327)	(1.020)	(1.189)	(0.205)	(0.166)	(0.190)	
Priv. domestic owned only	0.084	-0.029	-0.307	0.137	0.191***	0.163	4,288
	(0.164)	(0.544)	(0.658)	(0.104)	(0.063)	(0.114)	
Time spent with officials: low	-0.096	1.429	-2.150*	0.302*	0.174*	0.270	1,875
	(0.262)	(0.960)	(1.157)	(0.159)	(0.100)	(0.173)	
Time spent with officials: med	0.192	0.853	-0.906	0.055	0.389***	0.159	1,951
	(0.247)	(0.870)	(1.055)	(0.139)	(0.097)	(0.144)	
Time spent with officials: high	-0.355	-1.273	1.037	-0.008	0.167	0.003	1,449
	(0.258)	(0.847)	(1.089)	(0.217)	(0.109)	(0.191)	
CIS	-0.698**	0.237	0.006	-0.307*	0.218*	0.215	1,454
	(0.320)	(0.609)	(0.954)	(0.173)	(0.121)	(0.191)	
EU	0.202	-0.281	-0.676	0.268***	0.243***	0.009	2,632
	(0.188)	(1.110)	(1.134)	(0.111)	(0.077)	(0.120)	
SEE	-0.624	0.005	-0.468	0.085	0.265**	0.267	1,116
	(0.418)	(1.587)	(1.653)	(0.206)	(0.122)	(0.267)	

Notes: the table replicates Table 4 in the paper but the set of regressors also include log fixed assets and log materials. The sample used is smaller as many firms do not report data on fixed assets and/or material supplies.