How important is trade and foreign ownership in closing the technology gap? Evidence from Estonia and Slovenia

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Abstract

This study focuses on the impact that the different methods of privatization implemented in Estonia and Slovenia had on the transfer of technology to foreign affiliates and local spillovers to the domestic economy. We develop a model that looks at three aspects of the problem: the importance of direct and indirect effects of FDI; the role of local absorptive capacity; and the role of trade in technology transfer. By utilizing information contained in the input-output tables of each country, we also differentiate between intra-industry and inter-industry spillovers. We then estimate the impact that foreign ownership had on a panel of 363 manufacturing enterprises in Estonia and 1093 manufacturing firms in Slovenia covering the last half of the 1990s. The study finds that the method of privatization does influence the way a firm obtains technology from abroad: Estonia, which attracted a considerable amount of FDI through its privatization program, used this channel to gain direct access to global markets for technology, while Slovenia discouraged sales of State enterprises and encouraged firms to use trade to gain access to these markets.

JEL classification: D24; F14.

Keywords: Foreign direct investments, Technology transfer, Spillovers, Transition economics.

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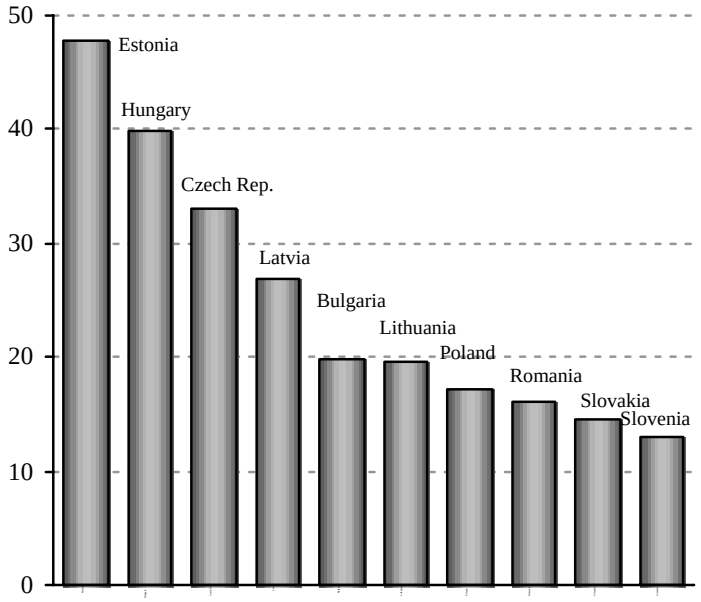
1. Introduction

Foreign direct investment (FDI) and trade can be important catalysts for the economic transformation of Eastern Europe. Their importance lies not only in restructuring old and outdated plants and equipment, but also in the transfer of technology and organizational forms from relatively more technologically advanced economies. They can also result in positive externalities or "knowledge spillovers" to the local economy through linkages with local suppliers and users, observing nearby foreign firms, and employee training programmes, etc. But they can also result in negative externalities by restricting access to technology and restricting competition.

Despite the controversies over the costs and benefits from FDI, some countries in eastern Europe have encouraged FDI much more than others. At the turn of the century, Estonia had the highest share of FDI stocks in GDP and Slovenia the lowest share among the Candidate countries. (see figure 1) Although both countries brought their regulatory systems in line with the EU *acquis* in preparation for EU membership, which created a largely open and non-discriminatory

Figure 1: Inward stock of FDI as percentage of GDP in 1999



Source: Authors' Own calculation based on UNCTAD TNC database

framework for FDI, they implemented two very different methods of privatization: Estonia opened the privatization process to foreign capital and Slovenia created barriers to foreign capital by favouring employee and management buy-outs.

Do such differences in privatization methods have an effect on the channel of technology transfer and spillovers? Undoubtedly, enterprises can obtain new technology and organizational skills through channels other than FDI, such as international trade, licensing agreements and alliances. This paper focuses specifically on the impact that the two different methods of privatization implemented in Estonia and Slovenia had on the transfer of technology through FDI and spillovers to the domestic economy. Availability of firm-level data for the second half of

the 1990s in both countries provide a unique opportunity to study not only the factors that lead to technology transfer and spillovers, but also compare these two countries with respect to their methods of privatization. Both countries are small and depend to a great extent on the global markets: Estonia has a population of about 1.4 million and Slovenia has a population of slightly less than 2 million. Yet about 30 per cent of the enterprises in Estonia are foreign owned as compared with about 10 per cent in Slovenia. This differences lead to very different patterns of technology transfer, despite that both countries closed the technology gap with the EU average in the late 1990s.

To better understand the nature of technology transfer and spillovers, this paper also makes a contribution to the measurement of technology transfer and spillovers. Like previous papers, we use firm-level data to study effects of direct technology transfer through FDI from parent multinational enterprise to its affiliates as well as to study indirect technology spillovers from the affiliate to other firms in the home country. Existing evidence from Eastern European firm-level panel data however suggests that there are few spillovers from FDI. Konings (2001) shows that FDI may be important for transferring technology to an affiliate, but provides no evidence of spillovers to local enterprises in Bulgaria, Poland and Romania from 1993 to 1997. Instead, there is significant evidence of negative spillovers in Poland. Djankov and Hoekman (2000) also provide evidence of negative spillovers and suggest that there may not even have been much technology transfer to the foreign affiliates in the Czech Republic from 1992 to 1996.

Kinoshita (2000) provides evidence of spillovers in the Czech Republic from 1995 to 1998, but they are limited to enterprises engaged in research and development (R&D) or in the production of electrical equipment. Finally, a recent study of some 8,000 firms in 10 transition economies by Damijan, et. al (2002), using a dynamic growth accounting approach, confirms that spillovers are rare in the eastern European Candidate countries, but there is no evidence of negative spillovers.

The analyses of panel data from other countries provide mixed evidence of technology transfer and spillovers. Aitken and Harrison (1999) show significant technology transfer to the affiliates and some positive spillovers to domestic enterprises in Venezuela located close to the affiliate, but there were also negative spillovers to the domestic economy as a whole. There was some positive spillovers in other developing countries, but these were limited to certain industries, such as those with relatively simple technology in Morocco (Haddad and Harrison, 1993), are export oriented as in Indonesia (Blomstrom and Sjoholm, 1999), or have sufficient human capital as in Uruguay (Blomström, 1994). Earlier studies that did not use panel data often found evidence of intra-industry spillovers. These include a study by Caves (1974) of Australian manufacturing in 1966, a study by Globerman (1979) of Canadian industry in 1972 and studies of Mexico in the mid-1970s by Blomström and Persson (1983) and the mid-1980s by Blomström and Wolff (1994). However, a study of US firms in Europe shown that spillovers were localized and that competition forced

many local competitors out of small markets (Cantwell, 1989). Recent analyses of panel data provide little or no evidence of spillovers in the 1990s. Girma, Greenaway and Wakelin (2001) provide evidence for the United Kingdom, (Berry, et. al. (2001), for Ireland, and Alverez, et. al. (2002) for Spain. There was also some evidence of negative spillovers in Ireland.

Unlike previous studies of spillovers from FDI, we include not only intra-industry spillovers, but also inter-industry spillovers. This allows us to capture some of the spillovers obtained from supplier and user linkages. The following section contains a discussion of the empirical model and the underlying theory. The model looks at the three aspects of the technology transfer problem: the importance of direct and indirect effects of FDI; the role of local absorptive capacity; and the role of trade in technology transfer. Section 3 discusses the data and the main empirical findings. Finally, Section 4 concludes by bringing the privatization method back into the discussion.

2. Modelling effects of foreign ownership on productivity growth.

Technology transfer and knowledge spillovers are not easy to measure. They can be measured indirectly in a production function approach by considering the residual of output growth as the rate of technological change after subtracting off the growth rates of labour and capital. But this residual may be more a measure of ignorance than a measure of technological accumulation as Abramovitz (1956) pointed out. An

alternative way is to include the technology variables directly in the production function, a method more reminiscent of the endogenous growth models developed since the late 1980s. This approach provides a way to study the various factors that affect productivity growth, including the technological accumulation. We do this by using the growth accounting approach and decomposing total factor productivity (TFP) into factors internal and external to the firm, such as R&D activity, human capital and channels of technology transfer.

Following Basu and Fernald (1995), we assume each firm has a production function for gross output:

$$Y_{it} = F^{i}(K_{it}^{\alpha} L_{it}^{\beta} M_{it}^{\gamma} T_{it}), \tag{1}$$

where Y_{it} is gross output in firm i at time t, and K, L, M, and T represent the capital stock, employment, materials used in production, and technology, respectively. The production function is homogenous of degree r in K, L and M, such that $r = \alpha+\beta+\gamma \neq 1$, which implies that F^{i} may have non-constant returns to scale. We include materials used in production because of measurement problems in K, which, typically for former socialist countries, arise because of poor accounting standards and the tendency to understate the value of capital due to the management and worker buy-out methods of privatization.

Differentiating equation (1) with respect to time, we get:

$$y_{it} = \alpha k_{it} + \beta l_{it} + \gamma m_{it} + t_{it}, \tag{2}$$

where the small letter variable indicates its logarithmic growth rate and α, β, *and* γ represent the elasticity of output with respect to *K*, *L* and *M*. We assume that technology *T* is a function of ownership variables $\mathbf{F}_{it}$ and of various spillover effects $\mathbf{Z}_{it}$ and an error term *e*:

(3) $$t_{it} = f^{i}(\mathbf{F}_{it}, \mathbf{Z}_{it}) + e_{it}, \text{ where}$$

$$e_{it} \sim (\sigma^2, 0).$$

The basic idea underlying this equation is that foreign firms can transfer newer technology and organizational skills both directly to the affiliate, and indirectly to other enterprises in the host economy. On one hand, direct effects generally appear to affiliates as changes in productivity (shown in F_i) and in better utilization of existing inputs (accounted directly in foreign affiliates by introducing interaction terms F_iK_{it}, F_iL_{it} and F_iM_{it} into model (2)). Presence of an affiliate, on the other hand, can also increase the rate of technical change and technological learning in the economy indirectly through knowledge spillovers to local enterprises. Knowledge spillovers occur as a consequence of affiliate introducing new technologies and organizational skills that are typically better than in the local enterprises. The innovation system and social capabilities of the host economy, together with the absorptive capacity of other enterprises in the host economy, will then determine the pace of technological progress in the economy as a whole.

Knowledge spillovers can occur between firms that are vertically integrated with the foreign affiliate (inter-industry spillovers) or in direct

competition with it (intra-industry spillovers). Kokko (1992) and Parez (1998) describe at least five ways how knowledge spillovers from foreign affiliates can increase technical change and technological learning. First, competition with the foreign affiliate can increase intra-industry spillovers by stimulating technical change and technological learning. Greater competitive pressure faced by local firms induces them to introduce new products to defend their market share and adopt new management methods to increase productivity. This kind of spillover, known as "competition effect", is most important in industries with relatively low actual and potential competition and high barriers to entry. Second, cooperation between foreign affiliates and upstream suppliers and downstream users increases knowledge spillovers (vertical spillovers). To improve the quality standards of their suppliers, foreign affiliates often provide resources to improve the technological capabilities of both vertically and horizontally linked firms. Third, human capital can spill over from foreign affiliates to other enterprises as skilled labour moves between employers. These spillovers are especially important for enterprises that lack the technological capabilities and managerial skills to compete in world markets. Fourth, the proximity of local firms to foreign affiliates can sometimes lead to demonstration or imitation spillovers. When foreign affiliates introduce new products, processes and organizational forms, they provide a demonstration of increased efficiency to other local enterprises. Local enterprises may also imitate foreign affiliates through reverse engineering, personal contact and industrial espionage. Finally, a

concentration of related industrial activities may also encourage the formation of industrial clusters, which further encourage FDI and local spillovers.

Although there are clear differences between these types of knowledge spillovers, the empirical literature captures mainly those occurring between firms within the industry. The reason is that competitive effects within an industry are much easier to measure than linkage effects across industries. Studies that estimate spillover effects using the production function approach similar to the one specified in equation (1) unintentionally pick up inter-industry effects contained in the variables *Y* and *M*. But with exception of Blalock and Gertler (2002) and Smarzynska (2002), none of the panel data analyses on the effect of knowledge spillovers on productivity growth considers inter-industry effects directly. We propose to capture these effects by incorporating direct requirements coefficients derived from the input-output accounts from each country into the empirical model.

To disentangle the two spillover effects, we define the scope for intra-industry spillovers, or horizontal spillovers, as the share of an industry's output produced by the foreign affiliates:

$$HS_{kt} = \frac{\sum_{i=1}^{n} FA_{ikt}}{\sum_{i,\,j=1}^{n,m} (FA_{ikt} + DF_{jkt})}, \tag{4}$$

where HS_{kt} is horizontal spillovers in industry k in period t, FA_{ikt} (i = 1,…,n) is output of foreign affiliate i in industry k and period t, and DF_{jkt} (j = 1,…,m) is output of domestic firm j in industry k and period t. These spillovers reflects mainly the competitive pressures that encourage local firms to introduce new products to defend their market share and adopt new management methods to increase productivity. Imitation, reverse engineering, personal contact and industrial espionage may also be captured by this variable. However, exports often comprise a large proportion of the output of foreign affiliates, reducing the impact they might have had on the domestic market. To compensate for this reduction of competitive pressures in the domestic market, we correct the measure of horizontal spillovers in (4) by the share of exports of foreign affiliates EX_{ikt} in their total output Y_{ikt}:

$$\overline{HS}_{kt} = \frac{\sum_{i=1}^{n} FA_{ikt}}{\sum_{i,j=1}^{n,m} (FA_{ikt} + DF_{jkt})} * (1 - \sum_{i=1}^{n} \frac{EX_{ikt}}{Y_{ikt}}) . \quad (5)$$

Foreign affiliates often provide resources to improve the technological capabilities and quality standards of their upstream suppliers. We account for these backward linkages BL_{kt} as a sum of output of industries r (r = 1,…,p) purchased by firms in the industry k (r = 1,…,k,…,p) weighted by the share of total foreign output HS_{kt}:

$$BL_{kt} = \sum_{r=1}^{p} \alpha_{krt} * HS_{kt} , \quad (6)$$

where α_{krt} $(0 \le \alpha_{krt} \le 1)$ is the proportion of industry's *r* output consumed by industry *k.* These direct input requirements are obtained from the input-output accounts. Since foreign affiliates tend to purchase a larger proportion of their inputs abroad than domestic firms, the measure of backward linkages in (6) should be corrected by different individual import orientation of the foreign affiliate and domestic enterprise:

$$\overline{BL}_{i,\,jkt} = \sum_{r=1}^{p} \alpha_{krt} * \frac{IM_{i,\,jkt}}{MC_{i,\,jkt}} * HS_{kt}, \tag{7}$$

where $IM_{i,jkt}$ and $MC_{i,jkt}$ are imports and material costs of foreign affiliate *i* and domestic firm *j*. Similarly, foreign affiliates often provide technical assistance to their downstream users. We account for these forward linkages FL_{kt} as a sum of output of foreign affiliates in industry *k* sold in the domestic market ($\overline{HS}_{kt}$) consumed by industries *r* (*r* = 1,…,*p*):

$$FL_{kt} = \sum_{r=1}^{p} \beta_{krt} * \overline{HS}_{kt}, \tag{8}$$

where β_{krt} $(0 \le \beta_{krt} \le 1)$ is the proportion of industry's *k* output consumed by industries *r* derived from the direct requirements coefficients. Again, foreign affiliates tend to export a larger proportion of their output than domestic firms. To correct for this, we introduce a different export propensity for foreign affiliates and domestic firms:

(9) $$\overline{FL}_{i,\,jkt} = \sum_{r=1}^{p} \beta_{krt} * \frac{EX_{i,\,jkt}}{Y_{i,\,jkt}} * \overline{HS}_{kt},$$

where $EX_{i,jkt}$ and $Y_{i,jkt}$ are exports and output of foreign affiliate *i* and domestic firm *j*. Thus, the higher import and export propensities of foreign affiliates mean there will be less scope for backward and forward linkages.

It is important to note that not all spillovers are positive. The parent firm can have a negative impact on the direct transfer of technology to its affiliate and reduce the knowledge spillovers to the local economy. For example, they can provide their affiliates with too few, or the wrong kind of technological capabilities, or even limit access to the technology of the parent company. This type of behaviour may restrict the production of its affiliate to low-value activities and can also reduce the scope for technical change and technological learning both within the affiliate and as spillovers to the domestic economy. Even if the parent firm transfers new technology to its affiliate, it can reduce the scope for knowledge spillovers by limiting downstream producers to low value added activities or eliminate them altogether by relying on foreign suppliers (including itself) for higher value added intermediate products. Domestic firms that don't have the capability to adapt can also be crowded-out of the market. Bardham (1998) also suggests that the parent company can restrict domestic production when they set up affiliates with the main purpose of protecting existing property rights and taking out patents in the host country.

3. Data

The empirical analyses in this paper are based on data obtained from databases on manufacturing firms provided by the Statistical Office of Estonia and the Agency for Payments of Slovenia. The first sample includes 363 manufacturing enterprises in Estonia for the period 1995 to 1999 and the other sample includes 1093 enterprises in Slovenia from 1994 to 1999. The Slovenian sample includes all manufacturing firms with more than 10 employees. In the samples, 106 enterprises are foreign owned in Estonia (about 30 per cent) and 116 enterprises in Slovenia (about 10 per cent). However, as shown in Table 1, the aggregate shares of foreign affiliates in total assets and sales exceed the share in total number of firms by two- to threefold. This indicates that foreign affiliates are not only larger relative do domestic firms in terms of employment, assets and output, but also that foreign affiliates are more capital intensive and more efficient in terms of labour productivity. More specifically, in Estonia the share of FDI in fixed assets, sales and exports is about 50 per cent.

R&D activities and other knowledge generating activities are concentrated mainly in foreign firms in Estonia as they account for more than 70 per cent of total R&D expenditures. On average, a foreign firm invests three times as much in R&D capital as a domestic firm. Similarly, although only about 10 per cent of enterprises in Slovenia are foreign owned, they account for 27 per cent of total sales, 35 per cent of

Table 1: Descriptive statistics for foreign versus domestic manufacturing firms in 1999

	Estonia	*Slovenia*
Number of observations:		
all firms	363	1093
foreign affilates	106	116
Per cent of foreign affiliates:		
Total firms	29.2	10.6
Employment	52.1	18.5
Sales	48.2	26.9
Assets	36.4	13.8
R&D Expenditures	71.4	14.2

Source: Authors' own calculations.

total exports and 42 per cent of total imports. These enterprises also export twice as much as domestic enterprises and they purchase significantly more inputs abroad. By contrast to Estonia, Slovenian foreign and domestic firms place equal emphasis on knowledge accumulation on average. On average a Slovenian firm with FDI invests more in R&D than one without, but the difference is not very large (3.5 versus 2.5 per cent of total sales). However, compared with Estonia, the share of R&D expenditures in the sales of Slovenian enterprises was five times higher if they were foreign owned and 10 times higher if they were domestically owned. These differences may have important implications for the autonomous innovative ability of domestic firms and their absorption capacity for potential knowledge spillovers.

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than 70 per cent of total R&D expenditures. On average, a foreign firm invests three times as much in R&D capital as a domestic firm. Similarly, although only about 10 per cent of enterprises in Slovenia are foreign owned, they account for 27 per cent of total sales, 35 per cent of total exports and 42 per cent of total imports. These enterprises also export twice as much as domestic enterprises and they purchase significantly more inputs abroad. By contrast to Estonia, Slovenian foreign and domestic firms place equal emphasis on knowledge accumulation on average. On average a Slovenian firm with FDI invests more in R&D than one without, but the difference is not very large (3.5 versus 2.5 per cent of total sales). However, compared with Estonia, the share of R&D expenditures in the sales of Slovenian enterprises was five times higher if they were foreign owned and 10 times higher if they were domestically owned. These differences may have important implications for the autonomous innovative ability of domestic firms and their absorption capacity for potential knowledge spillovers.

Table 2 shows that foreign affiliates in both countries are larger, more capital and skill intensive, more export oriented and less labour intensive. These differences in characteristics between foreign and domestic firms, suggest that the data might suffer under selection bias. The reason is that foreign investment decisions are not randomly distributed, but subject to the characteristics and initial performances of each enterprise. Foreign and domestic firms cannot therefore be treated

Table 2: Structural characteristics of foreign versus domestic manufacturing firms in 1994-1999
(mean average)

Variable[*]	*Estonia*		*Slovenia*	
	Firms with FDI	*Domestic firms*	*Firms with FDI*	*Domestic firms*
Number of firms	257	106	977	116
Domestic firm = 100				
Size (assets)	165	100	134	100
Capital intensity (Assets/Employee)	306	100	138	100
Skill intensity (Labour costs/employee)	141	100	114	100
Wage	123	100	114	100
Percentage				
Labour intensity I (Labour costs/value added)	70.3	81.8	65.5	76.5
Labour intensity II (Labour costs/total costs)	43.3	47.9	21.7	29.2
Export propensity (Exports/sales)	58.2	40.1	56.7	41.6

Source: Authors' calculations

as homogenous units of observation due to possible endogeneity of foreign investment decisions. To correct for this problem the generalized Heckman two-step procedure for correcting sample selection bias has been used. According to Heckman (1979), in the first step we determine the probability of foreign investment choices using a probit model. We base foreign investment choices on initial firm size, firm's initial capital and skill intensity, initial productivity, firm's initial export propensity and sector dummies. The first year or one year before the ownership change has been chosen as the initial year in our probit estimations. In the second step we then follow generalized Heckman approach as developed by Amemiya (1984) and calculate inverse Mill's ratios (also called lambda) for all observations (for non-zero as well as zero

Table 3: Probability of foreign investment decisions (Results of probit model)

Indicator	*Estonia*	*Slovenia*
Size	2E-06	-7E-08
	(0.668)	(-2.179)**
Capital intensity	0.003	2E-06
	(3.045)***	(1.035)
Skill intensity	0.015	0.0001
	(3.589)***	(2.130)**
Labour intensity	0.009	-0.010
	(1.530)	(-3.035)***
Labour productivity	6E-05	5E-06
	(0.182)	(1.747)*
Export propensity	0.006	0.014
	(2.242)**	(9.493)***
Sector dummies	Yes	Yes
Pseudo R^2	0.255	0.127
Number of obs.	373	1093

Notes: (i) dependent variable: FDI dummy, (ii) probit estimations on initial data (for year 1995 or one year before the ownership change), (iii) t-statistics in parentheses, (iv) *****, **** and ***** indicate significance at 1, 5 and 10 per cent level, respectively.

observations regarding foreign investment choices). In doing so we obtained an additional independent variable in our estimated model, which we then use as an instrument for the unobserved impacts of foreign investment decisions.

Table 3 presents the results of probit model. These results confirm the existence of selection bias in the data for Estonia and Slovenia. When deciding about the investment choices in Estonia and Slovenia, foreign investors tended to acquire more skill intensive and export oriented firms. In addition, in Slovenia labour-intensive firms are less

likely to be chosen by foreign investors, while in Estonia more capital-intensive firms are likely to be chosen.

4. Testing effects of foreign ownership and trade on productivity growth.

In the empirical analysis we consider three important influences of productivity spillovers: (1) direct and indirect effects of FDI on the productivity growth of all enterprises; (2) importance of absorptive capacity of domestic enterprises to get advantages of spillovers from FDI; and (3) importance of international trade as a general vehicle of productivity spillovers. The first and third influences provide the opportunity for technology transfer and knowledge spillovers and the second provides for their realization. Equations (1) through (9) provide the methodological basis of the consequent analysis.

(a) Direct and indirect effects of FDI

Based on equations (2) through (9), we can estimate the direct and indirect effects of FDI at the firm level as:

$$(10)\ y_{it} = b + \delta F_i + \kappa MF_i + \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \chi F_i k_{it} + \phi F_i l_{it} + \varphi F_i m_{it} + \\ + \mu HS_{jt} + \vartheta F_i HS_{jt} + \pi BL_{jt} + \tau F_i BL_{jt} + \rho FL_{jt} + \omega F_i FL_{jt} + \\ + \upsilon S_{jt} + \varsigma F_i S_{jt} + \theta_j d_j + \psi_t d_t + e_{it},$$

where b_{it} is a log of a constant term which accounts for alternative

sources of productivity growth not accounted for in the model. A variable *F*, a dummy variable that accounts for foreign ownership of 10 or more per cent of the assets of local firm by some multinational company, captures the direct effects of FDI on recipient firm. The dummy variable is also used to capture certain interaction effects between the factors of production and foreign ownership. A significant positive coefficient of this variable indicates that foreign affiliates grow faster in terms of TFP comparative to domestic firms. The equation also includes a dummy *MF* is also included to separate majority owned foreign affiliates from minority owned ones. This is to find out whether majority foreign ownership facilitates the transfer of more complex technology and management skills to domestic enterprises.

Equation 10 also differentiates between intra-industry or horizontal knowledge spillovers obtained from competitors *HS* and inter-industry spillovers obtained from backward linkages to local suppliers *BL* and forward linkages to users *FL*. The dummy variable *F* is also included measure differences in reception of both horizontal and vertical spillovers between domestic and foreign firms. Variables of horizontal spillovers are calculated at the 4-digit NACE classification so that all firms in the same NACE category have the same scope for horizontal spillovers. However, due to the unavailability of the input-output tables at more disaggregated levels the variables of vertical spillovers can be calculated only at the 2-digit NACE classification. The latter is clearly a handicap of this kind of analyses, but there is little that can be done about it since data at a more disaggregated level does not exist.

The production function also controls for size of individual sectors on the productivity growth of firms, S, additional sectoral effects, d_j and a dummy to capture time related effects, d_t. The economic transformation of Estonia and Slovenia makes it necessary to control for changes in the efficiency of enterprises over time. In the absence of other proxies, the time variable is also intended to capture time-specific aggregate shocks to the whole economy, i.e. shocks that are inherent to the transition economy, such as common economic policy shocks.

To estimate the model (10) it is necessary to employ one of the panel data estimators to study the dynamics of adjustment and to control for the individual heterogeneity of firms. The reason for this is that OLS estimators may give biased and inconsistent estimates of TFP because they suffer from probable correlation between the productivity effects and the output variable. As there are no suitable firm-specific instruments to control for this problem, it is necessary to use either the random or fixed effects model to take firm-specific effects into account (Woodridge, 2002). Though preferable to OLS, neither technique is absolutely accurate for estimating the above equations. Fixed effects models assume constant TFP growth over time for a single firm, which is inappropriate from the substantial point of view given that the aim of this study is to examine the impact of different factors on changes in TFP. On the other side, the assumption that changes in TFP at the firm level are uncorrelated over time is a major disadvantage of the random effects model. Hence, given these considerations our strategy is as

follows. We estimate model (10) in log first-differences to eliminate the individual specific fixed effects and to obtain directly the estimates of effects of FDI on TFP growth. Using this approach, the Hausman (1978) tests finds no significant differences between OLS estimates of first differenced model and fixed effects model estimations in levels. We therefore report only OLS estimations in all of the subsequent tables with estimation results.

Table 4 reports the estimation results obtained by estimating the model (10) on direct and indirect effects of FDI. The results reveal that after controlling for firm specific effects and selection bias, the direct transfer of technology from the parent to the affiliate was found to be significant in both countries. The effect of foreign ownership (represented by the FDI dummy) was higher in Estonia, which suggests that FDI had a greater impact on TFP growth of foreign affiliates in this country. At the same time, the parameter capturing the size of the sector *S*, was significant only in Estonia, which suggests the importance of external economies of scale. There were no knowledge spillovers detected in either country, but there was some indication that backward linkages might have some importance in Estonia. We can argue that absorptive capacity of local firms might play an important role in the capability of local firms to take advantage of the knowledge spillovers that are potentially available to the economy. We check for this possibility in the next subsection.

Table 4: Results of OLS estimation of equation (10): Direct effects and spillovers

	Estonia		*Slovenia*	
Const.	–0.268	(–2.46)***	–0.094	(–2.83)***
Capital (K)	0.111	(6.77)***	0.037	(6.28)***
Capital_FDI (FK)	–0.038	(–0.83)	0.001	(0.03)
Labour (L)	0.602	(11.62)***	0.382	(24.42)***
Labour_FDI (FL)	0.694	(11.94)***	–0.107	(–2.21)**
Materials (N)	0.007	(1.41)	0.296	(41.41)***
Materials_FDI (FN)	0.011	(1.31)	0.118	(4.94)***
FDI dummy (F)	0.854	(3.45)***	0.222	(3.32)***
Majority FDI (MF)	0.020	(0.42)	–0.024	(–1.35)
Hor_Spill (HS)	0.000	(–0.02)	0.002	(0.81)
Hor_Spill_FDI (FHS)	–0.035	(–0.84)	–0.006	(–0.88)
Backward_Spill (BL)	–0.015	(–0.65)	0.003	(0.52)
Backward_Spill_FDI (FBL)	–0.058	(–1.22)	0.010	(0.50)
Forward_Spill (FL)	0.020	(1.43)	0.000	(–0.02)
Forward_Spill_FDI (FFL)	–0.001	(–0.04)	–0.007	(–0.59)
Sector size (S)	0.022	(2.74)***	0.002	(1.05)
Sector size_FDI (FS)	–0.019	(–1.19)	0.000	(0.00)
Mill's ratio	–0.405	(–4.04)***	–0.121	(–3.05)***
Number of obs.	1053		5175	
Adj R-squared	0.799		0.435	

Note: Includes all firms. Time and sector dummies were calculated in both estimations. t-statistics in parentheses. *, **, *** denote significance at the 10, 5 and 1 percent levels of significance (two-tailed tests).

(b) Importance of absorptive capacity of domestic enterprises

The absorptive capacity of firms in the local economy can play an important role in generating knowledge spillovers. While relatively inefficient firms have a certain scope for catching-up, it is often difficult for the firm to build the necessary absorptive capacity that will allow it

to take the advantage of the knowledge spillovers that are potentially available to the economy. Closing the technology gap will be difficult without the relevant capabilities. As a result, there appears to be a certain threshold of development that countries must cross before the potential for knowledge spillovers can be realized (Borenzstein et al, 1998). To account for the absorptive capacity of enterprises in determining the existence and extent of knowledge spillovers in the examined transition economies, we rewrite the model (10) by including the variable on firm specific R&D activity (RD):

$$(11) \quad y_{it} = b + \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \eta RD_{it} + \mu HS_{jt} + \lambda RD_{it} HS_{jt} + \\ + \pi BL_{jt} + \sigma RD_{it} BL_{jt} + \rho FL_{jt} + o RD_{it} FL_{jt} + \upsilon S_{jt} + \xi RD_{it} S_{jt} + . \\ + \theta_j d_j + \psi_t d_t + e_{it}$$

The *RD* variable reflects both the innovation effect and learning effect of technological activity (Cohen and Levinthal, 1989). These two effects are separated in the model. When *RD* is included in the model (11) as a separate variable, RD_{it}, it accounts for the "innovation capacity" of individual firm that is completely internal to the firm. The interaction of *RD* with different measures of spillovers, $RD_{it}HS_{jt}$, $RD_{it}BL_{jt}$ and $RD_{it}FL_{jt}$, reflects the "absorptive capability" of firms to external knowledge spillovers. The latter three variables capture the intra-industry and inter-industry spillovers that might occur because the firm has the necessary absorptive capacity. In a corporate balance sheet these innovation and absorptive activities appear as intangible

assets, which include technological knowledge, marketing and management skills, export contacts, coordinated relationships with suppliers and users reputations. Since we are interested in accounting for the importance of different potential knowledge spillovers that are available to domestic firms in the economy, this model is estimated in a panel of domestic firms only.

Table 5 reports the estimation results obtained by estimating the model (11) on importance of firms' absorptive capacity for knowledge spillovers. We use share of intangible assets in total sales as a proxy for the extent of R&D activity since firm-level data of this kind are not available. Intangible assets make a good proxy because it contains the stock of new knowledge, whether it came from R&D activity, innovation activity, payments for technology, expenditures for software and information and communications technology (ICT), education and training, organizational change and marketing (Cross, 2000). The results show that innovation capacity appear to be very important in Estonia as domestic firms with larger R&D expenditures do grow faster in terms of TFP. The results also show that after controlling for innovation and absorptive capacity of domestic firms we were able to detect some intra-industry spillovers in Estonia. But this is a general finding for all domestic firms, while absorptive capacity does not seem to play an important role in capturing these benefits. Domestic firms in nether country appear to have benefited form inter-industry spillovers. Evidence from other studies is mixed.

Table 5: Results of OLS estimation of equation (11): Absorptive capacity

	Estonia		*Slovenia*	
Const.	–0.138	(–1.51)	–0.089	(–4.45)***
Capital (K)	0.050	(5.33)***	0.278	(32.61)***
Labour (L)	0.677	(15.47)***	0.647	(37.01)***
Materials (N)	0.010	(2.33)**	0.342	(36.81)***
Accumul_R&D (RD)	0.040	(2.43)***	0.005	(0.98)
Hor_Spill (HS)	0.047	(2.84)***	0.002	(0.68)
Hor_Spill_R&D (RDHS)	–0.001	(–0.14)	–0.001	(–1.28)
Backward_Spill (BL)	0.008	(0.28)	0.002	(0.32)
Backward_Spill_R&D (RDBL)	–0.10	(–0.41)	–0.001	(–0.11)
Forward_Spill (FL)	0.013	(0.75)	0.007	(0.39)
Forward_Spill_R&D (RDFL)	0.000	(–0.01)	–0.011	(–0.66)
Sector size (S)	0.030	(2.26)**	0.008	(0.38)
Sector size_R&D (RDS)	–0.001	(–0.10)	0.012	(0.59)
Number of obs	816		4886	
Adj R-squared	0.342		0.844	

Note: Includes domestic firms only. Time and sector dummies were calculated in both estimations. t-statistics in parentheses. *, **, *** denote significance at the 10, 5 and 1 percent levels of significance (two-tailed tests).

Djankov and Hoekman (2000) after controlling for firms' innovative and absorptive capacity report no significant spillovers to domestic firms in the Czech Republic in the period 1992-1996. In contrast, Kinoshita (2000a) finds innovative capacity of Czech domestic firms not to be correlated with their TFP growth and she also finds no significant spillovers (measured as the share of foreign owned firms in total sector's employment). But in contrast to Djankov and Hoekman she finds significant positive impact of absorptive capacity of Czech domestic firms in the period 1995-1998 to exploit spillovers generated by foreign affiliates in the country.

(c) International trade and knowledge spillovers

The economic growth observed in Slovenia after 1993 and Estonia after 1995 is not restricted to firms with foreign participation only, but is a general feature of the U-shaped economic performance and technological modernization of firms during the process of transition. Hence, if the R&D accumulation by individual local firms is not correlated with the growth of firms and if there are no knowledge spillovers from foreign affiliates, there must be some alternative sources of technology transfer to local firms. In this subsection we check for the impact of these alternative sources of international technology diffusion for domestic firms' productivity growth as suggested by Coe and Helpman (1995). Trade provides an important source of knowledge spillovers. Hence, we can rewrite the model (10) to account for international knowledge spillovers through international trade:

$$(12) \qquad y_{it} = b + \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \eta RD_{it} + \nu XS_{it} + \varpi RD_{it} XS_{it} + \iota IM_{it} + \xi RD_{it} IM_{it} + \theta_j d_j + \psi_t d_t + e_{it},$$

where ν and ι captures the international knowledge spillovers through exports as a percentage of sales *XS* and imports as a percentage of material costs *IM* of each firm (Estonia) or sector (Slovenia), and ϖ and ξ measure the absorptive capacity of domestic firms to technology shocks through exports $RD_{it}XS_{it}$ and imports $RD_{it}IM_{it}$. The model is

estimated again in a panel of domestic firms only. International knowledge spillovers to domestic firms are ideally measured by the share of imports in total costs of materials (imports of capital equipment and intermediate goods) and by the share of exports in total sales (indicating capability of firms to meet high quality standards in western markets).

Table 6 reveals significant international knowledge spillovers only in Slovenia. These positive spillovers from trade are not restricted to firms with higher R&D accumulation, but are a general feature of Slovenian manufacturing firms. The tests conducted in this Section therefore confirm that Estonian firms relied most heavily on FDI to obtain technology from the global economy. In contrast, Slovenian firms seem to rely much more on trade as a channel of technology transfer than on FDI. This may clearly be consequence of different privatization methods in both countries. Through privatization via foreign strategic partners Estonian firms were allowed to get direct access to global knowledge spillovers directly, while Slovenian firms, privatized by local insiders, were inclined to get access to global knowledge spillovers through arm-length trade.

Table 6: Results of OLS estimation of equation (12): Spillovers through trade

	Estonia		*Slovenia*	
Const.	–0.051	(–1.00)	–0.061	(–4.69)***
Capital (K)	0.053	(5.58)***	0.277	(32.47)***
Labour (L)	0.674	(15.32)***	0.651	(37.23)***
Materials (N)	0.010	(2.38)***	0.338	(36.27)***
Accumul_R&D (RD)	0.046	(2.88)***	0.005	(1.07)
Exports/Sales (X)	0.006	(0.79)	0.005	(3.77)***
Exports/Sales_R&D (RDX)	0.001	(0.19)	0.001	(0.73)
Imports/Mat.costs (M)	0.012	(1.47)	0.002	(2.04)**
Imports/Mat.costs_R&D (RDM)	–0.004	(–1.01)	–0.002	(–1.72)*
Number of obs	816		4886	
Adj R-squared	0.332		0.844	

Note: Includes domestic firms only. Time and sector dummies were calculated in both estimations. t-statistics in parentheses. *, **, *** denote significance at the 10, 5 and 1 percent levels of significance (two-tailed tests).

5. Concluding remarks

The most important conclusion that comes from this paper is that the method of privatization does influence the way a firm can obtain technology from abroad. Estonia, which attracted a considerable amount of FDI through its privatization program, used this channel to gain direct access to global markets for technology, while Slovenia discouraged sales of State enterprises and inclined firms to use trade to gain access to these markets. Of course, based on these findings it is difficult to make any general inference for future performance of firms in both countries. Up to now, different privatization paths do not seem to affect medium-term growth in both countries as both countries

managed to grow at similarly high growth rates over the second part of 1990s. The question arises, however, how much restructuring during 1990s has been done in firms without foreign strategic partners. This may be a crucial issue in the next years. Only firms that have undergone serious restructuring programs and have created viable production programs may be able to compete in the more competitive environment after accession to the EU. Here, privatization to foreign strategic partner and a direct access to global technology markets via foreign strategic partners might seem to be a superior strategy for closing the technology gap, but it crucially depends on the kind and extent of technology that multinational enterprise is willing to transfer to the local affiliate or the local economy as a whole. This potential direct access to global technology markets might be harmful for local affiliates when they get only a limited access to the technology of the parent company or they are restricted to low-value activities only. In this case, an indirect access to global knowledge spillovers via international trade might be superior to direct access via FDI. It remains to be seen, however, what will be the long-term overall effects of different privatization methods on TFP growth in Estonia and Slovenia.

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