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Does Distance Matter in Spillover?♣

Abstract

This paper examines the technology transfer through FDI in Hungary, using a large panel dataset of 24000 firm-level observations. We distinguish horizontal (intra-industry) and vertical (inter-industry) spillovers. Besides the sign and magnitude of these effects we are interested in the spatial structure of these technology transfers. For this we use distance data, correct for sample selection and for the endogeneity of input demand use Arellano-Bond dynamic panel data technique. Our main findings are that there are significant horizontal and backward spillovers for domestic-owned firms suggesting the presence of foreign competitors and customers is beneficial for domestic firms. The effect of regional and county boundaries is insignificant. Using the distance data we find clear spatial structure of spillovers: for domestic firms the foreign presence only matters in very small distance (25 km), for foreign-owned firms the stronger the spillover the larger the distance (50 and 100 km).

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1. Introduction

In Central-Eastern Europe after 1990 the foreign direct investment (FDI) flows became one of the most important engines of economic growth. It is especially true for Hungary who was the most important receiver of FDI in the first part of the 1990s. FDI flows into Hungary have substantially declined afterwards, that is what makes questions about the determinants of these inflows relevant.

The government, as in most neighboring countries, decided to offer various tax concessions and other tax reductions for investors to persuade them to choose Hungary.[1] These investments had significant positive direct effects: for instance employment has grown and the exports increased. But it is a widely held belief that FDI has even more important effect in the form of externalities for other firms, embodied in increased productivity of domestic-owned firms. The magnitude of this spillover effect is very important from the policy point of view as decisions about tax holidays and other subventions should be based on it. Another important question is exactly which firms are benefiting from these spillover effects, and in which industries these effects are the most important?

Several empirical studies were published about the magnitudes and signs of these spillover effects in Central and Eastern Europe and in other big receivers of FDI. In this study we use two very large datasets of the Hungarian manufacturing sector to estimate the effect of higher productivity on the performance of other firms. We estimate the direct and indirect effects of foreign ownership on the productivity of firms as well. As these databases contain data about the locations of the companies we can study the spatial dimension of spillover effects. In previous studies regional dimension is at best examined with the help of variables showing if the two firms are in the same region. We estimate the effect of the regional boundaries and the distance on the magnitude of spillover as well.

In Section 2 we discuss the most important channels of spillover effects and the related econometric questions. Section 3 discusses the empirical results for Central and Eastern Europe and especially for Hungary. In Section 4 we describe our datasets, the most important variables that we are using and the method of estimation. In section 5 the results are presented for different specifications. Section 6 concludes.

[1] Economists are divided on the effect of different tax concessions in attracting FDI. See for example: Desai and Hines (1999), Hines (1997), Görg and Greenaway (2003), Greenaway et al (2003) and Görg (2003).

2. Spillover and FDI. Theory and Measurement

We follow Görg and Greenaway [2004] in summarizing the theoretical issues about spillover effects. The question why foreign investment is better then simply exporting or licencing is an old one. The most common answer in the literature is that there is some firm-specific knowledge, and a market failure in protecting this knowledge or in transacting it (Markusen [1995]). As the transaction of this specific knowledge is too costly, firms choose to internalize these high transaction costs, thus set up foreign affiliates. The question is if there is any spillover of technology from these affiliates given this specific technology or knowledge? Are there other channels, through which higher productivity can be transferred?

First it is very important to emphasize that the magnitude of spillover depends on the relative levels of technology. Findlay [1978] emphasised the importance of relative backwardness and contagion. He suggests that the bigger the difference between the two technologies the greater the possibility for the spillover. On the other hand the bigger the difference and the more urgent to adapt, the bigger the danger of bankruptcy.

Glass and Saggi [1998] argues that if the gap is too wide between the two technologies the less advanced firm may not have the physical and human capital to use the more productive technology. Thus this gap is very important for the spillover: it signals something of the absorptive capacity of the firm. It is not clear, what is the exact connection between the gap and the absorptive capacity, but these two models suggest that it can be an inverted U shaped function.

There is a possibility that the spillover is a U-shaped function of absorptive capacity. Girma and Görg [2003] found for example that this case is relevant under some circumstances. They interpret it in the following way: firms with very low absorptive capacity are unlikely to benefit from positive spillovers but they are unlikely to be hurt by competition form multinationals as well. As they increase their absorptive capacity they start competing with multinationals, but they are still not able to benefit from positive spillovers. However for firms with very high absorptive capacity the benefits of positive spillovers outweigh the destroying effect of competition, thus for them the spillovers become positive.

There are several possibilities to measure absorptive capacity. Some papers use R&D intensity as the measure of a firm's absorptive capacity. For example Kinoshita [2001] uses this as absorptive capacity for firms in the Czech Republic, and she finds evidence for positive spillovers. Barrios

and Strobl [2002] argues that one can use the export ratio (the ratio of exports and total sales) as a proxy for more competitive technology and thus absorptive capacity as firms exporting more face more intense competition on foreign markets. Accordingly we expect that firms with higher export ratio have higher absorptive capacity, thus the spillover should be higher in their case. In most papers however (for example Girma et al [2001]) a measure of productivity difference is used. A convenient measure is the ratio of the TFP of the given firms to the TFP of the industry leader. In this paper we use both export ratio and TFP as measures for absorptive capacity.

What we can assess at first place is the direct transfer of technology for the acquired firm from the multinational. Of course this effect is not a spillover effect but it is very important from policy point of view if we try to summarize the effects of FDI on the host country's economy. The foreign company buys a firm because it has superior technology, with which it can be more productive and more successful than the others. Thus we can expect that after acquiring a firm the foreign owner will transfer technology and management knowledge to its new affiliate. On the other hand it is a common belief in transition economies that the aim of a number of takeovers is to buy markets or eliminate competitors. In this case we can expect a negative direct effect of foreign ownership. However, this effect can hardly be observed, because most firms acquired for this reason will be shut down. Thus the lack of negative direct effects does not show necessarily the lack of buying market and eliminating competitor. This direct technology transfer can be measured easily and it is mostly significant in empirical studies. For instance Damijan et al [2003] finds significantly positive effects of foreign ownership for Hungary, Slovenia and Estonia and negative direct effects for the Czech Republic, Lithuania, Poland and Romania. Smarzynska [2003] finds a significantly positive direct effect of FDI for Lithuanian firms. Thus the sign of this direct effect is far from clear for transition economies.

Besides the direct technology transfer what is intentional as it is seeking profit, there are unintentional technology transfers as well. The classical indirect technology transfer is *imitation*. The magnitude of imitation depends on the complexity of the technology and the legal and economic environment in the host country. In this respect the absorptive capacity is very important: the greater the gap between the new and the old technology, the smaller the probability that domestic firms can imitate the technology of production or the new products. On the other hand the more advanced the legal and economic environment is, the more costly the imitation is, as the imitators are facing the risk of a legal procedure. Thus it is unlikely that all the technological advantage will disappear, but strong spillovers can be present through this channel. We do not know too much from the geographical structure of this effect. On the one hand, for

reverse engineering and other such activities firms do not need to be physically close. On the other hand for the diffusion of some types of information there is need of personal contact, and this kind of knowledge spillovers operates on very small distances.

Some argue that the most important channel of spillover is the *acquisition of human capital*. Investor companies in order to fully exploit their technological advantage, will invest into their employees' human capital. This investment can be very significant in a country like Hungary where skilled labor is available at relatively low wage thus firms will substitute their unskilled labor with skilled. We can see very heavy investments from foreign owned firms into human capital in transition economies. For instance Kertesi and Köllő [2001] mentions a survey, in which 264 domestic owned and 78 foreign owned firms took part. According to this data domestic owned firms spend 2.4% of their investments on training, while this ratio was 14.2% for foreign-owned firms. We can find similar patterns for the Czech Republic as well: Filer et al [1995] reports that the money spent by foreign-owned firms on hiring and training was 4.6 times the money spent on the same by domestic-owned firms in 1993. Thus there is a great potential of spillover through this channel.

On the other hand we can see that foreign-owned firms employ younger and more educated people than the domestic-owned ones. (Kertesi and Köllő [2001]). These workers are mostly experienced, worked for 3 to 10 years.

One consequence of this direct labor market spillover is that it spills over to complementary workers in other firms. The indirect spillover means that other firms can 'persuade' the formal workers of the more productive firms to work for them, and in this case workers bring their newly acquired human capital with them to their new employers. For this channel absorptive capacity is very important as well: if there is a huge gap between the technologies of the two firms, the human capital can be simply useless for the less developed firm. On the other hand wage differentials can play a role. The foreign firms will pay higher wages to attract the best workers and make them stay there. Kertesi and Köllő [2001] shows that productivity of the young and educated workers is much higher in foreign-owned firms, thus we can expect that they are able to pay higher wages. On the other hand the authors mention, that the productivity and the wage of these workers first increased for foreign-owned firms, and just after this for the domestic owned ones. Thus it is likely that foreign-owned firms are cream-skimming: they employ the best former workers of other firms and free-ride on their hiring and training costs. Consequently it is possible that there are negative spillovers through the labor market.

The smaller the wage difference between foreign and domestic firms, the higher the probability of positive labor-market spillover. On the other hand distance can play a very significant role in this case: the mobility of workers can be very limited, thus we expect that if this spillover channel is dominant, it is unlikely that big spillovers will appear between regions or in big distances.

An important question is whether most of the knowledge of the workers of multinational firms is firm-specific or can be used elsewhere. This question was examined by Görg and Strobl [2002]. Their results suggest that firms which are run by owners that worked for multinationals in the same industry immediately prior to opening up their own firm have higher productivity growth than other domestic firms. The authors could not find any positive effects on firm level productivity if the owner had experience in multinationals in other industries, or received training by multinationals. This can be taken as micro-level evidence that the managerial skills of these people are industry, and not firm-specific.

The third channel of spillover is the *competition.* The sign of the competition spillover effect is far from clear. Empirical estimates show signs of negative and positive effects as well. For example Aitken and Harrison [1999] found negative horizontal spillovers for firms in Venezuela. On the other hand Kokko [1996] found positive effects for Mexico. Competition can decrease X-inefficiency, which is the difference of the efficient behavior of the firms, implied by the theory, and their real behavior. X-inefficiency can be very high on markets characterized by monopoly or low degree of competition. As in a socialist economy the X-inefficiency is very high because of the lack of incentives to be efficient, in transition economies the magnitude of X-inefficiency can be substantial. But on the other hand there is a big danger that more productive firms will crowd out domestic firms. In this case only the most efficient firms remain in the market and the average productivity of the economy increases due to compositional effect. Because of the crowding out effect it is possible that domestic firms cannot produce at their efficient level; they can not take advantage of economies of scale or scope. Thus their costs increase and they become less effective. In this case the competition spillover effect becomes negative. The absorptive capacity is very important in this case: if there is a great gap between firms, domestic firms may not able to compete and they will simply go bankrupt. For this channel the effect of distance is dependent on the regional dimensions of the product market, thus it can be very different for different industries.

The fourth channel is the vertical spillover. The vertical spillover operates through the input and output markets. Input producers can be supported by direct technology transfer from their buyers. It is possible that their employees can take part in training programs organized by the buyer. Even some employees of the buyer may visit the facilities of these companies and help them to organize work. On the other hand the higher requirements and the higher prices payed for them may increase productivity. This channel is called backward spillover.

Buyers of the more productive firms can make profit from effectiveness of their suppliers. These products may have better quality, so they can be used in a more productive way. This effect is the forward spillover. As both kinds of vertical spillover work through input or output markets, the spatial dimension of these spillovers depends on the spatial structure of these markets.

The most important contribution of this paper to the literature of productivity spillover is the extensive study of the role of distance for different spillover effects. Most of the studies which take into consideration the spatial dimension of spillover use both in-region and outside-region variables to study the effect of regional boundaries and physical closeness (Aitken and Harrison [1999], Girma et al [2000]). In this study we are in the situation to compare the working of this set of variables with variables based on geographical/economic distance.

There are several important measurement issues as well. The first – and possibly the most essential – is the question of appropriate data. As Görg and Strobl [2001] argues, the most useful kind of data is a panel data of firms. The cross-section data, which are used in most early studies produce biased estimates of parameters, because cross section data do not control for the time-invariant productivity differences between sectors, which can be correlated with the foreign presence but not caused by that. The problem is even more dramatic if we use data aggregated at the sectoral level. As we use a large panel data of firms in this paper, this problem does not occur. By estimating the TFPs by fixed-effects panel data method, we can control for the time-invariant sectoral productivity differences.

A second problem is the sample selection. Foreign firms do not choose the domestic firms by a random process. Naturally they choose firms, which are the best in some sense: the ones which are more productive now or in the future. Thus there is a danger that as we observe, that more productive firms are in foreign ownership, we think that it is a consequence of spillover, although in fact the more productive firms were acquired by foreign firms. We can use a sample selection model to correct this problem, for example the one suggested by Heckman (1979). Damijan et al

(2003) uses this method to estimate the model. In the first step of this procedure the authors estimate a probit model on foreign ownership, then using the inverse Mill's ratios of this model estimate the spillover equation. In our paper we correct for sample selection bias in a similar way.

Several endogeneity problems occur. Damijan et al (2003) suggests that the choice of the production factors (labor and capital) can be endogenous as it is possible that they are determined endogenously by the firm's past productivity. To correct endogeneity problems like this, several IV and GMM methods were proposed. For example Damijan et al (2003) uses a sys-GMM approach to correct for endogeneity. A problem with these approaches is that to create instruments one needs a longer time series as the first two years of observations are used up as instruments. Another problem is that the small sample properties of these complicated estimation techniques can be very poor or unknown. Consequently we have to be careful in using such techniques for transition economies, as the quantity of reliable data is very much limited in these economies. In this paper we use a GMM approach to control for the endogeneity in the production factors.

3. Spillover and FDI in CEECs

Although most of the studies of productivity spillover were concentrated to developed countries and developing countries in the Americas and in South-East Asia, in recent years a number of studies were published about the Central and Eastern European transition economies. These countries are worth studying because of the special structure of the economy and the major role what multinational enterprises play. It is possible that because of the special institutional setting of these countries effects are different from those in other parts of the world. The very fundamental changes and development create a good opportunity for studying spillover effects.

Because of the macroeconomic instability the comparability of the data in different years is questionable. Due to high inflation the value of the assets becomes less reliable. Data on capital in this period heavily depend on the accounting practices of the firms, which can be very different. This problem has become more severe because of the ever-changing accounting rules. On the other hand taxes were unstable, thus the incentives of the firms changed from period to period. As interest rates and exchange rates were very volatile, the real value of assets denominated in foreign currencies and the value of debts were very volatile too. In these years the shadow economy constituted a large portion of the economy, which is not only a problem because of a large part of the economy is not represented in the data, but that the firms represented in the samples worked partly in the shadow economy, thus some data cover the entire population of the firm, while others do not. On the other hand one can observe that there is a quite large number of entries and exits in the corporate sector for tax evasion reason, therefore it is not easy to find balanced panels. These problems became moderate for the second half of the ‘90s, thus econometric analysis is more appropriate.

A survey of the relevant studies can be found in Görg and Greenaway [2003]. Djankov and Hoekman [2000] uses a panel of Czech firms between 1993-1996 and found mostly negative spillover effects. Kinoshita [2001] uses also a panel of Czech firms in a later period, between 1995 and 1998. She finds that the spillover effect is stronger in sectors with higher R&D intensity. The spillover from joint-venture companies is insignificant in the Czech manufacturing sector. The spillover effects are stronger in sectors which are oligopolistic than in competitive sectors.

Bosco [2001] studies a panel of Hungarian firms between 1993-1997 which is a period when fundamental changes took place in the economy because of the creation of basic market

institutions, massive privatization and the macroeconomic stabilization in 1995. We have to admit, that the database used by Bosco [2001] and the other authors for Hungary seems to be rather poor in the sense of reliability and sample size as well. She found that foreign affiliates are more productive than Hungarian firms, just in case of Halpern and Kőrösi [1998, 2001], while the difference has substantially decreased. Konings [2001] uses panel datasets for Bulgaria Poland and Romania between 1993 and 1997. He finds mostly negative spillovers.

Damijan et al [2003] uses a dataset of more than 8000 firms for ten transition economies. It uses Heckman two-step procedure to correct for sample selection bias. In the first step the authors estimate the effect of different factors on the foreign investment decisions in 1995 using a probit model. Then, using the inverse Mill's ratio of these estimates as instrument, they estimate the spillover model in the second stage. As the input demands can be endogenous, they use a dynamic system GMM estimation technique. Authors found that direct FDI effects are much stronger than spillover effects. For Hungary, in the first-stage probit estimation they found that the greater the foreign presence in the industry, the greater the probability of foreign investment to the given firm. The capital intensity and the skill intensity variables were also significant. In the second stage estimation they found that firms with more foreign share were more productive thus the direct effect of the FDI is significant. For the entire sample they could not find evidence of spillover. For domestic firms, they found significant horizontal spillover effects, but no significant vertical spillover. In their model R&D of the firm is used as a measure of absorptive capacity. For Hungary, the lagged R&D has a positive significant effect for productivity, thus firms with more R&D have greater absorptive capacity and are able to utilize spillovers better.

4. Sample, data, estimation

4.1 Datasets

Our main source of data is the Hungarian tax dataset. It consists of the most important financial account data of the firms, like the balance sheet, revenues and costs. Firms are classified into four-digit NACE categories. For the 1996-2001 years, the database includes 24,255 observations in the manufacturing sector. As firms are identified by an id number, it is possible to build a panel. The number of observations and number of foreign owned firms are reported in Table 1.

Table 1. The number of companies in the sample

Year	Domestic Ownership	Foreign	Total
1996	2,504	883	3,387
1997	2,577	928	3,505
1998	2,632	947	3,579
1999	2,873	1,001	3,874
2000	3,927	1,180	5,107
2001	3,671	1,132	4,803
Total	18,184	6,071	24,255

In our database 25% of the firms are in majority foreign ownership. We can see, that this share did not grow in the period studied. However the share of foreign firms is even greater if we do not only consider the number of firms, but other indicators. The revenue share of foreign owned firms is 70% in the sample. The number of employees in foreign firms is 48% of all employees according to this sample. Even from these numbers we can see that the characteristics of foreign owned firms are significantly different from those domestic owned. Means of some indicators are reported in Table 2.

Table 2. Summary statistics of some variables and ownership

	domestic owned	foreign owned
# employees	114	317
revenue (m HUF)	823	5944
export ratio %	14	47
Industry hhi %	8	14

Foreign-owned firms employ 2.5 times more people in average than domestic-owned firms. Similarly the sales are 6 times higher. Foreign-owned companies export much more than domestic owned ones. The industry concentration, which is measured by the Hirschmann-Herfindahl index (hhi), is much higher in industries where foreign owned firms are present. Thus foreign investors do not choose companies randomly, which leads to sample selection bias.

Our second source of data is the wage survey, which covers firms employing more than 10 people. This survey however does not include all such firms: the sampling is heavily biased towards large firms; almost all firms employing more than 500 employees are included. This database is not only useful for calculating average wages for the firms, but we can find the location of the firms, which is not included in the tax database. From this location data we can calculate the distance between separate companies. If a firm operates more than one plant, we use the plant with the largest number of employees as the location of the firm.

To summarize, our data is a very good quality panel for studying spillover effects. The data is an individual firm based, relatively long panel with relatively high number of observations per year, which is the ideal dataset for such an exercise according to Görg and Strobl (2001). Although there are several problems in connection with the comparability of data from different years, we can conclude, that studying this panel is a good opportunity to investigate spillover effects in a transition economy.

For input-output data, we used the 1998 input-output table of Hungary, published by the Central Statistical Office of Hungary.

Throughout our work we used the data between 1996 and 2001. The main cause of it is that since 1995 firm level data are more reliable, no structural break is expected for this reason.

4.2 Spillover variables

To estimate the effect of distance on spillover we have constructed a number of variables. The horizontal spillover is measured by the weighted average of the foreign shares of the companies in the given industry, excluding the given firm, where the weights are the total sales of the firm:

$$VFS_{it} = \frac{\sum_{j \in industry; j \neq i} R_{j,t-1} FS_{j,t-1}}{\sum_{j \in industry; j \neq i} R_{j,t-1}},$$

where $R_{j,t-1}$ denotes the sales of firm j in year $t-1$, and $FS_{j,t-1}$ is the foreign share in firm i in year t.

The sign of the coefficient of this variable is not straightforward, as it was mentioned earlier. On the one hand it is possible, that imitation, competition and positive labor market effects coming from the better training of some employees are strong enough to generate a positive horizontal spillover in balance. On the other hand there may be harmful competition for firms using lower level of technology, and negative labor spillover, as foreign owned firms are more likely to convince the best employees of domestic-owned firms to work for them, and in this way the productivity of domestic-owned firms might decrease. Thus it is an empirical question, which of these effects is the stronger, e.g. if the increased foreign presence in the given industry is beneficial or harmful for the Hungarian firms.

We wish to investigate if regional boundaries or distance is the main determinant of the range of spillover. For this aim we constructed variables, which consist only the firms in the 25, 50, 100 km neighborhood of the given firm. For the 25 km range, the variable is:

$$d\_25\_VFS_{it} = \frac{\sum_{j \in industry; j \neq i; d_{ji} < 25} R_{j,t-1} FS_{j,t-1}}{\sum_{j \in industry; j \neq i; d_{ji} < 25} R_{j,t-1}}$$

Finally we used the weighted average of the foreign share in the region in the given industry, to study the effect of the regional boundaries. These are EU-regions, and there are 7 of them. These regions somehow reflect the historical economic regions of Hungary, thus we can expect that they represent real economic regions.

To investigate the effect of vertical spillovers we constructed similar variables, to represent backward and forward spillovers. The forward spillover variable is the following:

$$IFS_{it} = \sum_{j} \alpha_{jk} AFS_{jt-1} \quad ,$$

where α_{jk} is from the input-output table showing how much intermediate inputs used by industry k was produced by industry j, where k is the industry where the given firm (i) operates. $AFS_{j,t-1}$ shows the average foreign share in industry j, that is:

$$AFS_{jt} = \frac{\sum_{i \in industry\_j} R_{i,t-1} FS_{i,t-1}}{\sum_{i \in industry\_j} R_{i,t-1}}.$$

Thus IFS_{it} shows the weighted average foreign share in suppliers of the given firm, where the weights are the input shares from the input-output table.

The sign of the forward spillover effects may be positive, if higher foreign presence in the supplier side may mean better quality and increased competition in input markets, which is beneficial for the customers of these inputs. However it is possible, that foreign firms simply buy markets in these sectors, which leads to weaker competition and higher prices thus making customer firms less productive.

To study the effect of backward spillover we use the weighted average of the foreign shares of the customers of the given firm. To measure this effect we used the OFS_{it} variable, which is calculated the following way:

$$OFS_{it} = \sum_{j} \alpha_{kj} AFS_{jt-1},$$

thus the difference between the calculation of IFS_{it} and OFS_{it} is that for the former we use the share of input suppliers as weights, and for OFS_{it} we use the share of customers of inputs as weights.

The sign of the backward spillover effect is not obvious at all. The greater foreign presence in the customer sector may lead to very good bargaining position of customers. This may mean that they are able to motivate suppliers to reach higher productivity standards. They may even provide more advanced technology or training for their suppliers. With their better bargaining positions they might be able to reach lower input prices, what, by definition, leads to lower productivity. The other factor we should consider is that foreign owned firms are more likely to export more, which leads to decreased demand on their input markets. As a consequence only the best firms can survive, which can lead to a greater average productivity. In summary we cannot predict the sign of this effect theoretically.

The last class of variables is simply the average of the foreign share of firms within a region, weighted by their size. In this case we do not study vertical or horizontal linkages, just if the presence of foreign-owned firms makes firms more productive.

Similarly to the handling of the horizontal spillover we use several variables to study the effect of distance and regional boundaries on spillover, which are summarized in the following table:

name	Description
vfs	average fs in competitors
d25_vfs	average fs in competitors in 25 km range
d50_vfs	average fs in competitors in 50 km range
d100_vfs	average fs in competitors in 100 km range
r_vfs	average fs in competitors in the region
ifs	average fs in suppliers
d_25_ifs	average fs in suppliers in 25 km range
d_50_ifs	average fs in suppliers in 50 km range
d_100_ifs	average fs in suppliers in 100 km range
r_ifs	average fs in suppliers in the region
ofs	average fs in customers
d_25_ofs	average fs in customers in 25 km range
d_50_ofs	average fs in customers in 50 km range
d_100_ofs	average fs in customers in 100 km range
r_ofs	average fs in customers in the region
regional_fs	average fs in firms in the region
county_fs	average fs in firms in the county
d25_fs	average fs in firms in 25 km range
d50_fs	average fs in firms in 50 km range
d100_fs	average fs in firms in 100 km range

4.3 Econometric considerations

As it was mentioned, there are several econometric concerns in connection with measuring the spillover effects. The sample selection problem comes from the fact that foreign firms buy up systematically more productive firms. Thus if we find that foreign-owned firms are more productive it does not necessarily mean that they are more productive because of the foreign share but the causation can be reverse. We use the method proposed by Heckman (1979) to correct for it. In the first step we estimate a probit model where the dependent variable is if the majority of the firm is owned by foreigners, and the independent variables are some attributes of the given firm. From this first step estimation we predict the inverse Mill's ratios and use them in the production function as if they were omitted variables.

There are two econometric problems in connection with the calculation of Mill's ratios. First the majority foreign share variable behaves in a special way, e.g. some firms are initially in state ownership, then firms are privatized, and from that time they become foreign owned. This means that the variable is AR(1). On the other hand it is likely, that the parameters of the model change through time, as the incentives for foreign investment change. Thus there are two basic possibilities. The first possibility is to estimate a panel probit model with AR(1) disturbances. The other, and much simpler, possibility is to estimate the probit model separately for every year, and to obtain inverse Mill's ratios from these models. As the dataset is large enough, we choose the second possibility. We have to mention that to our knowledge no earlier study used such a dataset which consists of yearly ownership variables, thus we have a good opportunity to study the determinants of ownership.

The other most important problem is the problem of endogeneity of inputs. In the literature about production functions, it is well known, that the input choice of firms is not independent from the unobserved characteristics of the firm, including the past productivity (e.g. Blundel and Bond, 1998). To correct this problem, several dynamic panel estimators were proposed. In this paper we use the standard Arellano-Bond panel data estimator, proposed by Arellano and Bond (1991). Although in the spillover literature for example Damijan et al (2003) uses sys-GMM estimator to correct this problem, there is no convincing evidence that these estimators work significantly better in situations like spillover estimation, thus we prefer the simpler method as it seems to be the case that it has better finite sample properties.

When using the Arellano-Bond dynamic panel data estimator, first we differentiate the variables to eliminate the individual effects. In the second step we use the level variables of the first differenced endogenous variables as instruments.

For the estimation we use a Cobb-Douglas production function. The basic model is the following:

$$\ln\_y_{it} = \alpha \ln\_y_{i,t-1} + \beta_1 spill_{it} + \beta_2 \lambda_{it} + \gamma_1 \ln\_k_{it} + \gamma_2 \ln\_l_{it} + \nu_i + \varepsilon_{it} \qquad (1)$$

where $\ln\_y_{it}$ is the added value of firm i in year t, $\ln\_k_{it}$ and $\ln\_l_{it}$ are the natural logarithm of capital and labor, respectively, $spill_{it}$ are the different spillover variables, λ_{it} is the inverse Mill's ratio for the given firm from the first stage probit estimation, ν_i is the firm specific random effect. The Arellano-Bond model assumes that ν_i and ε_{it} are independent for each firm and year. In the following, we assume that capital and labor are endogenous as their choice is a function of the unobserved characteristics of the firm, including the past and present productivity.

We assume however that the spillover variables are strictly exogenous, as they are weighted averages of the foreign share in other firms, which is practically independent form the unobserved characteristics of the given firm. Moreover we assume that the inverse Mill's ratios are independent as well, as these are functions of exogenous variables.

The process of estimation is the following. First we differenced equation (1) to remove the random effects. Then we estimate the equation by using the lagged levels of dependent variable, the spillover variable and the inverse Mill's ratio as instruments for the endogenous inputs. Applying this procedure we get consistent estimates for all the parameters.

5. Results

5.1 The probit estimation

Djankov and Hoekman [2000] together with Evenett and Voicu [2001] claim that investors tend to invest into bigger and more successful firms. Damijan et al [2003] uses a dataset – different from the one used in this study – of Hungarian firms. The authors found that for Hungary in the first stage probit model the capital intensity, the foreign penetration in the industry were significant at 1% level and the skill intensity only at 10% level. They found that the size of the firm, the sector size and labor productivity were insignificant.

As it was described above, in the first step we estimated the probit model in which the dependent variable is the majority foreign share. The results of the probit models are the following:

	year_1996	year_1997	year_1998	year_1999	year_2000	year_2001	re_probit
# of employees	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0003
	[0.0001]	[0.0001]	[0.0001]	[0.0001]	[0.0002]	[0.0002]	[0.0001]
Hirschmann-Herfindahl index	0.0076	0.0089	0.0083	0.0067	0.0021	0.0005	0.0013
	[0.0020]	[0.0020]	[0.0022]	[0.0021]	[0.0016]	[0.0017]	[0.0018]
skill intensity	-0.1227	0.1126	0.0651	0.1985	-0.0385	-0.2368	-0.1153
	[0.1009]	[0.0940]	[0.1004]	[0.0971]	[0.0802]	[0.0854]	[0.1040]
capital intensity	-0.0186	-0.0031	0.0046	0.0061	0.0027	0.0395	0.0005
	[0.0085]	[0.0100]	[0.0063]	[0.0070]	[0.0020]	[0.0050]	[0.0017]
sector size	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
foreign penetration	1.8144	1.6863	1.7346	2.0824	1.8447	1.8762	0.6179
	[0.1615]	[0.1771]	[0.1430]	[0.1487]	[0.1067]	[0.1126]	[0.2183]
labor productivity	0.0421	0.0172	0.0078	0.0066	0.0113	0.0065	0.0022
	[0.0064]	[0.0048]	[0.0042]	[0.0035]	[0.0017]	[0.0027]	[0.0018]
mfs_1							3.8996
							[0.0511]
Constant	-1.7791	-1.6866	-1.7048	-1.9388	-1.7566	-1.8430	-2.1931
	[0.1013]	[0.1080]	[0.0987]	[0.1013]	[0.0803]	[0.0848]	[0.1605]
Observations	3387	3426	3579	3874	4695	4792	14865
Number of id							5257
Robust standard errors in brackets							

We have to note, that during the estimation we used industry dummies but we do not report their coefficients.

In the last column we can present the estimated coefficients of a panel random effects probit model. The first result is that the coefficients are similar in sign and magnitude in different years, thus we can rely on our estimates. The number of employees has positive coefficient, which

means that bigger firms are more probably acquired by foreign firms. The Hirschmann-Herfindahl index has a positive coefficient as well, thus foreign firms tend to buy firms in more concentrated industries. The effect of the skill and capital intensity is not unambiguous. In some years they are positive, in some years negative, but in most years they are not significant. The correlation between the two variables is 0.06, which means that this result is not the product of multicollinearity. The effect of foreign penetration into the NACE4 industry is high and significantly positive, which means that foreign firms tend to invest to industries with already high foreign penetration. Of course this can be the result of the fact, that these NACE4 industries reveal some unobserved characteristics, which are correlated with foreign presence. This fixed effect seems to be constant from our results. The effect of labor productivity is also significant and positive. This shows that foreign firms buy already more productive firms. Our concern about the endogeneity of foreign investment is a valid problem that is why we use this two step method. Finally the export ratio in the NACE4 industry has a positive and significant effect as well.

The panel probit model, qualitatively shows the same results, thus we can conclude that our estimates are robust to specification. As it was argued earlier, the yearly regressions are more flexible, thus those estimates can take into account the changing forces which determine ownership structure of the firms. Because of this we prefer to use the inverse Mill's ratios from these models.

5.2 The baseline spillover model

Our baseline model consists of the unweighted spillover variables. For the production function we do not assume constant returns to scale, thus our function is very flexible. The estimated model for domestic firms is the following:

$$\ln\_y_{it} = \alpha \ln\_y_{i,t-1} + \beta_1 vfs_{it} + \beta_2 ofs_{it} + \beta_3 ifs_{it} + \beta_4 fs_{it} + \beta_5 \lambda_{it} + \beta_k \ln\_k_{it} + \beta_l \ln\_l_{it} + \nu_i + \varepsilon_{it},$$

For the estimation we use year dummies as well. In this way we can allow for different pace of technological change in different years, different regions, for different industries and their interactions. Without using such a wide set of dummy variables, our results were not robust to different specifications. This possibility is important in a country with such high changes in the economic environment and where the speed of technological development can be different in different years in different industries and different regions.

As it was mentioned earlier we use Arellano-Bond dynamic panel estimator proposed by Arellano and Bond (2001), as the capital and labor can be endogenous because it is possible that firms with higher unobservable variables (e.g. productivity) might use these factors of production differently than less productive firms. All capital and labor variables are treated as endogenous, and all other variables treated as strictly exogenous. The only exception is the foreign ownership variable, which we handle as predetermined. The variable shows, since how many years the given firm is in majority foreign ownership, thus its difference shows if it is in majority foreign ownership. This assumption must be true for the year dummies and for the lambdas, which are functions of exogenous variables. The spillover variables are industry level variables and they are exogenous on the firm level.

The estimates are the following:

	Full sample	Foreign owned	Domestic owned
y(t-1)	0.26577	0.10968	0.33449
	[0.04624]**	[0.08624]	[0.05906]**
vfs	0.05372	0.00534	0.08664
	[0.02958]	[0.06046]	[0.03266]**
ofs	0.09049	0.01546	0.11026
	[0.04270]*	[0.08555]	[0.05290]*
ifs	-0.02615	-0.03289	-0.02201
	[0.05785]	[0.10262]	[0.06822]
mfs	-0.02549		
	[0.01170]*		

Robust standard errors in brackets
* significant at 5%; ** significant at 1%

From the results it is clear that none of the coefficients are significant for the foreign firms, as the sample size is relatively small for such a complex estimation procedure. Note that the standard errors of the vertical spillover effect coefficients are much higher then the standard error of the horizontal spillover coefficients. This comes from the fact that by construction the variation of the vertical spillover variable is much smaller. Consequently our results do not necessary show that vertical spillovers are weaker than the horizontal spillover, only we cannot find significant estimates in our sample.

The horizontal spillover effect is positive for foreign and domestic firms as well. It is significant at 1% level for domestic firms and it seems to be higher for domestic firms than for foreign firms. This means that domestic firms can benefit from the presence of foreign competitors. It implies that positive labor market and competition spillovers are stronger than negative ones. It is possible that these effects are weaker for foreign-owned firms as they are more likely to face

competition already on foreign markets. On the other hand X-inefficiency of foreign firms may be lower than domestic ones' inefficiency. To summarize, we can conclude, that domestic-owned firms are able to increase productivity from horizontal spillover, but foreign firms are not. Our results are similar to those of Damijan et al (2003), who found positive spillover for the domestic-owned firms but insignificant spillover for the whole sample.

The backward spillover (ofs) is positive for both domestic-owned and foreign-owned firms, although it is only significant at 5% for domestic firms and for the whole sample. If we consider the fact that the standard error of this variable is much higher by construction than the standard error of the horizontal spillover coefficient, our results suggest a very high backward spillover. This means that domestic-owned firms profit from the presence of foreign customers of their products. These customers are able to force their suppliers to produce better quality inputs with higher efficiency. Firms supplying foreign-owned firms face a reasonably strong competition as foreign-owned firms can easily switch to foreign suppliers. According to our results foreign-owned firms do not gain significantly from foreign-owned customers. This can be explained by the fact that foreign-owned firms already produce efficiently, and they do not need incentives from other more demanding customers. We cannot find such strong backward spillover as in Bosco [1997] or in Damijan et al. [2003]. This can be explained partly by the better quality of our dataset and partly by the fact that it took time for foreign firms to force domestic ones to produce at a higher productivity.

The forward spillover is small, insignificant and negative in our sample. This may show that the greater foreign presence in suppliers has no effect on the productivity of firms.

The most striking finding in our study is that the majority foreign ownership dummy is negative, and significant at 5% level. According to our analysis, the fact that a company is in foreign ownership implies that the productivity of that firm grows slower than the productivity of a domestic firm, ceteris paribus. This result contradicts the finding of Damijan et al. [2003], who found a positive and significant coefficient for the foreign ownership dummy. The explanation is that the productivity of domestic-owned firms grows faster partly because of the higher spillover effects and the higher existing productivity growth potential.

Our baseline spillover model tells that the presence of foreign firms has a significant positive effect on all firms, and this effect is higher for domestic-owned firms then for foreign owned ones. From this we can conclude that public policy supporting FDI inflow can be defended by the

positive spillover externality argument. Form our analysis we can conclude, that competitors and suppliers of foreign-owned firms gain from their presence, but their customers do not.

5.3 The effect of regional boundaries

In this subsection our question is what effects regional boundaries exert on the spillover effect. As it was mentioned earlier there are seven regions in Hungary, which represent somehow similar economic environment, or similar economic history. Our initial hypothesis is that from the viewpoint of spillovers physical distance or traveling time is more important than such historical considerations. We have to add, that former economic links inside these regions were demolished by the socialist system, as the firms operated county- or country-wise. Because of this we study the effect of county borders as well.

We use additional variables besides the variables used in the baseline model to investigate the differences. These variables are computed the same way as the vfs, ifs and ofs variables, but we use only the data of firms, which are in the same region as the given firm. These variables are denoted by r_vs, r_ifs and r_ofs respectively, and they are taken as exogenous variables. The results of the estimation are the following:

	Full sample	**Foreign owned**	**Domestic owned**
y(t-1)	0.25943	0.11002	0.33319
	[0.04813]**	[0.08615]	[0.05891]**
vfs	0.05615	0.00855	0.08601
	[0.02942]	[0.06048]	[0.03266]**
r_vfs	-0.01132	-0.01599	-0.00824
	[0.02094]	[0.03773]	[0.02630]
ofs	0.09286	0.01093	0.10989
	[0.04319]*	[0.08608]	[0.05278]*
r_ofs	0.28742	4.73118	-0.15014
	[1.04048]	[2.50323]	[1.05525]
ifs	-0.02493	-0.02856	-0.02138
	[0.05763]	[0.10346]	[0.06813]
r_ifs	-0.26469	0.91582	-1.66548
	[1.06492]	[1.69393]	[1.41550]
lambda	0.01670	-0.10274	0.21404
	[0.08476]	[0.10303]	[0.12958]
mfs	0.00923		
	[0.03230]		

The coefficients of the countrywide spillover effects are very similar to the baseline spillover model's coefficients. The regional spillover variables are all insignificant. This means that the spillover effects within and between regions are not significantly different from each other. Consequently the spillovers work on the same way if the two firms are in the same or in different regions. This can be interpreted as Hungary is a homogenous country from the viewpoint of spillovers because of its small size. The alternative interpretation, however, is that regional boundaries are not boundaries for spillovers.

We estimated if the foreign presence in the given county has any effect on the productivity of the given firm to investigate the regional effects further on. Therefore we constructed the county_fs and regional_fs variable which are the averages of foreign presence in the county and in the region, respectively, weighted by the net revenues of the firms. This variable consists of all firms, weighted by their size. In this we followed the method of Harris and Robinson (2001). Our estimates are the following:

	Full sample	*Foreign owned*	*Domestic owned*	*Full sample*	*Foreign owned*	*Domestic owned*
Y(t-1)	0.25988	0.10946	0.33444	0.05615	0.00544	0.08668
	[0.04824]**	[0.08621]	[0.05911]**	[0.02946]	[0.06042]	[0.03264]**
vfs	0.05751	0.00543	0.08988	0.09300	0.01583	0.11034
	[0.02946]	[0.06045]	[0.03261]**	[0.04313]*	[0.08551]	[0.05289]*
ofs	0.09385	0.01575	0.11219	-0.02598	-0.03548	-0.02321
	[0.04319]*	[0.08546]	[0.05300]*	[0.05723]	[0.10216]	[0.06806]
ifs	-0.02341	-0.03271	-0.01777	-0.08019	-0.05861	-0.07585
	[0.05739]	[0.10254]	[0.06812]	[0.05258]	[0.08290]	[0.06672]
county_fs	0.09515	-0.00259	0.15528			
	[0.04611]*	[0.07284]	[0.06148]*			
regional_fs				0.05615	0.00544	0.08668
				[0.02946]	[0.06042]	[0.03264]**

Robust standard errors in brackets
* significant at 5%; ** significant at 1%

From these estimates we can conclude, that the foreign penetration into the county/region has a significantly positive effect on the productivity of the domestic owned firms. We can observe that this effect is higher in magnitude for the county_fs. This means that firms within the county has a greater effect on the productivity of the firms. Thus form this point of view counties are the areas in which we should look for small-distance spillovers.

Generally previous studies could not find strong evidence for regional spillovers. Aitken and Harrison [1999] did not find positive spillovers from the presence of multinationals in the regions in Venezuela. Girma et al. [2000] and [2001] found evidence for positive spillovers within the same region, which was only significant for firms with low technology gap vis-à-vis multinationals. In our sample and with our estimation method we cannot measure absorptive capacity, thus we cannot test this hypothesis for Hungarian firms.

Our conclusion is that the vertical and horizontal spillovers for firms within a region are very similar to that for firms outside it. Our main finding is that the foreign presence for all firms in

the same county/region produces strong, small-distance spillovers for domestic firms, where the small distance means county-wide effects.

5.4 Spillover within a given range

Our next question is if we can explain spillover effects better using distance data, instead of regional boundaries. First, we investigate if the real boundaries between the short- and long distance spillover are the regional boundaries or some geographic distance. Thus we study the question what effects the foreign share of firms in a given range (for example 50 km) has on the productivity of the given firm. To estimate this, we calculated the vfs, ifs and ofs variables for the firms, which are situated in a given vicinity of the given firm. Our results are the following:

	25km full sample	25km foreign owned	25km domestic owned	50km full sample	50km foreign owned	50km domestic owned	100km full sample	100km foreign owned	100km domestic owned
ln y (t-1)	0.26002	0.10921	0.33433	0.26042	0.10704	0.33433	0.26049	0.10866	0.33514
	[0.04808]**	[0.08541]	[0.05901]**	[0.04813]**	[0.08636]	[0.05906]**	[0.04820]**	[0.08585]	[0.05915]**
vfs	0.06866	0.02863	0.09505	0.07667	0.03557	0.10767	0.08187	0.03316	0.11559
	[0.03149]*	[0.05885]	[0.03789]*	[0.03296]*	[0.05833]	[0.04086]**	[0.04104]*	[0.07138]	[0.05132]*
d25_vfs	-0.01386	-0.02526	-0.00934						
	[0.01693]	[0.03132]	[0.02011]						
d50_vfs				-0.02179	-0.02831	-0.02135			
				[0.02148]	[0.03367]	[0.02771]			
d100_vfs							-0.02681	-0.02809	-0.03053
							[0.03316]	[0.04707]	[0.04318]
ofs	0.09264	0.01465	0.11026	0.09360	0.00910	0.11174	0.09263	0.01605	0.11005
	[0.04306]*	[0.08399]	[0.05283]*	[0.04332]*	[0.08322]	[0.05287]*	[0.04319]*	[0.08504]	[0.05280]*
d25_ofs	0.01655	0.05688	0.00546						
	[0.01848]	[0.04123]	[0.01952]						
d50_ofs				0.00315	0.07764	-0.01525			
				[0.02202]	[0.04460]	[0.02396]			
d100_ofs							0.04352	0.10279	0.02689
							[0.02618]	[0.04770]*	[0.03242]
ifs	-0.02589	-0.03419	-0.02297	-0.02390	-0.03607	-0.02182	-0.02214	-0.03170	-0.02041
	[0.05789]	[0.10204]	[0.06860]	[0.05740]	[0.10292]	[0.06806]	[0.05730]	[0.10170]	[0.06822]
d25_ifs	0.02260	0.06642	0.00972						
	[0.01905]	[0.03994]	[0.02046]						
d50_ifs				0.02012	0.00790	0.03944			
				[0.02029]	[0.03976]	[0.02537]			
d100_ifs							-0.01791	-0.04311	-0.00247
							[0.02578]	[0.04589]	[0.03070]
Observations	9359	2629	6730	9359	2629	6730	9359	2629	6730

Robust standard errors in brackets

* significant at 5%; ** significant at 1%

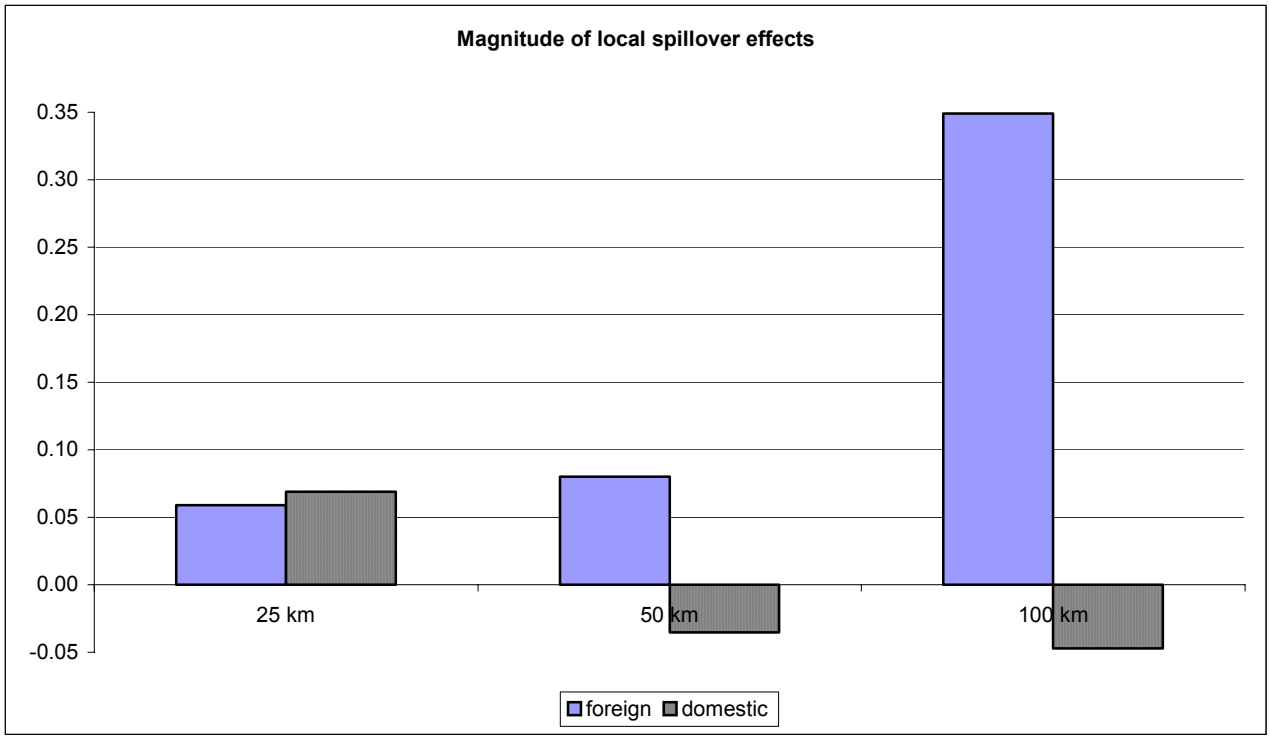
Our first observation is that the country-wide coefficients are practically the same as in the baseline model, and the within-range coefficients are not significant. This means, that spillover effects work very similarly in small- and large distance. Consequently it can be concluded, that Hungary is a homogenous area in this respect. This shows that the most important spillover channels are the long-distance spillovers such as competition or imitation.

On the other hand we can see some patterns in the short-distance spillover effects. The within distance horizontal spillover effects are all negative, which can be a sign that among nearby firms the overall horizontal spillover is weaker than among more distant firms. This shows that the small-distance spillovers are essentially negative ones. This can be a sign of negative labor market spillovers. The small-distance backward spillover however is positive in all cases. This shows the presence of small distance supplying networks, or other benefits for nearby suppliers. Just like the county-wise case we cannot report consistent pattern of forward spillovers.

Similarly to the previous section, we estimated if the foreign penetration within a given distance of the firm has effect on the productivity. Thus we constructed the variables d25_fs, d50_fs, d100_fs which represent the average foreign penetration within the 25, 50 and 100 km range from the firm, respectively. Our estimates are presented in the following table.

	full sample	*foreign*	*domestic*	*full sample*	*foreign*	*domestic*	*full sample*	*foreign*	*domestic*
ln y (t-1)	0.27503	0.09555	0.34715	0.27380	0.09498	0.34630	0.27354	0.08892	0.34611
	[0.05059]**	[0.09257]	[0.06169]**	[0.05054]**	[0.09233]	[0.06139]**	[0.05054]**	[0.09336]	[0.06134]**
vfs	0.07514	0.04820	0.09693	0.07503	0.04805	0.09580	0.07505	0.04925	0.09627
	[0.03158]*	[0.06571]	[0.03429]**	[0.03166]*	[0.06580]	[0.03427]**	[0.03159]*	[0.06548]	[0.03429]**
ofs	0.08112	-0.01560	0.10291	0.07978	-0.01744	0.10008	0.07962	-0.01459	0.10131
	[0.04569]	[0.09627]	[0.05536]	[0.04562]	[0.09663]	[0.05522]	[0.04576]	[0.09658]	[0.05532]
ilfs	-0.04327	-0.08551	-0.03167	-0.04443	-0.09094	-0.03728	-0.04440	-0.09112	-0.03549
	[0.06192]	[0.11666]	[0.07155]	[0.06194]	[0.11424]	[0.07151]	[0.06187]	[0.11752]	[0.07151]
d25_fs	0.06320	0.05890	0.06899						
	[0.02866]*	[0.05124]	[0.03540]						
d50_fs				0.01481	0.08002	-0.03540			
				[0.03591]	[0.08440]	[0.03946]			
d100_fs							0.06408	0.34915	-0.04726
							[0.07148]	[0.13272]**	[0.09042]
Observations	8559	2269	6290	8559	2269	6290	8559	2269	6290
Number of id	3367	887	2556	3367	887	2556	3367	887	2556

Robust standard errors in brackets
* significant at 5%; ** significant at 1%



From the estimates we can see a very clear pattern of the spillover effects. For the smallest distance we find similar positive effects for both domestic-owned and foreign-owned firms which is significant at 1% level for the whole sample. This means that on this very small distance there is a similar effect for the two groups of firms, which suggests a common and relatively strong labor market spillover, or small-distance knowledge spillover. As the distance is greater, the spillover for domestic firms becomes smaller and smaller negative. This means, that longer distance spillovers are dominantly negative for domestic-owned firms. The dominant labor market effects and positive small-distance knowledge spillovers disappear on the larger distance, and a slight insignificant negative effect remains. On the other hand for foreign-owned firms the long-distance spillover is solidly larger than the small distance one, showing that these firms can easily benefit even from the presence of relatively farther away firms. This finding can be explained by the fact that these firms are larger and think in a much wider perspective than domestic-owned ones. This may mean that there are some negative effects if foreign firms are too close to each other. These findings are in line with our previous observation, that domestic-owned firms can benefit more from the foreign presence in the county, and foreign-owned firms benefit mainly from the foreign presence in the region.

6. Summary and Conclusion

The aim of our paper was twofold. First we intended to estimate different kind of spillover effects in a large sample of Hungarian firms, using panel data approach and correcting for endogeneity problems. We got robust positive results for horizontal spillovers. This effect can be seen more clearly for the domestic-owned firms. This fact shows that positive labor market- and knowledge spillovers are stronger than negative labor market and negative competition effects. On the other hand the backward spillover is significantly positive for domestic-owned firms, showing that foreign customers can force domestic-owned firms to be more productive. In our estimates the forward spillovers are insignificant.

Our second aim was to study the spatial structure of spillover effects. Our first conclusion is that we cannot show any difference between vertical and horizontal spillovers if the firms are in the same region or in the same county, or within a given distance. We could show however that if we include every firm within a given range and do not confine to competitors or firms with vertical links, we can find very strong spillover effects. This means that even without competition or vertical links there is a strong and positive spillover coming simply from the presence of foreign-owned firms. This suggests that there are strong spillovers, which operate on a small distance, as

labor spillovers and small-distance knowledge spillovers. These small distance effects are dominant for domestic-owned firms, as for these firms spillover effects disappear in longer distance. For foreign-owned firms, the range of spillover is much longer, and it is even stronger if firms are far away from each other.

These findings can be used to derive policy recommendations. First as our analysis suggests that spillover externalities exist, this justifies policies supporting foreign direct investments. As the vertical spillover is positive, one does not have to be afraid of destructive competition. Our analysis supports the common belief that Hungarian firms supplying foreign-owned firms are more effective. The spatial analysis of spillover effects suggests that domestic-owned firms can benefit if the foreign firms are very close to them. Consequently it can be beneficial, if the government supports industry centres, where domestic and foreign firms can set up plants in the same place and where these positive effects really work.

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