Identifying Spillovers of Technology Transfer from FDI: The case of Estonia.[1]

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Foreign Direct Investment (FDI) is widely seen as generating technology spillovers to indigenous firms in a transition economy. Prior research has measured only the net effect of spillovers from FDI on the productivity of domestic firms. This paper disentangles the positive effect of technology transfer from that of competition. We use a production function framework to estimate the impact of technology transfer from FDI on the output growth of domestic firms in Estonia for the period 1995-1999. Employing panel data techniques we control for industry and firm specific effects, and a Heckman two-stage procedure is performed to control for sample self-selection bias.

The size of the spillovers varies with the characteristics of both the incoming FDI and the recipient local firm. The magnitude of the spillover depends on the measure of foreign presence employed as proxy, and it is moderated by the recipient firm's size, ownership structure and trade orientation. Spillovers of technology transfer benefit from competition of foreign firms as the competitive pressure induces domestic firms to use more efficiently their existing technologies, or search for new ones so that they are able to maintain their market shares. However, negative side-effects of FDI arise with their headhunting of qualified employees. Thus we find that local firms with high skilled labour experience higher growth, but this growth is negatively affected by FDI in the industry.

Our results, moreover, contribute to the enterprise transformation literature by showing interesting different impact on firms with different ownership structure. We find that state owned and outsider owned firms benefit from spillovers of technology transfer, whereas insider owned firms experience strong negative spillovers.

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(spellcheck: US English)

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INTRODUCTION

The expected spillovers of inward foreign direct investment (FDI) have motivated governments in many transition economies to adopt policies aimed at attracting investors. These countries have to modernize their industrial structure, upgrade their infrastructure and acquire new capabilities to flourish the capitalist market economy. The restructuring of enterprises is thus a core element of economic transition, and a central issue in economic research on transition economies (Jones et al. 1998, Estrin and Rosevear 1998, Buck et al. 1998). It is widely recognized that FDI plays an important role in this process of restructuring the formerly centrally planned economies by providing a vital source of investment for overcoming the situation of a collapsing state sector and a slowly growing private sector, and by contributing managerial skills, new technology, capital and competition (IMF et al. 1991, EBRD 1994, Meyer 2001). These contributions are expected to benefit not only the foreign-owned business, but also domestic firms that come in contact with the foreign-owned entity.

Domestic firms are expected to benefit by backward or forward linkages and demonstration effects and by acquiring modern technology from multinational corporations (MNCs), as foreign investment is associated with advanced technology. However, there may also be negative externalities for domestic firms, such as by loosing skilled employees to MNCs affiliate or increased competition in the host country. A common belief is that the positive effects in most cases outweigh the negative ones (UN 2001).

Scholars have attempted to show the positive or negative effects of FDI on the local industry to provide a basis to assess policy measures. So far, results have been mixed for both developing (e.g. Haddad and Harrison 1993, Aitken and Harrison 1999) and transition economies (e.g. Djankov and Hoeckman 1998, Konings 2001). Yet few studies have explored under which conditions such externalities occur. In this study, we provide new evidence on the size of technology spillovers on productivity of local firms, and on the industry conditions that favor such spillovers.

We focus on spillovers of technology transfer affecting output growth of local firms in the same industry. Our prime research questions are: Are these spillovers positive, and of what magnitude? How do they vary with domestic firm characteristics,

such as firms' absorptive capacity, trade orientation, firm size, and ownership structure? In this study we investigate the role of competition at the industry level by including in the analysis a competition control variable and the role of domestic firms' ability to benefit from spillovers of technology transfer. In addition, we use a unique dataset for Estonian manufacturing sector that provides us with very rich firm and industry level panel data (Jones and Mygind 1999).

We employ three alternative proxies for spillovers, and find that their magnitude varies with the proxy used, underlining that different types of inward FDI generate different spillovers. In addition, spillovers depend on the recipient firm's size, its ownership structure, domestic firm trade orientation and proximity to foreign firms. Moreover, domestic firms benefit from competition of both foreign and other domestic firms as it induces them to use more efficiently their existing technologies, or search for new technology so that they maintain their market shares. In turn, this increases their ability to reap up the benefits of spillovers. Furthermore, although skilled labor increases firm's output growth, its movement toward foreign firms significantly reduces this effect. Our results, moreover, contribute to the enterprise transformation literature (Estrin and Wright 1999) by showing interesting different impact on firms with different ownership structure. We find that state owned and outsider owned firms benefit from spillovers of technology transfer, whereas insider owned firms experience strong negative spillovers. However, only outsider owned firms have the resources and the ability to catch up with foreign competitors. Positive spillovers of both state and outsider owned firms are also supported by competition.

2. Spillovers from Foreign Direct Investment

2.1. International Transfer of Technology, and its Spillovers

MNCs produce, control and own most of the world's technology. Almost 80 percent of all private R&D expenditures worldwide are accounted by MNCs (Dunning 1993, 290). By encouraging MNCs to invest, developing countries hope to generate technology transfer to local firms since foreign direct investment is associated with the existence of intangible assets owned by the parent firm (Kokko 1992, Blomstrom and Kokko 1996).

Technology can be transferred across countries through different channels including international trade, foreign investment, and contractual transfers. International trade transfers new technologies embodied in goods, for example new varieties of differentiated products, or capital goods and equipment. FDI transfers knowledge within the boundaries of one MNC or between a foreign firm and a local joint-venture partner. Contractual agreements may transfer technology as arm-length trade in intellectual property, for instance in form of licensing contracts. The type and extent of technology transfer vary with characteristics of the technology itself (e.g., age and complexity) and of the host country (e.g., level of education, labor skills, technology transfer requirements and competition). For instance, Mansfield and Romero (1980) found that technologies transferred to affiliates in developed countries were younger than those transferred to affiliates in developing countries, while the technology given for licensing and to joint ventures was older than the technology transferred to affiliates. Hence, the more modern and complex the technology, the less willing the MNC is to transfer it to a third party but rather to the affiliate. Moreover, Kogut and Zander (1993) show that attributes of technology such as tacitness, codifiability and teachabiliy determine the likelihood of licensing. Their results suggest that the more tacit the technology is, the more likely is that technology is transferred by wholly owned subsidiary. While codifiability and teachability improve the feasibility of licensing, complexity of technology is a deterrent for licensing. Nevertheless, if a firm would like to extract all of the rents from its new and complex technologies they are likely to favor FDI (Caves 1996, World Bank 2000).

A technology that is employed only in a foreign-owned affiliate has limited impact on the host economy. Yet, through various forms of spillovers, or externalities, it can be disseminated throughout the host country. Technology spillovers occur when the activities of one firm lead to improvements in technology and, hence, in productivity of another firm and as such the first firm cannot capture all benefits created by its technology. Accordingly, spillovers of technology transfer may materialize through four main channels: demonstration-imitation, training of domestic employees, competition and backward-forward linkages. Positive spillovers of technology transfer occur when the foreign firms after entering the market demonstrate their advanced technologies to domestic firms, which may afterwards adapt and imitate them (Kokko 1992), when they

train domestic employees who may leave for the domestic firms[2] or through backward-forward linkages.[3] Negative effects may arise from competition when foreign firms with advanced technologies produce at lower marginal cost and therefore gain market shares from domestic firms, which results in a reduced domestic productivity. Especially in the short run, competition can have a negative impact on indigenous firms' productivity (Aitken and Harrison 1999). However, it may also be the case that domestic firms react to foreign competition by using the existing technology more efficiently or by investing in new technology in order to maintain their market shares (Blomstrom and Kokko 1998)[4].

2.2. Empirical Evidence

The empirical literature on FDI spillovers via technology transfer to domestic firms includes studies on both transition, developing and developed economies. Yet this literature provides rather mixed results as some studies find that foreign presence has a positive impact on the productivity of domestic firms, while others find no evidence or a negative effect.

Scholars have used two approaches to estimate spillover effects of FDI, using industry level data or firm level data. Studies of the first type generally find positive spillovers to domestic firms. For instance, Caves (1974) who examines Australian manufacturing, Globerman (1979) in a study of Canadian manufacturing, and Blomstrom and Persson (1983) who study Mexican manufacturing in 1970, present evidence on the positive effect of foreign presence on the labor productivity of local firms. All these studies confirm on the basis of aggregate data that spillovers are significant across industries. However, Kokko (1994) argues that spillovers might not occur in all kinds of

[2] Empirical evidence on spillovers from labor mobility is far from conclusive. However, given that MNCs pay higher wages to prevent spillovers from labor mobility, one would expect to see low labor mobility especially in developing countries where MNCs have substantial advantages over domestic firms compared to MNCs in developed countries. For instance, Gershenberg (1987) finds only 16% of labor movement from MNCs to Kenyan firms. While Aitken, Harrison and Lipsey (1995) in a study for Venezuela, Mexico and U.S. show that higher level of FDI is associated with higher wages in all three countries. However, in the two developing countries they find no evidence of domestic firms paying higher wages. Recent theoretical papers by Glass and Saggi (2000) and Fosuri, Motta and Ronde (2001) on spillovers from labor mobility seem to confirm previous arguments.

[3] Because of high transportation costs and/or local content requirements foreign firms are forced to purchase intermediate goods from domestic suppliers and as identified by Lall (1978) improve the productivity of indigenous firms by providing technical assistance and training of employees to increase the quality of suppliers products', by assisting them in purchasing of raw materials so that they maintain high quality intermediate goods and by causing pressure on suppliers to meet reliability and speed of delivery.

[4] Negative welfare effects can also occur under certain conditions of export taxes and/or import subsidies that occurred in some transition economies (Devereux and Roberts 1997).

industries, especially if foreign firms operate in “enclaves”, i.e. in isolation from domestic firms. Using a cross section of Mexican manufacturing industry, he finds no spillovers in industries with high foreign market share and large productivity gaps. On the other hand, industries without such characteristics show a positive correlation between foreign presence and local productivity.

Studies of the second type employing firm level data provide no or negative evidence of spillovers to domestic firms. For instance, Haddad and Harrison (1993) examine the effect of foreign presence on the relative productivity of local firms (i.e., comparing the firm level productivity with that of the best practice firm in the industry). Using data for Morocco they find no evidence of spillovers. However, competition seems to push local firms toward the best practice frontier in industries with low level of technology. Hence, spillovers do not always take place in all industrial sectors. Aitken and Harrison (1999) find negative spillovers, which they refer as “market stealing effect”, i.e., foreign investment reduces domestic plant productivity in the short run by forcing domestic firms to cut production. In addition, they also test for the possibility that spillovers are “local”. However, they find almost no evidence to support this claim.

Kokko, Tasini and Zejan (1996) use firm level data for Uruguayan manufacturing sector in examining how the productivity of individual plants (rather than industry averages) is affected by foreign presence. Dividing the sample in two sub-samples by size of the technology gaps, they find that spillovers are significant only in industries with a small technology gap. If the gap is small, foreign technology appears to be more useful for local firms as they posses the skills needed to apply or learn the foreign technology. In contrast, Sjoholm (1999) finds evidence of spillovers to domestic firms only in a sub-sample with a large technology gap. Moreover, he finds that a large degree of competition increases spillovers.

Studies on transition economies have emerged only in recent years. Djankov and Hoeckman (1998), Yudaeva, et al (2000), Kinoshita (2000) and Konings (2001) investigate spillovers of technology transfer in transition economies on the basis of firm level data, whereas Zhang (2001) uses data from Chinese regions. The conclusions of most of these studies are in line with previous results of no or negative spillovers to domestic firms in developing economies. For instance, Yudaeva et al. (2000) find no

evidence on local spillovers, however, in contrast to Aitken and Harrison (1999) they find strong positive spillovers for medium size firms which dominate over the negative spillovers of small firms. In contrast to Yudaeva et al. (2000), the results of Konings (2001) are in line with Aitken and Harrison (1999). He finds negative spillovers to domestic firms in Bulgaria and Romania, which suggests that the negative effect of competition dominates the positive effect of technology transfer. In contrast, he finds no evidence of spillovers for domestic firms in Poland. Djankov and Hoeckman (1998) using firm level data for Czech Republic for the period 1992-1996 find that firm characteristics such as firm size, labor productivity and profitability seem to attract FDI. Accounting for them and using the whole sample of foreign and domestic firms, the authors find a positive, albeit insignificant, impact of FDI on TFP growth. While focusing only on domestic firms they find negative and significant spillovers. Accordingly, the authors conclude that other channels of technology transfer such as trade channels (measured by import penetration) positively affect the performance of Czech firms. Differently from all these studies, Zhang (2001) investigates the impact of FDI on China's economic growth and finds that FDI contributes to economic growth through positive spillovers of technology transfer and facilitated transition. Furthermore, these spillovers are larger in the costal than the inland regions.

The different inferences in the literature on the existence of positive spillovers from FDI are mainly the result of using aggregate versus firm level data. In the studies employing cross sectional data of industries rather than firms, the coefficient on the foreign share has been interpreted as the measure of spillovers. Yet, aggregate data at the sector level have been unable to control for differences of productivity across sectors, which may be correlated with the foreign presence. In other words, the observed correlation between the foreign presence and the productivity of domestic firms might be partially due to the fact that foreign firms invest in more productive industries. This issue is known as the endogeneity problem, which if not controlled for leads to an upward bias of the spillover coefficient. In the present research we employ a panel of firm-level data, which allows us to control for endogeneity, as well as selection biases.

2.3. The approach in this study

The prior theoretical and empirical literature suggests that technology spillovers from FDI may increase or decrease the productivity of domestic firms in the same industry. Our first proposition thus is that there is a spillover effect, and we aim at establishing its direction and magnitude. Prior studies have measured only the net effect between the positive impact of technology transfer and negative impact of competition, both stemming from the entrance of the foreign presence in the market. In this paper we disentangle the effect of technology transfer from that of competition by employing technology and competition control variables.

Secondly, the literature suggests that spillovers vary with characteristics of the local firms. To explain the causes of spillovers, we aim to identify characteristics that explain the reaction of domestic firms to entry of foreign firms, and consequent changes in competition, and higher technology level employed in foreign investment firms. Accordingly, we include investment in intangible assets, investment in new machinery and equipment and labor quality as measures of innovation at firm level, investment in new technology to replace the outdated capital and labor force ability to operate the new technology. Intangible assets in their definition include technological know-how, brand names, patents, managerial skills, marketing and export networks and reputation, which are important elements of research and development[5]. In addition, as stressed by Teece (1977), intangible assets are more likely to be transferred at a reasonable cost to subsidiaries rather than by licensing to an independent firm.

We moreover analyze interaction effects of these firm specific variables with technology spillovers of FDI. Cohen and Levinthal (1989) have argued, there are two 'faces' of R&D: it not only simulates innovation but also increases firm's absorptive capacity, i.e. its ability to identify, assimilate and exploit outside knowledge[6]. This absorptive capacity is accounted for with the interaction effect between intangible assets and investment in new machinery and equipment with the spillover variable.

[5] For more on this issue see Caves (1996).

[6] Wang and Blomstrom (1992) also highlight the importance of learning efforts (absorptive capacity) of a local firm in increasing the rate of technology transfer. Furthermore, Kamien and Zang (2000) show through a game theoretical framework that a firm should "buy a ticket to meet the foreign firm halfway" i.e., it should invest in R&D so that it is able to absorb the advanced technology of foreign firms.

The impact of the movement of skilled labor movement to and from domestic firms is captured by the interaction of labor quality with foreign presence at the industry level. By moving to domestic firms, skilled workers bring with them the knowledge of the advanced technologies of foreign firms, which may lead to improvements in technology and hence in productivity of domestic firms. Borensztein et. al. (1998) include an interaction term of human capital with the FDI flow to account for the fact that a country needs human capital to benefit from FDI. They find that FDI contributes to higher productivity growth only if the country has a minimum threshold of human capital. Hence, if there is skilled labor movement from foreign to domestic firms we expect the coefficient of interaction term of labor quality with foreign presence to be positive. On the other hand, skilled labor movement in the opposite direction will result in a negative coefficient of the interaction term. Likewise, the existence of the absorptive capacity would be identified by a positive coefficient of both interaction terms of intangible assets and investment in new machinery and equipment with foreign presence.

3. Empirical Analysis

If technology embodied in foreign-owned firms is transmitted to local firms this should result in higher productivity levels and growth rates of local firms. As productivity (levels and growth rates) is usually analyzed with production functions, we start our analysis with a general form of the production function. To produce the output Y_{it} the firm needs capital K_{it}, labor L_{it} and materials M_{it}. Therefore the production function of each firm (i) is:

$$Y_{ijt} = A_{ijt} F(K_{ijt}, L_{ijt}, M_{ijt}) \quad (1)$$

where i denotes the firm, j the industry and t the year. We assume that the production function is homogenous of degree g in inputs, and it is also increasing and concave in all its arguments.

A_{ijt} is the total factor productivity (TFP) or Solow residual, which is assumed to vary across firms, sectors and over time. Felipe (1999) in a survey of the literature on total factor productivity describes A_{ijt} as “a measure of elements such as managerial

capabilities and organizational competence, R&D, inter-sector transfer of resources, increasing returns to scale, embodied technical progress, and diffusion of technology." Hence, one can express A_{ijt} as function of such variables depending on the focus of the study. Such an approach has also been adopted by Haddad and Harrison (1993), Sjoholm (1999), Zukowska-Gagelman (2000) and Kinoshita (2000).

Taking log of (1) and time derivative and expressing the growth of variables in discrete time (1) will be transformed as follows:

$$dY_{ijt} / Y_{ijt} = dA_{ijt} / A_{ijt} + [d (\log Y_{ijt}) / d (\log K_{ijt})]\, dK_{ijt} / K_{ijt} + [d (\log Y_{ijt}) / d (\log L_{ijt})]\, dL_{ijt} / L_{ijt} + [d (\log Y_{ijt}) / d (\log M_{ijt})]\, dM_{ijt} / M_{ijt} \quad (2)$$

where dY_{ijt} is the time derivative of log Y, the same holds for dA, dK, dL, dM.

In addition, $d (\log Y_{ijt}) / d (\log (z)) = b_{yz}$, where $z = K_{ijt}, L_{ijt}, M_{ijt,}$ is the elasticity of output with respect to inputs. Hence, we can rewrite (2) as follows:

$$dY_{ijt} / Y_{ijt} = dA_{ijt} / A_{ijt} + b_{yk}\, dK_{ijt} / K_{ijt} + b_{yl}\, dL_{ijt} / L_{ijt} + b_{ym}\, dM_{ijt} / M_{ijt} \quad (3)$$

In discrete time (3) is transformed in:

$$\log(Y_{i,jt+1} / Y_{ijt}) = b_{yk} \log(K_{i,j,t+1} / K_{ijt}) + b_{yl} \log(L_{i,j,,t+1} / L_{ijt}) + b_{ym} \log(M_{i,j,t+1} / M_{ijt}) + d\, A_{ijt} / A_{ijt} \quad (4)$$

Based on the discussion above the growth of total factor productivity is assumed to be a function of the following variables:

$$dA_{ijt}/A_{ijt} = f\ (IAsset_{ijt}/Y_{ijt},\ Investment_{ijt}/Y_{ijt},\ LaborQuality_{ijt},\ Spillover_{jt},\ Concentration_{jt},\ Export_{ijt}/Y_{ijt},\ d_j,\ d_t\ ) \quad (5)$$

$IAsset_{ijt}/Y_{ijt}$ the ratio of intangible assets to net sales;

$Investment_{ijt}/Y_{ijt}$ the ratio of the expenditure on new machinery and equipment to net sales, to account for the investment in new technology;

$LaborQuality_{ijt}$	the share of skilled workers in total workforce;
$Spillover_{jt}$	proxied by three alternative measures: the share of foreign firm's employment/ equity/ sales in total industry's employment/ equity/ sales;
$Export_{ijt}/Y_{ijt}$	the ratio of export revenues to net sales;
$Concentration_{jt}$	industry concentration is proxied by Herfindahl index[7] (A high value of this indicates a high degree of industry concentration, thus less competition);
d_j, d_t	industry and time dummies included to capture industry specific effects such as general demand conditions in a given industry. Time dummies are included to capture economy wide shocks in productivity.

*** Table 1 approximately here ***

We expect coefficients for inputs to be positive and significant, whereas the coefficient for the spillovers variable may be positive or negative. A positive coefficient points to positive spillovers of technology transfer while a negative coefficient would indicate that foreign firms might operate in clusters that impede spillovers or that domestic firms are not able to benefit from foreign presence in the market. The coefficients of investment in intangible assets, in new machinery and equipment, the share of skilled workers, and exports are expected to have a positive and significant effect on the growth of output. Finally, the coefficient for industry concentration (Herfindahl index) may be positive or negative as competition can make domestic firms use more efficiently the existing technology or search for new technology in order to maintain their market shares. However, competition may be detrimental for domestic firms, if fewer economies of scale are realized, or firms retain excess capacity as foreign firms enter the

[7] Herfindahl is calculated at a 2-digit industry level. Although it would have been better to use a much more disaggregated Herfindahl, we could not do this because at a more disaggregated level the number of firms drops substantially. In addition, official statistics do not provide information on industrial concentration ratios.

domestic market with advanced technology and produce at a lower marginal cost and take away market shares away from domestic firms.

4. The Data

The data used in this analysis contains yearly information on Estonian firms for the period 1995-1999. This data has been obtained from the Estonian Statistical Agency (ESA) and, in broad terms, consists of ownership, financial and wage information. The ownership information is provided by a special ownership survey run by ESA sent to non-fully state owned firms, i.e. firms that have been fully or partially privatized. This information is then augmented with that of the fully state owned firms known as such in a given year. Financial and wage data comes from firm's financial statements (balance sheet and income statement). The data set used in the estimation consists of 1836 observations of which 430 firms in 1995, 412 in 1996, 380 in 1997, 320 in 1998 and 294 firms in 1999. Table 2 presents means and standard deviations of principal variables used in the analysis. This data set is quite representative as it covers 50% of manufacturing employment of year 95, the starting year of our analysis. The different number of firms in every year is caused by exit of firms over time. This lack of observations for some firms over the whole time period gives rise to sample selection problem, which will be treated in detail in the next section.

A common problem with data over time is that for a given year data is expressed in current prices. This makes it important to avoid biases that might arise due to inflation. With 1995 as the base year, all variables are deflated to 1995 prices using the appropriate PPI deflators. There are four ownership groups calculated from the data: insider owned, foreign owned, state owned, and outsider owned firms. Foreign firms are considered those with at least 10% of their nominal capital owned by foreigners while the rest of the three groups is classified as domestic firms[8]. We do not distinguish between joint ventures and FDI because the purpose of this study is to assess the impact foreign firms

[8] This definition is the same as that of OECD. Other researchers, such as Sjoholm (1997) take as threshold 15% of equity owned by foreigners, Haddad and Harrison (1993) define as foreign firms those with at least 5% equity owned by foreigners and Djankov and Hoekman (1998) consider a threshold of 20%.

have on domestic firm performance, through technology transfer. Thirteen industrial groups are defined according to a 2-digit ISIC classification (see Table 3).

*** Tables 2 & 3 approximately here ***

4.1. Data Description

Variables used in the empirical analysis, and their measurements are reported in table 1. Regarding the measure of spillover, as seen in this table, we use three different measures in line with the received empirical literature.

Table 3 in the appendix presents the number of observations by industrial affiliation for the total sample. Foreign presence, denoted as spillovers in table 1, is highest in the following industries: leather products, wood and paper products, rubber, plastic and non-metallic mineral products and electricity, gas and water supply. In most industries, foreign presence is higher in industry sales and equity than in industry employment. Column 4 of this table also shows the distribution of mean intangible assets across industries. We see that while foreign presence varies substantially in magnitude across industries, intangible assets vary less, but are highest in food products, wood and paper products, rubber, plastic and non-metallic products and furniture products. Foreign presence is not associated with large investment in intangible assets, as might be expected.

Table 4 shows the relative performance of foreign firms, reported as ratio of the mean of the respective variable for foreign firms to that for domestic firms, for each industry[9]. Foreign firms outperform domestic firms by most criteria: in most industries they have higher capital intensity, higher labor productivity, pay higher wages and export more than domestic firms. It may be expected that higher productivity and better export performance may come from firm size effect. However, in most industries foreign firms tend to be smaller than domestic ones (column 4). Moreover, domestic firms invest more

[9]For instance, each number in the column of capital intensity is obtained from the ratio of the mean of the foreign firm's capital intensity with the mean of the domestic firm's capital intensity. A number less than 1 means that the domestic firm is performing better for the given variable. Firm size is measured by number of employees.

in intangible assets and new machineries than foreign firms in most industries[10](column 3 and 5) This is consistent with the catching up hypothesis, i.e. domestic firms invest relatively more than foreign firms in order to increase their technological capabilities and their ability to benefit from foreign firms' advanced technology.

*** Table 4 approximately here ***

5. Estimation Procedures

We use Ordinary Least Squares (OLS), Fixed Effects (FE) and Generalized Least Squares (GLS) methods to estimate equation 4. The specification includes output growth as the dependant variable and the growth in inputs, the spillover variable, the ratio of investment in intangible assets to output, the ratio of investment in new machinery and equipment to output, labor quality, their interaction with the spillover variable, Herfindahl index as a measure of industry concentration separated into foreign and domestic concentration, the ratio of export to output as well as industry and time dummies as independent variables.

The interaction of labor quality with the spillover variable accounts for the movement of skilled labor from and to domestic firms, whereas the Herfindahl indexes capture the effect of competition. Therefore what remains to be captured from the spillover coefficient is the effect of demonstration-imitation and vertical linkages.

We employ different panel data procedures to avert the following estimation problems that may otherwise generate biased and inefficient estimates: sample self-selection bias, endogeneity, autocorrelation and heteroskedasticity. Sample self-selection bias steams from the fact that the dependant variable is not observed for all firms over the whole time period in the data set. This might result from the fact that firms go bankrupt, merge with other firms or choose not to report. Not correcting for it leads to biased estimates (Greene 1993). We account for this by running a Heckman two-step procedure to calculate the probability that the firm is included in the sample based on firm's profit,

[10] As in most cases the ratio is less than one, i.e., the mean of investment in intangible assets and in new machinery is higher for domestic firms.

labor productivity and industry affiliation. The resulting inverse mills ratio is then included as right hand side variable.

Endogeneity can arise by two different effects. First, foreign firms may invest in more productive industries, leading to a reverse causality from the left hand side variable to the spillover measure. Second, domestic firms' decision to invest in new machinery and equipment depends on past and current levels of output and profit, which on their side are affected by investment rates. To account for both sources of endogeneity, we employ lagged values as instruments for the respective variables, i.e., investment in new machinery and equipment and spillovers.

Autocorrelation may be caused by omission of unobserved variables. These omitted variables, such as better management or organizational structure may give rise to the correlation between indigenous firm output growth and the spillover variable. Heteroskedasticity arises from different firm and industry characteristics. Although, heteroskedasticity is generally corrected by weighting observations with the variable that is its source (Greene 1993), in this framework we have to account for a general form of heteroskedasticity. In table 5, we present the results of a first order autocorrelation and heteroskedasticity test exploiting the panel nature of the data. As seen the null hypothesis of no autocorrelation and no heteroskedasticity is rejected at any significance level. There are different approaches to correct for them separately[11], however, in our analysis we have to correct for both simultaneously to obtain efficient estimates and robust standard errors. We do this with a GLS regression that corrects for a general form of heteroskedasticity and group specific first order autocorrelation structure.

*** Table 5 approximately here ***

The OLS results are adjusted for heteroskedasticity using clusters based on individual firm groupings over time, where clusters also help in attenuating autocorrelation. Nevertheless, to exploit the panel nature of the data and to control for

[11] The use of panel data instrumental variable approach with GMM method would allow to correct for a general form of heteroskedasticity but not of a general form of autocorrelation. On the other hand, employing autocorrelated panel data techniques allows to correct for first-order autocorrelation but not for

unobserved fixed effects we also run fixed effects, which still suffers from all above-mentioned econometric problems.

Finally, our main regression, which corrects for all the estimation problems of the panel data, except for the specification described above also includes the inverse mills ratio from Heckman two step procedure, the lagged value of spillovers and investment in new machinery and equipment. In addition, we apply a generalised least squared method which corrects for a general form of both heteroskedasticity and autocorrelation.

6. Results

6.1. Sectoral Spillovers of Technology Transfer

In this section we present and discuss empirical estimates of spillovers of technology transfer. We first focus on overall spillovers of technology transfer at the sectoral level, then discuss how spillovers vary with firm size, trade orientation, on firm' s ownership structure and, finally, how spillovers depend on proximity of domestic firms to foreign firms.

Table 5 shows the results of estimating the basic specification, i.e. without interaction terms, with OLS, FE and GLS estimation methods for three measures of spillovers. Our main spillover variable is the share of foreign firms' employment in total industry's employment. However, two other measures of spillovers, the share of foreign firms in total industry's sales and total industry's equity are used as robustness check.

In the interpretation we focus on interpreting the estimates obtained with the GLS method, which is the methodologically most rigorous procedure. Most of the coefficients are significant at 1% and 10% significance level. The effect of technology transfer is positive and significant when spillover is measured as share in employment and equity. These spillover estimates suggest that an increase of FDI presence by 10 percentage points would increase the output growth of domestic firms by 1.5% in if FDI presence measured as share in employment, and by 0.4% if it is measured as share in equity. The effects are larger but less significant when using the less accurate OLS and FE methods.

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heteroskedasticity. The estimates from these methods are similar in sign and significance to those obtained by fixed effects, therefore are not presented in the appendix.

Hence, the size of spillover effects is positively related to foreign presence in terms of equity and employment but not sales. Among the control variables, investment in intangible assets is positive and significant at 1% significance level, although, quite small in magnitude. That is, if the domestic firm increases its investment in intangible assets (know-how, brand names, managerial skills or marketing and export networks) by 10% this will contribute to an increase of 0.05% of output growth. Increasing the investment in new machinery and equipment by 10% will induce an output growth of between 0.9% and 1.2%. If the local firm increases the number of skilled workers by 10%, its output would growth by 1.1% for all three measures of spillovers. With respect to competition variables all coefficients but one are insignificant.

In table 6 we present GLS regression results including the interaction terms of the spillover variable with investment in intangible assets, investment in new machinery and equipment and labor quality, to account for the indirect effect of spillovers. Since the interaction of labor quality with the spillover variable accounts for the movement of skilled labor from and to domestic firms, and the Herfindahl indexes capture the effect of competition, what remains to be captured from the spillover coefficient is the effects of demonstration-imitation and vertical linkages.

The direct spillover effect is positive and significant at 1% significance level if proxied by FDI-share in employment or sales. Thus base-case domestic firms with low intangible assets, investments and human capital benefit from an increase in foreign share in employment or sales.

In the same equations, investment in intangible assets is positive and significant at 1% significance level. Hence, firms increasing investment in intangibles by 10% increases the output growth by 0.5% and 0.3% respectively. However, the interaction with the spillover variable is negative and significant at 1% significance level. The negative coefficient of this interaction term means that the larger the presence of foreign firms in industry, the less investment by domestic firms will lead to output growth. A possible explanation is that in industries with large foreign presence, the foreign firms dominate the up-market segment (where intangible assets are crucial) and local firms find it hard to penetrate this segment by upgrading their technology and brand names.

The coefficient of labor quality is positive and significant at 1% in all cases and similar in magnitude, suggesting that a larger share of skilled workers increases domestic firms output growth. The interaction of labor quality with the spillover variable is negative and significant at 1% significant for both the spillover measured as share in employment and sale. In other words, the larger the share of foreign firms in industry's employment or sale the lower is the share of skilled workers in domestic firms. We interpret this negative coefficient of the interaction term as indication of a net-movement of skilled labor from domestic towards foreign firms, possibly attracted by higher wages. This argument is supported from our findings on the performance of foreign firms relative to domestic firms, in table 4. The last column on real wages, as argued before shows that foreign firms pay higher wages (efficiency wages) than domestic firms.

The effect of competition is captured by separate Herfindahl indices constructed for foreign and domestic firms respectively. This coefficient is negative and significant at 5% or 10% significance level, suggesting that competition from foreign firms matters for the productivity growth of domestic firms. Competition from foreign firms appears to induce domestic firms to better use their resources in order to maintain their market share, which in turn enhances their productivity. A reduction of industry concentration (increase in competition) by 10% increases output growth by 3.4% to 3.9%.

The effects differ on some aspects if the spillover is proxied with foreign investor's share of equity in the industry. The direct effect is negative and significant at 5% significance level. This suggests that a large share of foreign firms in industries' equity is not beneficial for base case local firms. However, they can increase their benefits by investing in intangible assets or labor quality, both of which have positive and significant coefficients, whereas investment in new machinery and equipment has a significant but counter intuitive negative sign. The interaction of the spillover variable with investment in new machinery and with labor quality is positive and significant. Hence where foreign firms in the industry are equity-intensive, domestic firms would benefit in higher output growth by investing in upgrading their physical and human capital.

As an overall conclusion, we find that spillovers from technology transfer to domestic firms are on average positive and substantive (Table 5). However, the actual

benefits received by a local firm depend on both its own characteristics and the capital and employment intensity of the foreign investors (Table 6). The direct effect on base-case local firms is positive when spillovers are measured as foreign firms' share in employment or sale, but negative when measured as foreign firms' share in equity.

Intangible assets such as know-how or brand names, investment in new machinery, and skilled workers increase the output growth of domestic firms. However, if foreign firms dominate the industry, domestic firms experience a smaller effect of these investments on output. Moreover, competition from foreign firms positively affects the output growth.

Substantial negative spillovers may arise with the loss of skilled workers to foreign firms. This is detrimental for the output growth of domestic firms. Nevertheless, for firms with high labor quality its impact on output growth depends on the type of foreign investor they face.

6.2. Firm Size and Trade Orientation.

The pooling of all firms in our sample to estimate the spillover coefficient may hide important variations in spillover effects for different groups of firms. We thus differentiate the analysis by firm size and trade orientation. Large firms arguably have more resources to invest in new technology and hence are able to absorb the advanced technology of foreign firms or to attract qualified labor force and therefore cope better with increased competition introduced by foreign firms. On the other hand, export oriented domestic firms produce for foreign markets, and thus may have interfaces of their own to learn about advanced technology and management practices. In order to account for both factors we divide the sample into large and small firms[12] as well as into firms that export and firms that produce only for domestic market and run our baseline specification for both sub-samples.

Table 7 shows the regression results for the sub-samples of large and small domestic firms. We find that large domestic firms do not benefit from a direct spillover via demonstration or linkage effects. (K: A large firm with base case characteristics does

not exist!). The spillovers they may receive depend on their own investment in intangible assets, in new machinery and equipment and in skilled workers. Hence, it appears that large firms are to a high degree masters of their own destiny. In contrast, small firms receive large positive direct spillovers attributable to demonstration-imitation and vertical linkage effects. Yet, they are not able to increase benefits of spillovers by own investment in intangible assets and new machinery and equipment. Moreover, they experience a loss of skilled labor. Hence, small firms may grow with direct relations with foreign firms, but the size of this spillover does not increase with own capability development.

Table 8 presents the results from firm trade orientation. For exporting firm, the direct effect is negative and not significant, and apart from the labor quality variable, the interaction effects are small and insignificant. This result supports the argument that for exporting firms what matters more is knowledgeable of buyers overseas, rather than foreign presence in the domestic markets. In remarkable contrast, non-exporting firms experience positive significant direct spillovers. They can significantly increase the extend of spillovers with their own investment in new machinery and equipment, as the interaction effect is positive and significant at 1% significance level. Another interesting result is that while competition from domestic firms is beneficial for domestic firms, competition from foreign firms is harmful, however not as much as to push domestic firms up their average cost curve resulting in negative spillovers as in Aitken and Harrison (1999).

6.3. Spillovers related to domestic firm ownership structure.

As an extension to the literature referred in this paper, in this section we would like to investigate spillovers related to ownership structure. As suggested in the literature FDI may foster economic growth by increasing competition in the host country, forcing thus domestic firms to restructure in order to be efficient. Restructuring has been very important in transition economies. The outcome of privatization process in Estonia, as well as in other transition economies, has resulted in full or partial transfer of ownership rights of firms to different groups such as managers, employees, domestic institutions,

[12] Small firms are those with at least 100 employees, while large firms those with more than 100 employees. With this division our sample of 1478 domestic firms has 947 small firms and 531 big firms,

domestic individuals not employed by the firm and/or foreign firms or individuals. This has given rise to a wide variety of ownership structures that for the purpose of this study are classified within three main domestic firm ownership groups: insider dominated, domestic outsider dominated and state dominated. The question asked is whether firms belonging to one of the last three groups are more likely to benefit from spillovers than those belonging to the other two groups? As usually insider owned firms are small, labor-intensive and face limited access to capital, therefore we expect them to be less able to absorb technology and cope with competition than domestic outsider and state owned firms.

Table 9 shows the results of the impact of domestic firm ownership structure on its output growth. The first column of this table presents results without dummy for ownership control, which we also discussed in table 6. After controlling for domestic firm ownership structure we see that the significance, sign and magnitude of variables generally remains the same. In contrast, the coefficients of foreign and domestic competition are larger in magnitude. Furthermore, both ownership dummies are positive and significant, however, the coefficient of the dummy for outsider owned firms is slightly larger in absolute value than that of the state owned firms' dummy. That is, if both ownership shares increase by 10 percent, outsider owned firms experience an output growth of 0.1% larger than state owned firms. This finding is consistent with Jones and Mygind (1999) who find private owned firms to perform better than state owned firms. Nevertheless, insider owned firms perform worse than both state and outsider owned firms. This is not surprising given that, as suggested from the theory, workers interests are in conflict with managers who look upon the long-term interests of their enterprise. They will hamper restructuring by resisting lay-offs and investing little in capital equipment as stressed for example by Frydman et al (1993).

The above specifications, however, assume that different ownership structures affect only the regression's intercept but not the slopes, i.e., all coefficients other than the intercept are the same across firms with different ownership structures. Nevertheless, this may not be the case, therefore, we proceed in our analysis by dividing the sample of domestic firms into state, outsider and insider owned and run regressions for all these

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whereas the mean number of employee is 139 employees.

sub-samples. Table 10 provides the results of these regressions. We see that although state owned firms have large positive and significant spillovers from demonstration-imitation and vertical linkages they do not have the ability to benefit from spillover effects through their own investment in intangible assets (know-how, brand name, managerial experience, etc), and in new machinery and equipment. Furthermore, they experience a loss of skilled workers to foreign firms. This suggests that for these firms what matters most is the direct contacts with foreign firms, rather then their own capability development. Competition, however, has a positive effect on their performance inducing them to use inputs more efficiently in keeping their market share. On the other hand, outsider owned firms, as expected, do benefit from spillovers from demonstration-imitation and vertical linkages, but not as much as state owned firms, because, as indicated by the coefficients of interaction terms, they rely on their internal abilities to catch up with their foreign counterparts.

Insider owned firms experience negative spillovers from technology transfer. This suggests that they are neither able to benefit from direct contacts with foreign firms nor capable to absorb advanced technologies of foreign firms. Yet, these firms can hold on to their skilled labor, probably due to the fact that employees in these firms are also shareholders of the company. Finally, they also face a detrimental competition from both foreign competition and the other domestic firms. That is, foreign and other domestic firms produce at a much lower cost and hence take market shares away from these firms pushing them up their average cost curve, thus, forcing them to cut on production.

As a conclusion, ownership structure matters for the ability of the domestic firms to benefit from spillovers of technology transfer. We find that state owned and outsider owned firms benefit from spillovers of technology transfer, whereas insider owned firms experience strong negative spillovers. However, only outsider owned firms have the capability development to catch up with foreign competitors. Positive spillovers of both state and outsider owned firms are also supported by competition.

7. Conclusions

In this paper we investigate spillovers from technology transfer to domestic firms in a transition economy. The research questions we raise are the following: a) Are there spillovers of technology transfer to domestic firms? b) Do these spillovers depend on domestic firms' absorptive capacity? c) Do spillovers depend on firm size and domestic firm trade orientation?, and d) on the ownership structure of domestic firms?

In answering these questions we have disentangled the effect of technology transfer from that of competition employing technology and competition control variables. We employ a panel data on Estonian firms for the period 1995-1999, and use a production function framework to estimate the impact of technology transfer from FDI on the productivity of domestic firms. We find that spillovers from technology transfer depend on the measure of spillovers used. Furthermore, they depend on firm size, its ownership structure, domestic firm trade orientation and their proximity to foreign firms. In addition, spillovers of technology transfer benefit from competition of foreign firms as it makes domestic firms use more efficiently their existing technologies, or search for new ones to maintain their market shares. Moreover, although possessing skilled labor increases output growth, its movement toward foreign firms significantly harms the indigenous firm output growth. Furthermore, by investing in intangible assets and in new machinery and equipment benefits domestic firms in higher output growth. However, this is not sufficient for domestic firms to benefit from the advanced technology of foreign firms especially when the industry is characterized by large shares of foreign firms in employment, sales or equity. In addition, we find that state owned and outsider owned firms benefit from spillovers of technology transfer whereas, insider owned firms experience strong negative spillovers. However, only outsider owned firms have the resources and capabilities, such as better managerial experience, better access to finance or deeper restructuring, to catch up with foreign competitors. Positive spillovers of both state and outsider owned firms are also supported by competition. In conclusion, the policy implications for the host country governments would be to foster competition as it induces domestic firms be more efficient in using the existing technology or search for new technology so that they keep their existing market share. As domestic firms benefit

more from an increase in foreign share in employment or sale, rather than an increase in foreign share in equity, the host country government should create incentives for foreign firms to employ mainly local workers and invest in their training. This would reduce the movement of skilled workers from domestic to foreign firms. Moreover, for the country itself is important to possess educated people as this is necessary for the domestic firm output growth and for benefiting from the advanced technology of foreign firms.

Although the conclusions of this paper point towards significant effect of foreign presence on domestic firms' output growth future research ought to verify the robustness of our results. More specifically alternative definitions of competition such as industry concentration ratio, import penetration, market share and rents could be employed. Furthermore, if data becomes available one potential extension would be to distinguish in between intra and inter industry spillovers.

Appendix

Table 1: Variable definition

Variables	**Definitions**
Output	Net sales are used as proxy. Expressed in thousands of kroons.
Employment	Firm' s number of employees per year.
Materials	Materials are calculated as the sum of raw materials, fuel and electricity. Expressed in thousands of kroons.
Capital	Capital is calculated as the average of fixed assets at the beginning and end of year. Expressed in thousands of kroons.
IAsset	Intangible assets. Expressed in Thousands of kroons
Spillover (Employment)	Spillover in industry is the share of foreign firms' employment in total employment of the industry.
Spillover (Sale)	The share of foreign firms' sales in total industry sales.
Spillover (Equity)	The share of foreign firms' equity participation in total industry equity.
Location Spillover	The share of foreign firms' employment in total employment in industry j in region i.
Real Wage	Real wage per worker is the ratio of total expenditure on wages and salaries per year to number of employees. Expressed in thousands of kroons.
Investment	The expenditure on new machinery and equipment per year. Used to account for investment in new technology. Expressed in thousands of kroons.
Labor Quality	The share of skilled workers in total workforce
Export	Total revenue from export. Expressed in thousands of kroons
Ownership Share	The share in firm' s equity of a particular group.
Herfindahl Index	Used to capture monopoly power = $\sum_j \left(\frac{Sale_i}{Sale_j} \right)^2$ j-industry, i-firm
Industry Groups	Constructed on a two-digit industry classification.

Table 2: Mean and Standard Deviation for the whole sample

Variables	Observations	Mean	Standard Deviation
Output	1836	40734	95877
Labor	1836	132	232
Capital	1836	12768	35846
Materials	1836	15562	45414
IAsset	1836	888	4583
Investment	1836	1319	5873
Export	1836	13099	40552
Real wage	1836	34.3	34.64
Share of Skilled workers	1278	0.79	0.17
For. Herfindahl	1836	0.048	0.111
Dom. Herfindahl	1836	0.09	0.08

All variables are deflated at the 1995 prices.

Table 3: Descriptive Statistics

Industries	Number of Firms			IAsset/Y	Foreign Presence in %		
	Domestic (1)	Foreign (2)	Total (3)	in % (4)	Spill.Emp (5)	Spill.Sale (6)	Spill.Equity (7)
Food Products	227	21	248	49.9	8.37	17.8	25
Textile Products	97	30	127	2.3	13.2	11.3	5.4
Leather Products	19	14	33	2.17	50.2	73	84.18
Wood, Paper and Pulp Products	158	36	194	8.69	17.8	24.2	57.4
Coke, Petroleum and Chemical Products	37	21	58	3.20	13.3	20.3	19.7
Rubber, Plastic & Non-Metallic Products	85	42	127	8.56	45.5	68.5	56.9
Metallic Products	75	17	92	0.84	8.7	15.1	21.16
Manufact. of Machinery & Equip	79	18	97	1.4	10.9	17.8	4.5
Manufac. of Electrical and Transp Equipment.	107	30	137	4.03	13.2	22.2	14.86
Furniture & Other Manufacture	72	22	94	5.91	16.6	25.3	12.78
Electricity, Gas & Water Supply	56	5	61	0.36	34.7	72.7	25.8
Construction	199	11	210	1.67	6.9	8	1.5
Wholesale & Retail Trade	267	91	358	1.43	12.6	23.3	31.9
Total	1478	358	1836	9.76	15.6	25	26.2

Table 4: The performance of foreign firms relative to domestic firms

Industry	K/L (1)	Y/L (2)	IAsset/Y (3)	Fsize (4)	Invest/Y (5)	Export/Y (6)	RW/L (7)
Food Products	2.76	2.36	0.02	1.04	0.67	1.76	1.53
Textile Products	0.64	0.93	1.41	0.46	0.4	1.09	1.18
Leather Products	2.71	2.67	0 .5	1.27	0.91	1.67	2.03
Wood, Pulp and Paper Products	2.67	2.61	0.07	0.86	1.5	1.72	1.58
Coke, Petroleum & Chemical Products	5.24	2	0.92	0.13	0.31	1.04	1.46
Rubber, Plastic & Non-Metallic Products	5.54	2.69	1.97	1.67	0.56	2.05	1.79
Metallic Products	1.69	3.23	0.65	0.44	0.31	0.99	1.38
Manuf. of Machinery and Equipment	0.49	2.40	0.19	0.41	1.06	2.33	1.78
Manuf. of Transport and Electrical Equip.	0.69	2.68	0.13	0.44	1.15	1.52	1.56
Manuf. of Furniture and Other Manufacturing	1.36	2.52	0.48	0.53	1.72	1.34	1.63
Electricity, Gas and Water Supply	3.00	6.59	11.5	7.1	0.46	.	2.27
Construction	0.96	1.32	0.18	1.48	0.53	1.49	1.33
Wholesale and Retail Trade	2.17	2.96	1.43	0.35	1.66	1.5	1.77
All Industries	2.27	2.49	0.25	0.69	0.95	1.75	1.55

Note: Each number is obtained as: Mean(Variable)Foreign Firm/Mean(variable) Domestic Firm.

Table 5: The net impact of spillovers to the output growth of domestic firms using different estimation methods.

Dependant Variable: Growth of output of domestic firms.

Variables	**Spillover Employment**			**Spillover Sale**			**Spillover Equity**		
	OLS (1)	**FE** (2)	**GLS** (3)	**OLS** (4)	**FE** (5)	**GLS** (6)	**OLS** (7)	**FE** (8)	**GLS** (9)
Spillover $_{t-1}$	0.19 (0.84)	0.34 (1.43)	0.15* (3.30)	0.08 (0.43)	0.29 (1.52)	0.03 (1.21)	0.05 (0.59)	0.12 (1.26)	0.04*** (1.78)
IAsset/Y	0.005*** (1.78)	0.004 (0.24)	0.005* (3.05)	0.005*** (1.81)	0.004 (0.28)	0.005* (2.91)	0.005*** (1.79)	0.004 (0.26)	0.005* (4.62)
(Investment/Y) $_{t-1}$	0.14 (0.49)	-0.08 (-0.39)	0.09* (2.85)	0.15 (0.51)	-0.09 (-0.44)	0.11* (3.01)	0.15 (0.51)	-0.08 (-0.41)	0.12* (3.64)
Labor Quality	0.11 (1.40)	-0.08 (-0.72)	0.11* (18.33)	0.11 (1.40)	-0.10 (-0.90)	0.11* (19.9)	0.11 (1.37)	-0.09 (-0.86)	0.11* (17.9)
For. Herfindahl	-0.41 (-0.82)	-0.37 (-0.50)	-0.15 (-1.18)	-0.37 (-0.77)	-0.42 (-0.56)	-0.09 (-0.68)	-0.39 (-0.87)	-0.38 (-0.51)	-0.20 (-1.34)
Dom. Herfindahl	-0.21 (-0.49)	-0.11 (0.22)	-0.16*** (-1.71)	-0.18 (-0.42)	-0.11 (-0.22)	-0.08 (-0.83)	-0.24 (-0.57)	-0.21 (-0.42)	-0.15 (-1.30)
Export/Y	0.003 (-0.06)	0.05 (0.35)	0.01 (0.19)	-0.002 (-0.07)	0.04 (0.32)	0.003 (0.56)	-0.003 (-0.07)	0.04 (1.30)	0.005 (0.65)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nr. Observations	791	791	725	791	791	725	791	791	725
R-Sq	0.47	0.50		0.47	0.50		0.47	0.49	
F-test[13]	14.59 (0.000)	23.56 (0.000)	9.8e+08 (0.000)	14.41 (0.000)	23.59 (0.000)	9.6e+07 (0.000)	14.16 (0.000)	23.52 (0.000)	1.14e+07 (0.000)
Hausman-Test		66.34 (0.000)			68.5 (0.000)			66.78 (0.000)	
LM test of AR(1) For unbalanced panels.		105 P(chi2)= 0.0000			105 P(chi2)= 0.000			103 P(chi2)= 0.0000	
Wald-test for groupwise heteroscedasticity		278.00 P(chi2)= 0.0000			122 P(chi2)= 0.0000			147 P(chi2)= 0.0000	

Note: Inputs (capital, labor and materials), a constant and Mills ratio (obtained from Heckman two-step procedure) are also included in regression as right hand side variable.
*, ** and *** indicate 1%, 5% and 10% significance level, respectively.
z-statistic in parentheses.

[13] The equivalent of F-test in GLS regressions is Wald-statistic that has a chi-squared distribution.

Table 6: The net impact of spillover with interaction terms, accounting for indirect effect of spillovers.

Dependant Variable: Growth of output of domestic firms.

Variables	**GLS (Empl)** (1)	**GLS (Sale)** (2)	**GLS (Equity)** (3)
$Spillover_{t-1}$	0.36* (4.80)	0.35* (6.40)	-0.12** (-2.41)
IAsset/Y	0.05* (9.36)	0.03* (10.89)	0.07* (6.88)
$(Investment/Y)_{t-1}$	0.03 (0.35)	0.08 (1.06)	-0.32* (-3.53)
Labor Quality	0.15* (17.52)	0.19* (17.09)	0.08* (5.71)
IAsset/Y *$Spillover_{t-1}$	-0.41* (-8.33)	-0.13* (-13.18)	-0.21* (-6.21)
$(Investment/Y)_{t-1}$*$Spillover_{t-1}$	0.025 (0.05)	0.11 (0.29)	0.93* (4.62)
Labor Quality*$Spillover_{t-1}$	-0.26* (-3.93)	-0.33* (-5.67)	0.19* (3.67)
For. Herfindahl	-0.34*** (-1.84)	-0.39** (-2.24)	-0.36** (-2.30)
Dom. Herfindahl	-0.19 (-1.34)	-0.23*** (-1.88)	-0.20 (-1.30)
Export/Y	0.01 (-1.46)	-0.01 (-1.59)	-0.006 (-0.61)
Industry Dummy	Yes	Yes	Yes
Time Dummy	Yes	Yes	Yes
Nr. Observations	725	725	725
Wald-test for joint significance of coefficients	1.87e+07 (0.000)	8.2e+04 (0.000)	1.7e+04 (0.000)

Note: Inputs (capital, labor and materials), a constant and Mills ratio (obtained from Heckman two-step procedure) are also included in regression as right hand side variable.
*, ** and *** indicate 1%, 5% and 10% significance level, respectively.
z-statistic in parentheses.

Table 7: The impact of firm size on spillovers to domestic firms.

Dependant Variable: Growth of output of domestic firms. GLS results.

Variables	**Large Firms** (1)	**Small Firms** (2)
$Spillover_{t-1}$	0.09	1.68*
	(0.37)	(8.32)
IAsset/Y	-0.44	0.043*
	(-1.48)	(10.89)
$(Investment/Y)_{t-1}$	-0.84*	1.01*
	(-4.02)	(11.21)
Labor Quality	-0.15**	0.38*
	(-2.79)	(14.79)
IAsset/Y *$Spillover_{t-1}$	2.53***	-0.32*
	(1.92)	(9.17)
$(Investment/Y)_{t-1}$*$Spillover_{t-1}$	2.24**	-1.20
	(2.03)	(-1.51)
Labor Quality*$Spillover_{t-1}$	0.44***	-1.86*
	(1.64)	(-7.93)
For. Herfindahl	-0.64***	-0.91
	(-1.85)	(-0.29)
Dom. Herfindahl	-0.37	-0.22
	(-1.17)	(-1.09)
Export/Y	-0.016	0.11*
	(-0.96)	(8.98)
Industry Dummy	Yes	Yes
Time Dummy	Yes	Yes
Nr. Observations	297	396
Wald-test for joint significance of coefficients	6.3e+03 (0.000)	5.6e+05 (0.000)

Note: Inputs (capital, labor and materials), a constant and Mills ratio (obtained from Heckman two-step procedure) are also included in regression as right hand side variable.
*, ** and *** indicate 1%, 5% and 10% significance level, respectively
z-statistic in parentheses.

Table 8: The impact of trade on spillovers to domestic firms.

Dependant Variable: Growth of output of domestic firms. GLS results.

Variables	**Exporting Firms** (1)	**Non-Exporting Firms** (2)
$Spillover_{t-1}$	-0.27 (-1.26)	3.21* (9.50)
IAsset/Y	0.16* (2.87)	0.11* (5.79)
$(Investment/Y)_{t-1}$	-0.30** (-1.51)	-0.34 (-1.24)
Labor Quality	-0.05** (-2.25)	0.36* (13.15)
IAsset/Y *$Spillover_{t-1}$	-0.54 (-1.16)	-0.99* (-5.28)
$(Investment/Y)_{t-1}$*$Spillover_{t-1}$	0.37 (0.48)	9.86* (4.41)
Labor Quality*$Spillover_{t-1}$	0.79* (3.74)	-3.97* (-10.36)
For. Herfindahl	-0.21 (-0.70)	2.39* (3.43)
Dom. Herfindahl	0.05 (0.20)	-2.54* (-6.81)
Industry Dummy	Yes	Yes
Time Dummy	Yes	Yes
Nr. Observations	457	211
Wald-test for joint significance of coefficients	3.8e+05 (0.000)	1.61e+09 (0.000)

Note: Inputs (capital, labor and materials), a constant and Mills ratio (obtained from Heckman two-step procedure) are also included in regression as right hand side variable.
*, ** and *** indicate 1%, 5% and 10% significance level, respectively.
z-statistic in parentheses.

Table 9: The impact of firm ownership on output growth.

Dependant Variable: Growth of output of domestic firms.

Variables	**GLS** W/o Ownership control. (1)	**GLS** W. Ownership control. (2)
$Spillover_{t-1}$	0.36* (4.70)	0.39* (3.02)
IAsset/Y	0.05* (9.36)	0.05* (14.94)
$(Investment/Y)_{t-1}$	0.03 (0.35)	0.02 (0.25)
Labor Quality	0.16* (17.52)	0.17* (16.04)
IAsset/Y *$Spillover_{t-1}$	-0.41* (-8.33)	-0.44* (-14.13)
$(Investment/Y)_{t-1}$*$Spillover_{t-1}$	0.026 (0.05)	0.12 (0.21)
Labor Quality*$Spillover_{t-1}$	-0.26* (-3.93)	-0.33* (-3.72)
For. Herfindahl	-0.34*** (-1.84)	-0.45** (-2.14)
Dom. Herfindahl	-0.19 (-1.34)	-0.33*** (-1.86)
Export/Y	-0.01 (-1.46)	-0.004 (-0.66)
State Dummy		0.039* (6.74)
Outsider Dummy		0.044* (7.71)
Industry Dummy	Yes	Yes
Time Dummy	Yes	Yes
Nr. Observations	725	725
Wald-test for joint significance of coefficients	1.87e+07 (0.000)	2.8e+06 (0.000)

Note: Inputs (capital, labor and materials), a constant and Mills ratio (obtained from Heckman two-step procedure) are also included in regression as right hand side variable.
* and ** indicate 1% and 5% significance level, respectively.
z-statistic in parentheses.

Table 10: Spillovers to State and Private Owned Firms.

Dependant Variable: Growth of output of domestic firms. GLS results.

Variables	**State Firms** (1)	**Outsider-Owned Firms** (2)	**Insider-Owned Firms** (3)
$Spillover_{t-1}$	2.49*	0.61**	-4.93*
	(7.92)	(2.03)	(-6.93)
IAsset/Y	0.43*	-1.62*	0.59
	(5.64)	(-7.46)	(1.34)
$(Investment/Y)_{t-1}$	1.48*	-0.11	0.12
	(9.43)	(-0.71)	(0.14)
Labor Quality	0.53*	-0.008	-0.40*
	(12.38)	(-0.18)	(-5.01)
IAsset/Y *$Spillover_{t-1}$	-3.90*	4.69*	-2.67**
	(-5.53)	(4.81)	(-2.26)
$(Investment/Y)_{t-1}$*$Spillover_{t-1}$	-3.92*	0.31	-15.44**
	(-4.26)	(0.54)	(-2.32)
Labor Quality*$Spillover_{t-1}$	-2.45*	-0.36	5.51*
	(-7.38)	(-1.13)	(6.92)
For. Herfindahl	-3.13*	-0.79*	4.43*
	(-7.33)	(-3.97)	(3.31)
Dom. Herfindahl	-2.25*	0.12	1.69*
	(-6.09)	(0.59)	(2.94)
Export/Y	-0.003	0.08*	-0.026
	(-0.10)	(4.22)	(-0.86)
Industry Dummy	Yes	Yes	Yes
Time Dummy	Yes	Yes	Yes
Nr. Observations	320	203	164
Wald-test for joint significance of coefficients	3.1e+06 (0.000)	6.98e+07 (0.000)	1.46e+07 (0.000)

Note: Inputs (capital, labor and materials), a constant and Mills ratio (obtained from Heckman two-step procedure) are also included in regression as right hand side variable.
*, ** and *** indicate 1%, 5% and 10% significance level, respectively.
z-statistic in parentheses.

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