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Foreign Investment and Productivity Growth in Czech Enterprises

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This article uses firm-level data for the Czech Republic to show that during 1992–96 foreign investment had the predicted positive impact on total factor productivity growth of recipient firms. This result is robust to corrections for the sample bias that arises because foreign companies tend to invest in firms whose initial productivity is above average. Together, joint ventures and foreign direct investment appear to have a negative spillover effect on firms that do not have foreign partnerships. However, with foreign direct investment alone, the magnitude of the spillover becomes much smaller and loses significance. This result, in conjunction with the fact that joint ventures and foreign direct investment account for a significant share of total output in many industries, suggests that further research is required to determine the extent of knowledge diffusion from firms that have foreign links to those that do not.

There is a rich case-study literature documenting how firms and industries adopt new technology and knowledge. It points out that imports and openness to trade are vital to learning, which is achieved through reverse-engineering, direct inputs into production, and communication with foreign partners (suppliers and buyers). A number of recent studies that use aggregate data conclude that trading with countries that are relatively intensive in research and development (R&D) leads to higher productivity growth in domestic industry (Coe and Helpman 1995 and Coe, Helpman, and Hoffmaister 1997). These findings are consistent with the endogenous growth literature, although they do not reveal much about *how* technologies are transferred from one country to another.

The microeconomic literature emphasizes three channels through which technologies are transferred internationally: imports of new capital and differentiated intermediate goods (Feenstra, Markusen, and Zeile 1992 and Grossman and Helpman 1995), learning by exporting (Clerides, Lach, and Tybout 1998), and foreign investment (Blomström and Kokko 1997). Particular attention has

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centered on the role of foreign investment as a channel for the transfer of knowledge and on the spillover of this knowledge to other firms in the economy.[1] Foreign investment should be associated with the transfer of knowledge because, by definition, it is driven by intangible assets owned by the parent firm (Markusen 1995). The conventional wisdom holds that foreign investment is a major channel for technology transfer to developing countries. Pack and Saggi (1997) note that transactions in royalties and license fees between parent firms and subsidiaries account for more than 80 percent of global flows of foreign investment.

What matters for economic growth are the spillovers to other firms within and across industries. Evidence on this issue is much less robust. Case studies have argued that positive spillovers are significant. They also have documented the importance of local skills and in-house technological capacity for adapting and using techniques developed elsewhere (Lall 1992 and Evenson and Westphal 1995). However, recent microeconometric studies using firm-level panel data have reached more ambiguous conclusions. Some analysts have found a statistically significant negative relationship between the value of foreign investment in an industry or economy and the productivity of domestic firms (see, for example, Harrison 1996 and Haddad and Harrison 1993).

This article investigates how foreign investment affected the productivity of firms in the Czech Republic during the initial post-reform period (1992–96). We distinguish between Czech firms that established partnerships with foreign firms—either through joint ventures or through direct sales of a majority equity stake—and those that did not and ask whether the total factor productivity (TFP) growth rates of these groups differed.[2]

I. Channels of Technology Transfer

Although there is little doubt that technologies make their way across international borders, the mechanisms through which this occurs are poorly understood. Aside from case studies, most of the empirical evidence is based on aggregate data or cross-sectional surveys and is subject to multiple interpretations. Technologies may be transferred through several channels. New technologies may be embodied in new varieties of differentiated products or capital goods and equipment. They may be transferred through imports or through arm's-length trade in intellectual property, such as licensing contracts. Firms may learn about new technologies by exporting to knowledgeable buyers who share product designs

1. A separate but related literature on technology diffusion has focused largely on two issues: the determinants of the number of firms or the proportion of industry output produced by a new technology (aggregate diffusion) and the determinants of the time at which a firm adopts a new technology relative to other firms (the so-called duration models). See, for example, Ray (1964) and Karshenas and Stoneman (1994). We cannot analyze the types of questions asked in the diffusion literature because we cannot identify specific technologies in our data set.

2. TFP is an indirect measure of technology transfer. Data constraints prevent us from using more direct measures, such as investment in R&D or the turnover of managers and highly skilled labor.

and production techniques. Technologies also may be transferred in the context of formal cooperative arrangements between foreign and local firms, such as foreign direct investment (FDI) (acquisition) or project-specific joint ventures.[3] In all of these cases absorbing and adapting new technologies require workers who have appropriate training and expertise. The absence of such capacity is often held to explain why TFP frequently is lower in developing-country firms than in industrial-country firms, even if both use identical equipment (Pack 1987).

It is helpful to differentiate between technology transfers that are made in the context of formal cooperative arrangements between a foreign and a domestic firm and those that occur at arm's length. The latter, which include arm's-length trade in machinery and components and direct purchases of knowledge (payment for patents, blueprints, and so on), can be a major avenue of technology transfer. However, not all technologies are available at arm's length. Some may be obtainable only through formal cooperation—either majority ownership (acquisition) or project-specific joint ventures.[4] In theory, firms will be adverse to unbundling and selling knowledge or products if there are important incentives for internalization—in this case FDI may be the preferred channel for acquiring knowledge (Markusen 1995, 1998).

Foreign investment is likely to be associated with the transfer of both hard (machinery, blueprints) and soft (management, information) technologies. It has two dimensions: generic knowledge, such as management skills and quality systems, and specific knowledge, which cannot be obtained at arm's length because of weaknesses in the receiving country's policy environment (such as poor enforcement of intellectual property rights) or because of incentives for internalization.[5] As for generic knowledge, foreign partners may reduce the cost of learning and upgrading by helping to identify and implement systems to ensure that the product meets technical specifications, is delivered on time, and so on. Our interviews with managers of enterprises that have foreign partnerships suggest that all of these dimensions are prevalent in the Czech Republic. Still more important is access to information specific to the parent firm, as well as production and distribution networks.

An important question is whether and the extent to which knowledge that multinationals transfer to affiliates diffuses to other firms in the industry.[6] Theoretical models of foreign investment suggest that there should be a positive rela-

3. See for example, Helleiner (1973) and Keesing and Lall (1992) on subcontracting; Feenstra, Markusen, and Zeile (1992) on imports of inputs; Blomström and Kokko (1997) for a recent survey of the literature on FDI; and Pack and Saggi (1997) for a general survey of the literature on technology transfer.

4. Notions of arm's-length exchange used in the literature vary. For example, Pack and Saggi (1997) distinguish between intrafirm exchange (FDI) and contractual exchange (licensing, joint ventures, turnkey projects). They call contractual exchange arm's-length arrangements.

5. See Smarzynska (1998) for a recent analysis of the relationship between intellectual property protection and FDI in transition economies.

6. Equally important may be spillovers across industries. We do not explore this issue here, although it may be important in the context of transition.

tionship between FDI and diffusion. Knowledge will move from firm to firm through demonstration effects, labor turnover, or reverse-engineering. Das (1987) models a foreign subsidiary as the price leader and domestic firms as the competitive fringe. If the learning of domestic firms is proportional to the output of the multinational firm—that is, the larger the multinational is relative to the domestic industry, then the easier learning is—the multinational firm has an incentive to transfer technologies to its subsidiary since more advanced technologies raise profits. The greater output of the subsidiary then induces local firms to learn and adopt the foreign technologies at a faster rate. Wang and Blomström (1992) use a similar setup, but endogenize both the amount of technology transferred from the parent company to the subsidiary and the domestic firms' investment in learning activities. Foreign firms again transfer technologies at a higher rate if domestic firms invest more in learning activities. Blomström, Kokko, and Zejan (1994) find some empirical support for this prediction.

The empirical evidence on spillovers from foreign-owned affiliates to indigenous firms is mixed (Blomström and Kokko 1997). An extensive case-study literature seeks to determine the size of spillovers from R&D, if any. Much of this literature focuses on industrial countries.[7] The studies on developing countries reveal that the magnitude of potential knowledge spillovers depends on the technological capabilities of indigenous firms that would enable them to assimilate knowledge (Pack and Westphal 1986). A unique feature of many transition economies compared to most developing countries is that their technological ability is substantially greater. In principle, this should facilitate the adoption of new technologies and allow rapid convergence toward best practice.

Much of the econometric literature has focused on productivity measures as proxies for measures of technology diffusion. Early studies using industry-level data, such as Blomström and Persson (1983), find that foreign presence in an industry, measured by the foreign share of industry employment, positively influences domestic labor productivity. More recent studies using firm-level data are less supportive of the existence of spillovers. Aitken, Hanson, and Harrison (1997) and Haddad and Harrison (1993) find that foreign investment has a negative effect on the performance of domestically owned firms. Harrison (1996) suggests that in imperfectly competitive markets entry by foreign investors implies that domestic incumbents lose market share, impeding their ability to attain scale economies. The result showing negative spillovers contrasts with the findings of the case-study literature and may to some extent reflect the omission of important variables, such as the level of R&D spending, expenditures on training, and the percentage of employees with technical degrees (engineers, scientists).[8]

7. See Griliches (1992) for a survey of the literature on R&D spillovers and Nelson and Wolff (1997) for a recent contribution to this literature.

8. The literature on acquiring and adopting technologies in developing countries is substantial. See, for example, Evenson and Westphal (1995), Lall (1987, 1992), and Pack and Westphal (1986). Westphal, Rhee, and Pursell (1981) discuss the case of the Republic of Korea in some depth.

In this article we estimate production functions using TFP as a proxy for technology transfer. By relying on TFP as the dependent variable, we assume that the adoption of new technologies will, with some lag, improve productivity. A serious problem with this assumption is that, as the case-study literature has documented, such improvements depend on the technological abilities of domestic firms. Nelson and Pack (1998) demonstrate that the production function methodology can underestimate or ignore the use of improved technologies at the level of the firm and thus affect estimates of TFP growth. Differences in technological capacity across firms in an industry may be an important determinant of TFP, but we do not have this information—data on variables relevant to technology, such as R&D expenditures or the composition of the workforce, are not available at the level of the firm. However, the Czech Republic is not a developing country—it has a long-standing industrial base and is well endowed with engineering and scientific human capital. For the economy as whole, therefore, the capacity to upgrade productive efficiency rapidly by adopting best-practice techniques (both hard and soft) should be considerable.

II. A Profile of Czech Firms

We compiled information on Czech enterprises for 1992–96 from surveys using a questionnaire that we prepared and a database developed by the Czech Statistical Office containing financial and ownership information. We defined financial variables using international accounting standards from the onset of the survey in 1992. The database comprises 513 firms quoted on the Prague stock exchange whose shares traded at least four times in a given year (this restriction excludes smaller firms from the sample) and that reported the financial information required. Of the sample firms, 340 did not establish joint ventures or attract FDI, 91 concluded joint ventures with foreign companies, and 82 attracted majority foreign equity investment. Thus 34 percent of the sample (173 firms) had a foreign link—either a joint venture or FDI—with relatively uniform distribution across sectors (table 1). There is a selection bias in the data, as the sample does not cover all listed firms with foreign ownership or partnerships. Moreover, privately held firms are not included in the sample. For example, the largest foreign acquisition in the Czech Republic to date—the takeover of Skoda by Volkswagen—is not publicly traded.

To determine whether or not a firm had a foreign partnership or foreign ownership, we chose as our criterion that at least 20 percent of the equity had to be owned by a single foreign entity or the firm had to have established one or more joint ventures with a foreign partner. Because minority shareholders have little protection under Czech law, equity investors have an incentive to take a majority stake. Most firms with foreign equity ownership in the sample are majority foreign-owned. Although the share of firms with foreign links appears to be high, it is representative of Czech industry more generally. Aggregate statistics using a criterion of 5 percent or more foreign equity ownership reveal that during 1994–

Table 1. *Descriptive Statistics of Sample Firms, 1992–96*

Sector	*Total in sample*	*No foreign partner*	*Foreign partner (foreign direct investment or joint venture)*
Mining	11	8	3
Construction	82	55	27
Food and beverage	54	36	18
Textiles and apparel	39	28	11
Furniture and other wood products	11	5	6
Pulp and paper	14	10	4
Printing and publishing	13	6	7
Chemicals	30	18	12
Shoes and leather products	6	5	1
Nonmetallic mineral products	21	16	5
Basic metals	13	9	4
Fabricated metal products	24	12	12
Electric and electronics	82	54	28
Transport equipment	12	5	7
Other manufacturing	10	6	4
Retail services	15	11	4
Financial services	76	56	20
Number of observations	513	340	173
Share in total (percent)	100.0	66.3	33.7

Source: Authors' survey.

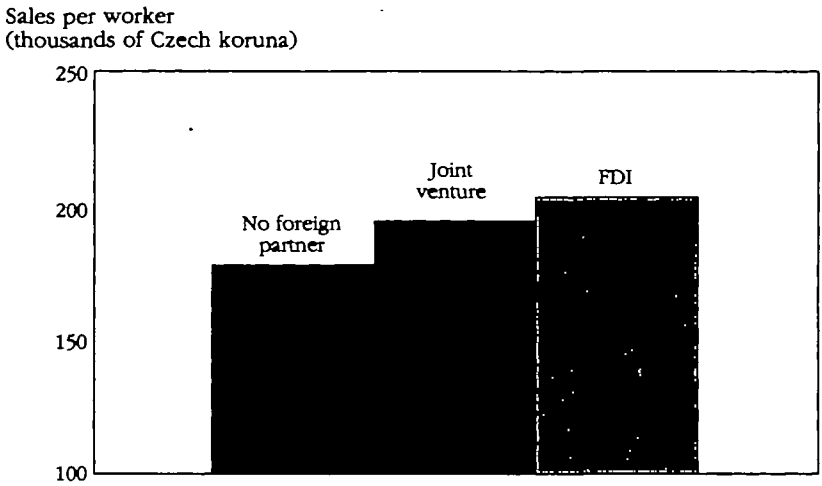
97, 42 percent of all manufacturing firms with more than 10 employees were involved in some kind of foreign partnership (Czech Statistical Office 1998).

Firms with foreign partnerships tend to be significantly larger than firms that remain independent: the median number of employees is 689 in FDI firms, 578 in firms with joint ventures, and 352 in firms without foreign links. Foreign affiliates or joint ventures also have higher initial labor productivity, measured as sales per worker in 1991 (figure 1). This suggests that foreign investors are attracted to firms with above-average performance and size.

Firms with FDI also have the highest average TFP growth of the three groups, followed by firms with joint ventures and then domestic enterprises (figure 2). This ordering may reflect the fact that the initial productivity of firms that attract foreign investment is better than average, implying that foreign investors choose the best firms as partners. In our statistical analysis we therefore correct for the possibility of selection bias. TFP growth rates are highest in earlier years and taper off toward the end of the sample period, reflecting a marked deterioration in macroeconomic conditions in 1996, a common effect for all firms. TFP growth rates initially diverge substantially; growth rates rise in firms with foreign investment and fall in others. Thereafter, some convergence occurs, suggesting that spillover effects may be in play toward the end of the period.

Our questionnaires reveal that both joint ventures and FDI are associated with technology transfers. A questionnaire sent to the sample firms in early 1997 in-

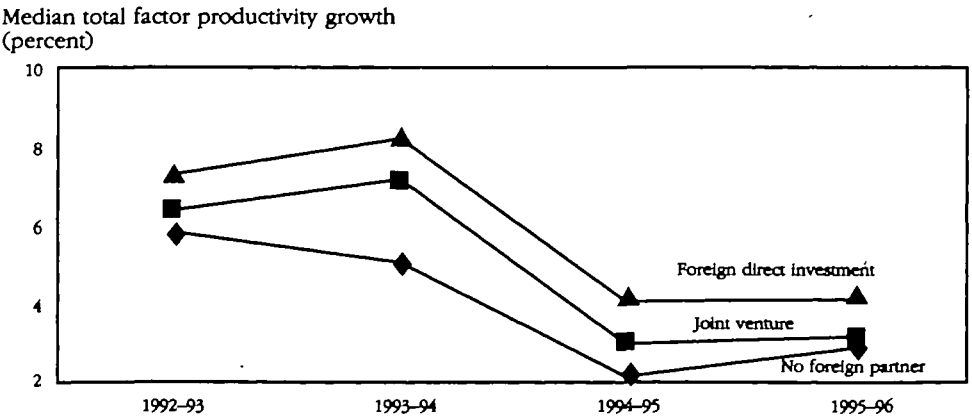
Figure 1. *Initial Labor Productivity, 1991*



Source: Authors' survey.

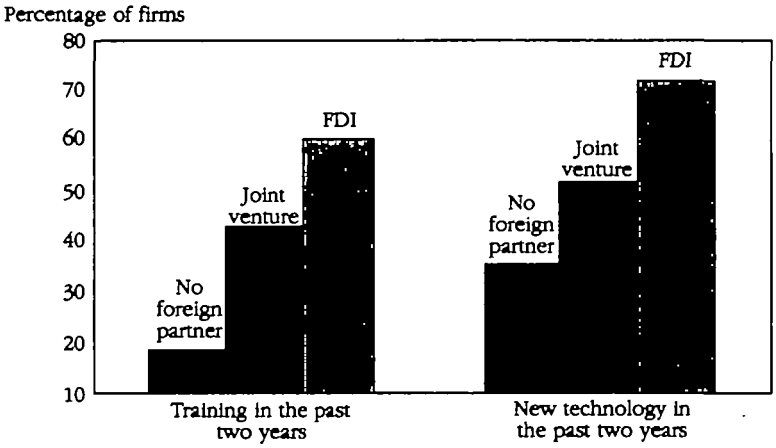
cluded two questions related to training and acquisition of new technologies (figure 3). Managerial responses clearly reveal what appears to be a significant difference between firms with and without foreign partnerships. The questionnaire first asked managers whether their workers had undergone any training in the past two years. Managers were given discrete choices: yes or no. In firms without foreign partners only 18 percent replied positively, while 42 and 62 percent of managers whose firms were involved in joint ventures or FDI, respectively, answered positively. The second question asked whether the firm had obtained new technologies (machinery, equipment) or related knowledge in the previous two years. Again, the response was similar. In more than 70 percent of the FDI firms

Figure 2. *Total Factor Productivity Growth, 1992–96*



Source: Authors' calculations.

Figure 3. *Training and Acquisition of New Technologies, 1997*



Source: Authors' survey.

and 50 percent of the joint ventures the partner had acquired some kind of new technology, as opposed to only 35 percent of firms without foreign links. The relative difference between the two sets of firms is greater for the training variable (software) than for the technology variable (hardware).

III. The Estimation Procedure

We estimate production functions for the firms included in the sample. Each firm i has a production function for gross output:

$$Y_i = F^i(K_i, L_i, M_i) \tag{1}$$

where Y is gross output, and K, L, and M are inputs of capital, labor, and materials. The firm's production function F is homogeneous of degree g $(g \neq 1)$ in K, L, and M. Firms are assumed to be price takers on factor markets, but they may have market power in output markets. The assumption that firms are price takers is reasonable since most wages were set centrally during the sample period, and most materials were bought abroad at world market prices.

The production function in equation 1 implies the following relation between marginal physical products and outputs:[9]

$$F_L^i L_i + F_M^i M_i + F_K^i K_i = g_i Y_i \tag{2}$$

where F_J^i is the marginal product of input J. The optimal choice of inputs by a firm with some monopoly power implies:

$$P_i F_J^i = \mu_i P_{Ji} \tag{3}$$

9. We are grateful to a referee for suggesting the specific formulation used below.

where P_{Ji} is the price of factor J, P_i is the price of the firm's output, and μ_i is the markup of price over marginal cost: $\mu_i = P_i/MC_i$, where MC_i is marginal cost. Combining equations 2 and 3, we obtain:

$$s_{Li} + s_{Mi} + s_{Ki} = g_i/\mu_i \tag{4}$$

where $s_{Ji} = P_{ji}J_i/P_iY_i$ are expenditures on each factor J_i relative to total enterprise revenues. Since firms do not necessarily produce under constant returns to scale, the sum of these shares is not always unity. Using equation 4, the revenue share of capital can be defined as:

$$\hat{s}_{Ki} = 1 - s_{Li} - s_{Mi} = s_{ki} + (1 - g_i/\mu_i). \tag{5}$$

The productivity equation can then be derived from equation 1 as

$$dy_i = \mu_i(s_{Li}dl_i + \hat{s}_{Ki}dk_i + s_{Mi}dm) + \mu_i(s_{Ki} - \hat{s}_{Ki})dk_i + \frac{F_T^i T_i}{F^i}dt_i \tag{6}$$

where dy_i is output growth and $(F_T^i T_i/F^i)dt_i$ measures the technology change or TFP growth not accounted for by the increase in input use. The second term on the right side can be simplified to $(g_i - \mu_i)dk_i$ using equation 5.

We estimate equation 6 in log-differences, using actual enterprise-level data to construct the first right-side term. There are two terms to estimate for each industry, g_i and μ_i, the scale and markup parameters, in addition to the TFP parameter for each enterprise. We use the reported book value of fixed assets to construct the share of capital revenue.

To correct for the likelihood that foreign investment choices are not randomly distributed, we use the generalized Heckman two-step procedure for correcting sample selection bias as developed by Amemiya (1984). This procedure involves separately estimating the foreign investment decision and the firm's subsequent productivity growth. The first step uses a probit model to determine the probability of foreign investment based on initial efficiency (proxied by the share of variable costs in total revenue), firm size, and type of industry. The second step involves estimating productivity using only observations on firms with foreign links. Because this would generate omitted variable bias, the Amemiya procedure provides a specification of the omitted variable that can be used in the full sample to alleviate sample selection. This additional variable estimated in the first step is then included as a regressor in the second step.

Since the primary focus of this article is to test for an association between productivity growth and foreign investment, we augment equation 6 by including dummies for firms with foreign partners as additional factors of production. The dummies (FDI, JV) take the value of 1 if a firm had either FDI or a joint venture in the preceding year and 0 otherwise. This approach is similar to the empirical design that Harrison (1994) uses. We also have to control for the ef-

fects of other changes in the economic environment, but we do not have good proxies for these changes, nor can we account for each of them individually. Instead, we include annual dummies in the estimating equation. These pick up the net effects of changes in the aggregate economy.

We also are interested in determining whether there have been any spillover effects from foreign investment. To do so, we run equation 6 on domestic firms only and include as an additional independent variable (called SPILLOVER) the ratio of the assets of firms with FDI or joint ventures to the assets of all firms in each sector. If foreign participation has beneficial spillover effects, we would expect the coefficient to be positive. We also run an alternative specification, grouping joint ventures together with local firms. We then estimate the spillover effects that FDI firms have on the larger group.

Because of the probable correlation between productivity and the independent variables, ordinary least squares (OLS) may give biased and inconsistent estimates. This simultaneity problem is endemic to the empirical literature on measuring productivity. We address this issue first by using *F*-tests to reveal whether or not OLS is appropriate. Then, if OLS is inappropriate, we use the Hausman specification test to choose between random- or fixed-effects frameworks.

These two tests suggest that a random-effects model is most appropriate. A fixed-effects estimation assumes that firm productivity growth is constant over time. The problem with this assumption is that we want to examine changes in productivity arising from increased competition. The random-effects model avoids this assumption, but it assumes that productivity shocks at the firm level are uncorrelated over time. This restriction may not be reasonable if there is convergence or divergence in corporate performance. Estimates for the major coefficients or variables of interest are reported in table 2.

IV. Results

We estimate equation 6 using both an OLS and a random-effects specification (table 3). The estimated coefficient on the dummy for FDI is positive and statistically significant for both specifications, suggesting that, as predicted, foreign investment involves an additional transfer of technology. The dummy for joint ventures also has a positive sign, but it is slightly smaller in magnitude and is not statistically significant.

We consider the possibility that foreign investment will have a positive spillover effect by including the share of assets of firms with foreign partners in total assets (lagged one year) as a separate regressor. This is a continuous, not a categorical, variable. This approach assumes that spillovers are sector-specific and therefore ignores possible spillovers between industries. Contrary to what is predicted, spillovers are negative: greater foreign participation in an industry has a statistically significant negative effect on the performance of other firms (table 4). Each 10 percent increase in the share of foreign assets is associated with a 1.7 percent fall in sales growth of domestic firms.

Table 2. *Revenue Shares of Inputs, Markup, and Scale Estimates, 1992–96*

Sector	Revenue share of			Markup	Scale estimates	Share of foreign assets	Share of FDI assets
	Materials	Labor	Capital				
Mining	0.538	0.215	0.246	1.246	1.200	0.398	0.124
Construction	0.720	0.169	0.111	1.137	1.088	0.432	0.325
Food and beverage	0.629	0.206	0.165	1.388	1.264	0.635	0.311
Textiles and apparel	0.677	0.180	0.142	1.284	1.132	0.294	0.182
Furniture and other wood products	0.743	0.145	0.110	1.152	1.001	0.542	0.261
Pulp and paper	0.791	0.129	0.079	1.211	1.113	0.715	0.521
Printing and publishing	0.730	0.136	0.133	0.889	0.992	0.885	0.605
Chemicals	0.757	0.151	0.091	1.201	1.163	0.547	0.281
Shoes and leather products	0.612	0.224	0.162	1.182	1.119	0.128	0.000
Nonmetallic mineral products	0.615	0.191	0.193	0.958	0.996	0.408	0.241
Basic metals	0.702	0.155	0.142	1.211	0.880	0.367	0.134
Fabricated metal products	0.733	0.121	0.145	1.192	1.100	0.785	0.191
Electric and electronics	0.657	0.191	0.151	1.201	1.039	0.356	0.110
Transport equipment	0.687	0.117	0.195	1.272	1.070	0.428	0.127
Other manufacturing	0.594	0.171	0.233	n.a.	n.a.	0.524	0.229
Retail services	0.257	0.453	0.289	1.352	1.198	0.402	0.221
Financial services	0.190	0.609	0.200	1.079	1.324	0.368	0.141
Average	0.625	0.209	0.164	1.184	1.104	0.483	0.191

n.a. Not applicable.
Source: Authors' calculations.

Table 3. *Panel Regression Estimates (Full Sample)*

Dependent variable: Growth in sales	*Ordinary least squares estimation*	*Random-effects estimation*
Amemiya selection bias correction variable	Yes	Yes
Sector-specific returns to scale and markups	Yes	Yes
Foreign direct investment dummy	0.015**	0.015*
	(2.011)	(1.937)
Joint venture dummy	0.011	0.010
	(1.372)	(1.286)
Dummy for 1994	–0.012*	–0.011
	(–1.873)	(–1.672)
Dummy for 1995	–0.052**	–0.052**
	(–7.034)	(–6.942)
Dummy for 1996	–0.054**	–0.053**
	(–7.062)	(–7.534)
Number of observations	513	513
F-test (A, $B = A_p$ B)	0.89	
Hausman test (random versus fixed effects)[a]		25.66 [30.19]
Adjusted R^2	0.894	0.861

* Significant at the 10 percent level.
** Significant at the 5 percent level.
Note: Heteroskedasticity consistent (White correction); *t*-statistics are in parentheses. A constant term is included in both regressions.
a. Cutoff point is in square brackets.
Source: Authors' calculations.

It has been argued that spillovers from joint ventures should be greater than those from FDI (establishment of majority-owned affiliates), since the foreign partner has less ability to control the behavior of the domestic partner, and the domestic partner has a greater incentive to pursue R&D itself (see, for example, Pack and Saggi 1997). In contrast, internalization through FDI should be better able to limit technology leakage. If this is indeed the case, then excluding joint ventures from the SPILLOVER measure of the share of foreign ownership and reestimating the equation should increase the magnitude of the negative spillovers. The evidence, however, does not support this argument (table 5). Instead, the magnitude of the spillover effect becomes smaller and statistically insignificant, although it remains negative. Thus excluding joint ventures has an offsetting effect. In part this reflects the fact that joint ventures have higher TFP growth than firms without foreign partnerships, which raises the average of the group without FDI. This finding illustrates that the initial result of negative spillovers may not be robust. Tests for spillovers with the methodology used here (and in the literature more generally) require some assurance that in distinguishing between two subsets of firms in an industry on the basis of whether or not there is majority foreign ownership (or more generally foreign links of some kind) one is not ignoring other important determinants of firm performance.

One such determinant likely to be important is firms' investment in improving their technology. The survey questionnaire reveals that joint ventures invested significantly more in training and new technologies than purely domestic firms. The technological ability and effort that many of the firms without foreign partners

Table 4. *Spillover Effects (Firms without Foreign Links)*

Dependent variable: Growth in sales	*Ordinary least squares estimation*	*Random-effects estimation*
Amemiya selection bias correction variable	Yes	Yes
Sector-specific returns to scale and markups	Yes	Yes
Spillovers (share of assets of firms with joint ventures and foreign direct investment)	–0.178**	–0.172**
	(3.125)	(2.054)
Dummy for 1994	0.002	0.002
	(0.215)	(0.178)
Dummy for 1995	–0.038**	–0.037**
	(–4.201)	(–3.934)
Dummy for 1996	–0.036**	–0.035**
	(–3.534)	(–3.642)
Observations	340	340
F-test	0.92	
Hausman test (random versus fixed effects)[a]		4.57 [14:45]
Adjusted R^2	0.887	0.843

* Significant at the 10 percent level.

** Significant at the 5 percent level.

Note: Heteroskedasticity consistent (White correction); *t*-statistics are in parentheses. A constant term is included in both regressions.

a. Cutoff point is in square brackets.

Source: Authors' calculations.

Table 5. *Testing for Spillover Effects (Firms without Foreign Direct Investment)*

Dependent variable: Growth in sales	*Ordinary least squares estimation*	*Random-effects estimation*
Amemiya selection bias correction variable	Yes	Yes
Sector-specific returns to scale and markups	Yes	Yes
Spillovers (share of assets of foreign affiliates in total assets of the sector)	–0.077	–0.074
	(1.425)	(1.218)
Dummy for 1994	0.003	0.002
	(0.897)	(0.178)
Dummy for 1995	–0.032**	–0.031**
	(–2.985)	(–2.257)
Dummy for 1996	–0.027*	–0.025
	(–1.847)	(–1.514)
Observations	431	431
F-test	0.91	
Hausman test (random versus fixed effects)[a]		4.13 [14.45]
Adjusted R^2	0.894	0.857

* Significant at the 10 percent level.
** Significant at the 5 percent level.
Note: Heteroskedasticity consistent (White correction); *t*-statistics are in parentheses. A constant term is included in both regressions.
a. Cutoff point is in square brackets.
Source: Authors' calculations.

expend may be too low to absorb spillovers when they occur, or the firms with foreign links may have absorbed a significant share of the available stock of labor with requisite skills. Also, given that FDI and joint ventures together account for a significant share of total assets, sales, and employment in the Czech Republic, the potential for positive spillovers may be significant among firms with foreign partnerships, such as from FDI firms to joint ventures and among joint ventures. This suggests that, if domestic firms were excluded from the sample, FDI would have a positive effect on firms with joint ventures. But the effect is not statistically significant (the *t*-statistic is 1.42, possibly reflecting the small sample size).

Finally, account also should be taken of the short time frame on which the study is focused. Spillovers may require more time to affect TFP growth rates. And, as mentioned, absorbing new techniques requires significant in-house technological effort, which may not be captured adequately by the production function methodology used. Clearly, further research is required.

V. Concluding Remarks

Firm-level data for the Czech Republic during 1992–96 suggest that foreign investment has the predicted positive impact on TFP growth of recipient firms. This result is robust to corrections for the sample selection bias that arises because foreign companies tend to invest in firms with above-average productivity. It is not surprising that foreign investment raises TFP growth (with a lag), given

that foreign investors transfer new technologies and knowledge to partner firms. FDI appears to have a greater impact on TFP growth than do joint ventures, suggesting that parent firms are transferring more knowledge (soft or hard) to affiliates than joint venture firms obtain from their partners.

Taken together, joint ventures and FDI appear to have a negative spillover effect on firms that do not have foreign partnerships. This effect is relatively large and statistically significant, and it cuts across industries. However, if we restrict attention to the impact of foreign-owned affiliates (FDI) on all other firms in an industry, the magnitude of the negative effect becomes much smaller and loses statistical significance. This result, in conjunction with the fact that joint ventures and FDI together account for a significant share of total output in many industries in the sample, suggests that further research is required to determine the extent to which knowledge diffuses from firms that have strong links to foreign firms to firms that do not have such relationships. Particularly important in this connection is exploring the extent of spillovers among joint ventures and between foreign affiliates and joint ventures. Insofar as joint ventures invest more in technological capacity (as is suggested by their training efforts), we would expect them to be better able to absorb and benefit from the diffusion of knowledge. The absence of such capacity may underlie the observed negative spillover effect. Longer time series and collection of data that measure firms' in-house technological efforts would help to identify the magnitude and determinants of technological spillovers.

Further analysis of the performance of Czech firms is necessary to see whether our results hold up for a larger sample of firms and in more recent years. Such data are being collected at the World Bank as part of a research project on knowledge transfer, and more robust results will emerge in the future.

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