SPILLOVERS FROM FDI IN HUNGARY

by

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Abstract

The main question of this thesis is whether and under which conditions do domestic firms benefit from foreign direct investment in a transition economy. For this exercise I use a large firm-level dataset of Hungarian manufacturing firms in the period between 1992 and 2003.

In a brief introduction I describe the related theory presented in the international trade literature. After reviewing the theory of multinationals, I turn to models of knowledge transfer, in particular to the relationship between knowledge transfer and competition, and to its empirical relevance. In Chapter 2 I estimate horizontal and vertical spillover effects and deal with the spatial dimension, that is, whether physical distance matters. The results show that distance is important in the case of horizontal spillovers, suggesting that knowledge transfer is effective only on smaller distances. In Chapter 3 I turn to the question, whether the technology chosen by multinationals affects the productivity of domestic firms. This chapter provides evidence that spillovers from more labour intensive industries and firms are less positive. Chapter 4 asks if foreign entry leads to spillovers in terms of markups besides productivity. The regressions results show that multinational entry leads to change in the markups of domestic firms. These effects remain significant when controlling for productivity.

Keywords: international trade, technology transfer, multinationals, FDI, productivity estimation, prices and market structure, panel models

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Needless to say, all remaining errors are mine.

1 Introduction

Knowledge flows among countries are a major determinant of world-wide growth. While its importance was clear for the scholars of comparative economic development, only relatively recent endogenous growth models are able to show that the structure of international technology transfer is critical to growth and international convergence patterns (Feenstra 2003, Ch. 9). International knowledge transfer took place via very different channels thorough history. One of these channels has been international trade for most countries and most of the time. The institutions facilitating international trade, however, went through a long evolution through time (e. g. Greif 2006). Since the beginning of the 20th century a very substantial institution organising international trade and international production emerged: the multinational corporation. It is very appealing intuitively to assume that multinational activity is even a more potent channel of technology transfer than arms-length trade, as production and not only consumption takes place in the host economy. This intuition, in addition to the very high level and growth of multinational activity in the world economy provides an important motivating factor for the theoretical and empirical study of the determinants of knowledge transfer via multinational activity.

As part of the empirical literature of these knowledge spillovers, my thesis analyses intra- and inter-industry productivity spillovers at a large firm-level panel database of Hungarian firms. Besides estimating spillovers within and between industries, I address a number of less standard questions. Does distance between multinationals and domestic firms matter in the transfer of the tacit knowledge assets of multinationals? Do multinationals using different production technology generate different spillovers effects? What is the relationship between productivity and spillovers and changes of the price-cost margins and profitability of domestic firms?

This introduction first reviews the wider theoretical context of spillover research, and then provides theoretical motivation for the individual questions in latter chapters with an emphasis on the interrelations among them. The Appendix of the Thesis describes the data briefly and presents some results about the estimated productivities.

1.1 Theory of multinationals

While multinational firms play an important role in international trade, theory is able to handle this phenomenon only for a relatively short time. Classical models of international trade, in particular the Heckscher-Ohlin (H-O) model, were not really suitable for modelling multinationals, as firms were practically nonexistent in these models of perfect competition and constant returns to scale. This framework, however made possible the analysis of factor mobility. Mundell (1957) in his seminal article modified the H-O model in such a way, that one of the factors of production, capital was allowed to move between countries. The main result is that a tariff introduced by one of the countries leads to substantial capital movements between the two economies. This capital movement continues until the rental rate of capital is equalized between the two countries. Even more remarkably, this movement of the capital stock reproduces the production pattern prior to the introduction of the tariff – trade in factors substitute for trade in goods.

These results proved that the H-O model is suitable for modelling capital mobility, a very important empirical fact. Also, this analysis shed light on some important theoretical determinants of capital mobility: trade frictions, transportation costs and tariffs. What is missing from the framework is the distinction between portfolio investment and foreign direct investment. As firms do not have any role in the H-O model, it is not possible to explain why a specific firm wants to build a plant in the foreign economy, instead of lending money for a local entrepreneur because of differences in the rental rate.

As famously argued by Dunning (1981), models of multinational activity should provide an answer to three questions: location choice, ownership and internalization. A successful multinational should own some kind of intangible asset which is a source of competitive advantage in foreign countries. But an attractive asset and location cannot provide an explanation for the fact that host country operations should be organised within the firm and not by arms-length contracts. Internalization of host country production requires the firm to be able to organise international production more efficiently when internalised. The answer to this question requires a theory about the boundaries of the firm, to which I will return latter.

The advent of new trade theory, highlighted by the highly influential book of Krugman and Helpman (1985), made possible the inclusion of MNEs into models of international trade. In new trade models the main explanation of international trade is not the difference between factors of production in different countries, but rather gains from specialization in activities which can be characterized by increasing returns to scale. In such industries perfect competition is impossible, consequently new trade theory models should build on imperfectly competitive industries. Increasing returns to scale and imperfect competition makes the notion of the firm meaningful. As a consequence, the questions of ownership and internalization can be addressed.

A very important summary of research on multinationals is Markusen (2002). In his models, the knowledge asset leads to the competitive advantage of the MNE, and makes possible its expansion. For analytical reasons, it is useful to distinguish between two forms of multinationals at this point. *Vertical* multinationals operate their headquarters and production facilities in different countries, while *horizontal* multinationals operate production plants in multiple countries. In Markusen's knowledge capital model, horizontal and vertical multinationals coexist. For this, three important assumptions are needed. The first two makes possible the emergence of vertical multinationals. First, *fragmentation* should be possible, meaning that knowledge-based headquarters can be fragmented geographically from production activity. Second, headquarters activities should be more *skilled-labour intensive* than production. The third assumption, which is related to horizontal MNEs is called *jointness*: headquarters activities have a public good characteristic, they provide inputs for multiple production facilities. This means firm-level economies of state, while vertical multinationals rely on plant-level economies of scale.

From these assumptions, the following results can be derived, which are quite robust to changes in assumptions about market structure. In case of vertical multinationals factor price differences between the countries make multinational activity more likely. Typically, headquarters are located in a skilled labour-abundant small country, while production takes place in an unskilled labour-abundant and large host country. The vertical MNE can benefit from factor price and country size differences. Horizontal multinationals, on the other hand, have headquarters in one country, but locate production activities into multiple countries. Locating production into multiple countries may make it possible to economise on transportation costs by exploiting the firm-level economies of scale, which is a consequence of the fact that the firm may operate a number of production facilities from one headquarters unit. Horizontal multinationals are likely

to appear when the countries are similar in size and factor endowments, and when trade costs are high.

It should be clear, however that in Markusen's model multinationals do not have any specific attribute, as all firms are symmetric in terms of technology in the new trade theory framework. In equilibrium sometimes multinational and national firms coexist, but this is a consequence of a mixed strategy equilibrium and general equilibrium effects rather than some kind of inherent heterogeneity. These models do not provide an answer to the question: *which* firms become multinationals. For this, one has to consider heterogeneous firm-level knowledge capital, as a source of competitive advantage. This is not a theoretical abstraction – recent firm-level productivity studies have shown the fundamental importance of firm-level heterogeneity in productivity (Bernard and Jensen 2004). This empirical observation provided the motivation for theoretical work on heterogeneous firms in international trade (Melitz 2003). Heterogeneous firm models provide another source of gains from trade: more efficient firms are able to expand by exporting, while the least efficient firms exit the market, which process leads to an increase in average productivity within industries. It is possible to integrate horizontal multinationals into this framework (Helpman, Melitz and Yeaple 2003). These authors consider the decision of firms to export or found an overseas affiliate. The results suggest a pecking order pattern: as a consequence of trade liberalization the least productive firms exit, more productive firms operate only at the domestic market, even more productive firms engage in exporting, and the most productive firms conduct FDI. As a consequence, essentially the quality of the firm-level knowledge capital determines which firms will produce in host economies. As the most productive firms conduct FDI, their knowledge-specific assets may be an important source of productivity spillovers.

While these models of multinational activity provide a powerful tool for analysing location decisions, two questions which are very important for the spillover potential of foreign affiliates are left unanswered. First, these models treat the composition of 'headquarters activities' and 'production activities' as exogenous. In this context, the main question for the host economy is whether the MNE is willing to build a plant there. However, it is clear that firms have a remarkable flexibility in deciding which activities to conduct in the host country. This is a very important question, because the more knowledge-intensive or state of the art technologies are outsourced, the more host country firms can learn. A class of models which treat this decision as

endogenous, are surveyed by Feenstra (2004: Ch. 4). In his model, the firm uses a continuum of inputs when producing the final good. If one list these activities in increasing order of their skilled labour intensity, there is a threshold level of intensity, below which the firm will outsource activities. This threshold is a function of factor endowments in the countries. A major implication of the model is the possibility of increase in the wage of skilled labour in both countries. Beyond this, this modelling strategy makes possible the study of the determinants of outsourcing knowledge intensive activities, thus spillover potential of the affiliate.

A very different framework, which may shed light on the composition of outsourced activities builds on the seminal work of Grossman and Hart (1986) who refers to earlier ideas of Coase (1937) and Williamson (1985). This literature assumes that contracts are incomplete, not every detail can be specified ex ante, leading to the possibility of renegotiation. Contractual incompleteness appears to be very relevant for a manufacturing firm, when deciding whether to outsource an important input to an unskilled labour abundant country. The legal system of either country may be able to enforce contracts between firms in different countries only to a limited degree. In this case, ex post the surplus will be allocated according to a bargaining process. As a consequence of this, each side appropriates only a fraction of the surplus generated by its investment. This fact leads to a suboptimal level of ex ante relationship specific investments, thus an inefficient outcome. When the bargaining takes place between firms in different countries, higher level of contractual incompleteness implies a tradeoff between the efficient amount of relationship-specific investments and lower wages in the host country (Antras 2005). The larger importance of the input and relationship-specific investments from the input supplier make outsourcing more attractive. This modelling framework emphasises relationship-specific investments and contractual incompleteness as determinants of outsourcing activities and spillover potentials besides factor endowments underlined in Feenstra's model.

Another very important advantage of the incomplete contract (or property rights) framework is that it can shed light on internalization decisions. This is very important from the point of view of spillover research, as decisions about FDI or outsourcing of specific inputs through arms-length contracts is an important determinant of spillovers from downstream firms to their suppliers. Ownership structure, which determines residual rights of control, affects ex post bargaining positions and through this, levels of relationship-specific investments. Because of this, ownership matters. As Antras (2005) argues, this framework is able to shed light on some of the

determinants of the FDI versus arms-length contracting decision. The fundamental determinant of this decision is the importance of the relationship-specific investment of the supplier firm in the production process. When the input (and investment) produced by the supplier is very important, property rights should be allocated to an independent supplier (to improve its bargaining position, and its incentives to invest), otherwise production of the intermediate input should be internalized within the multinational. Under some conditions, the most important of which is a large enough difference between wages in the two countries, Antras shows that as the importance of the intermediate input increases in the production function three regimes can be observed: (i) the input is produced in the home country (ii) the input is produced in the host country within the boundaries of the multinational and (iii) the input is produced in the host country by an independent supplier.

Internalisation decisions can also be analysed in more standard frameworks as well, as for example shown by Markusen (2002: Ch. 13-15). The joint input or public good character of the knowledge capital makes possible opportunistic behaviour of an independent enterprise related by an arms-length contract to the multinational. Opportunistic behaviour may present itself as free riding on the reputation of the MNE, 'stealing' the technology and setting up an independent competitor or may mean moral hazard because of information advantage of the local party. In order to constrain opportunistic behaviour, the MNE may internalise the host country operations.

After reviewing the broader theoretical context of multinational activity, I turn to describe some questions more specifically related to the empirical work in my thesis.

1.2 Productivity spillovers

As it can be seen from the theory of multinationals, MNEs usually have a knowledge asset which provides their ownership advantage. Host country governments often hope that some of this knowledge will 'spill over' to domestic firms. A by now large literature analyses the empirical relevance of spillovers. In particular, the question is formulated in terms of the relationship between foreign presence and productivity of host country firms. Productivity ‘spillover’ is generally (but not always) defined as the effect of foreign presence on productivity of domestic firms; this is the way how I will use this term in these essays. Görg and Greenaway (2004) survey this literature extensively. The most important, and somehow surprising conclusion is that there is no strong evidence for positive intra-industry (horizontal) spillovers – most studies report

insignificant or negative productivity effects, which does not seem to make a strong case for the government intervention we observe in reality. Earlier research and results of this thesis both find insignificant or negative horizontal spillover for the Hungarian economy. The analyses both in Section 1 and 2 proceed from baseline regressions showing that horizontal spillovers are insignificant in Hungary.

1.3 Firm and industry-level heterogeneity

Empirical research reacted to the lack of positive intra-industry spillovers in two ways. The first line of research, represented by Javorcik (2004) analysed inter-industry (vertical) spillovers. Empirical research on vertical linkages utilizes input-output tables to map supplier-buyer relationships between industries. Generally two types of vertical spillovers are distinguished: backward (from foreign owned firms to their suppliers) and forward (from foreign-owned upstream firms to their customers). The main conclusion is that supplier industries are able to benefit from foreign presence – backward vertical spillovers are positive. These results may provide rationalization of FDI promoting policies: domestic firms which supply industries with large MNE presence can become more productive, possibly with positive consequences on labour market outcomes and growth. Recent research, however unveiled large heterogeneity in the extent of backward spillovers. Moran (2007) argues convincingly, that policies leading to protection or asking for domestic content requirements are contraproductive. Multinationals entering into protected industries tend to apply obsolete technologies with low spillover potential. Also, when facing domestic content requirements, MNEs tend to outsource inputs at very low level of sophistication. Large positive backward spillovers tend to be observed in countries, to which MNEs enter to compete in international markets. Chapter 2 in this thesis follows this strand of literature by analysing inter-industry spillovers, showing that backward spillovers are positive in Hungary.

The second line of research emphasises the great extent of heterogeneity which can be observed between and within industries. While it is straightforward that different industries apply very different technology with very different importance of knowledge assets and possibilities to spillover, current research also underlines the importance of firm-level heterogeneity in terms of productivity even within very narrowly defined industries (Foster, Haltiwanger and Krizan 1998). Firm-level heterogeneity turned out to play an important role in international trade (Melitz 2003)

and the theory of multinationals (Helpman, Melitz and Yeaple 2003), as previously mentioned. This line of spillover research assumes that spillover effects are not homogeneous, the attributes of industries or firms matter.

Heterogeneity may be present in both sides of the spillover relationship. One the one hand some foreign firms may have larger productivity spillover potential (PSP), while on the other hand domestic firms may have heterogeneous absorptive capacities. The theoretical explanation for differing PSPs is related to the natural heterogeneity of knowledge capital and internalization decisions.

Related to the firm-specific, intangible and tacit nature of the knowledge capital of MNEs, Chapter 2 relies on the assumption that this knowledge can only be transferred (voluntarily or involuntarily) to host-country firms if some degree of personal, face-to-face interaction is present between the employees of foreign and domestic firms. This may mean personal relationship between the employees/managers of different firms, motivating domestic firms to introduce the technological/organisational innovations in order to imitate the production process of nearby foreign-owned firms. The second possibility is the acquisition of human capital. When managers or employees of foreign firms move to domestic ones, they may initiate innovations at their new workplace on the basis of knowledge embodied in their human capital. Both face-to-face interaction and the inter-firm mobility of workers are limited to a large extent by physical distance. The main hypothesis of Chapter 2 is the following: if the tacit nature of firm-specific assets is important, then physical distance should be an important determinant of the empirical magnitude or sign of spillover effects. The empirical strategy in chapter 2 relies on this hypothesis. Besides the simple averages of foreign presence in different industries (which are the standard way to identify spillover effects in the literature), two kinds of non-conventional, distance-related measures are applied to estimate the importance of distance in horizontal and vertical spillover effects. First, distance-weighted foreign presence measures are included into the specifications besides the conventional measures. Nearby firms enter with larger weights into these measures than more far-away firms. The significant positive sign of distance weighted foreign presence measures suggests the importance of distance and through this the relevance of tacit knowledge and personal interactions in knowledge transfer. Second, close-weight and far-weight measures of foreign presence are applied, where the close-weight measures only include firms within a circle with a given radius around the firm, and far-weight measures include only

firms outside this circle. The main conclusions are very similar to that from distance-weighted measures – horizontal spillovers are more positive in smaller distances. Distance, however does not matter in case of vertical spillovers. On the one hand, it is possible that this finding is only a result of weaker data in case of vertical spillovers, as the national input-output tables used to calculate these measures are likely not to represent actual transactions within small geographical regions with a high precision. However, this result does not contradict the theory. In case of vertical spillovers personal interactions between suppliers and customers may be less related to distance.

Another very important approach suggests that intentional knowledge transfer may play an important role in vertical spillovers, as suggested by Glass and Saggi (2001) and empirically analysed by Blalock and Gertler (forthcomming). MNEs may be willing to transfer knowledge to their suppliers in return of lower prices, higher quality or a larger variety of inputs. The theory also suggests voluntary knowledge transfer for a number of host country suppliers as otherwise the MNE could be held up by a single supplier. As an intended consequence competition may intensify in upstream industries. It can be argued, that in case of voluntary knowledge transfer, distance may play a less important role as MNEs are motivated to bridge distance. The potential importance of voluntary knowledge transfer may also affect markups of upstream firms, which is analysed in Chapter 4.

The mentioned tacit and unique nature of the firm-specific knowledge capital implies that spillover potential in different industries or in case of different multinationals may vary to a large extent. Besides the firm-level heterogeneity in these assets, it is also important from the viewpoint of host country firms, how the production process is organised internationally. Very different organisational forms of multinationals are possible. The literature on international fragmentation of production emphasises the role of different organizational solutions to conduct multinational activity and their determinants. The degree or type of knowledge present in the host country may fundamentally determine spillover effects. In a classical vertical multinational, most knowledge-related activities may remain in the home country of the MNE, and only less knowledge-intensive processes are outsourced to host countries. In this case, the PSP of foreign plants may be very low even in otherwise knowledge- and innovation intensive industries. A small but growing recent literature examines the role of industry level heterogeneity in spillover. Castellani and Zanfei (2006, Ch. 6) and Sembenelli and Siotis (2005) show that spillovers depend

on the R&D intensity of multinationals, using data for Italy and Spain, repectively. Another related paper is Javorcik and Spatareanu (2008) who show that the magnitude of spillovers differs between wholly-owned and partly-owned foreign investment projects using Romanian data. This kind of heterogeneity of spillover potential provides the motivation for Chapter 3.

In this chapter MNEs' PSP is proxied with the production technology (e.g. capital intensity). By controlling for both firm and industry production technology in this way, we are able to disentangle firm and industry effects. The results are in line with theoretical predictions; spillover potential is smaller both in more labour intensive industries and firms. The estimates also suggest that industry heterogeneity is more important in this respect than firm-level heterogeneity. The latter seems to be significant only in the later phase of transition. Further analysis also suggests important differences on the receiving side. Different aspects of spillover potential appear to be important for different types of domestic firms. For small firms, production technology used by the industry in general is more important, while for larger domestic firms production technology of individual foreign firms relative to industry average is significant. Interestingly, the estimates do not suggest important differences with respect to export status of domestic firms. All in all, production technology of multinationals appears to be an important determinant of spillover effects to domestic firms in Hungary.

The theoretical importance of these kinds of results is that they shed some light on the micro determinants of the economic consequences of multinational activity. They suggest that when considering the externalities related to trade and investment liberalization firm- and industry-level heterogeneity and spatial topology of multinational presence should not be ignored. These findings nicely complement the large number of recent papers on emphasizing the importance of firm-level heterogeneity in international trade and gains from trade.

Factors and policy instruments affecting location choice, relationship with domestic suppliers or the technology choice of multinational affiliates may have very strong consequences on the competitiveness of domestic firms. The consequences of such policies are not very easy to predict, however. For example the results concerning vertical spillovers show the extent of externalities when multinationals choose their suppliers without strong policy incentives, as argued by Moran (2007). Spillover estimates may be productively used to quantify the expected gains from multinational entry or a generally liberal policy regarding foreign direct investments, but they

should not be used for the rationalization of large subsidies for individual projects. Finally, the results also suggest that the effect of FDI is far from uniform; the results may shed some light on the distributional effects of FDI liberalization.

1.4 The relationship between spillovers and competition

The spillover effects from FDI are not constrained to technology transfer. The generally negative point estimates of horizontal spillover effects in Chapter 2 and 3 suggest that foreign entry in general can reduce the productivity of domestic firms. This conclusion is somehow strengthened by the analysis of Chapter 2. While knowledge transfer is more likely in shorter distances, large-distance spillover measures should mainly reflect the effect of entry transmitted through output markets. Consequently the exercise in this chapter may be interpreted as an attempt to disentangle different spillover channels. The negative coefficient of far-weight measures and the positive close-weight ones reflect negative competition effects.

It is not really easy to explain the robust finding on negative competition effect in a transition economy, as it is appealing intuitively to expect that foreign entry or trade liberalization has a disciplinary effect on highly inefficient post-socialist firms, which are forced to reduce their X-inefficiency (Leibenstein 1966). The explanation of the negative estimate may be found in the presence of increasing returns, as suggested by Aitken and Harrison (1999) in their influential article. The entry of multinational affiliates may lead to market loss of domestic firms, and they have to decrease their output below the minimum of their average cost curve. The larger the foreign competition, the larger the reduction in output and in productivity loss.

While the arguments of Aitken and Harrison are very clear-cut, unfortunately the empirical relationship between markups and productivity is interrelated to a high extent. The next subsection of this introduction argues that spillover measurement can be plagued when competition is imperfect and the entry of foreign firms changes competitive pressure. Apart from these empirical problems, industrial organisation theory suggests strong interrelatedness of spillovers and competition. When multinationals can decide on their production technology or innovation to some extent, their decision may be strongly affected by the competitive situation in the industry (Pack and Saggi 2001, Spence 1984, D'Aspremont and Jacquemin 1988, Suzumura 1992, Belderdos et al 2004). The presence of spillover effects may also change the competitive situation in the industry, as it leads to changes in costs.

These arguments suggest that the micro structure of productivity spillovers requires the understanding of the relationship between foreign entry, competitive pressure and economies of scale. Interestingly, in contrast to effects on productivity, this kind of analysis is applied only in few papers. This fact is even stranger, if one takes into account the fact, that the analysis of the relationship between foreign entry and domestic profitability can shed light on a number of other interesting issues beyond the structure of spillover effects. First, a large margin from gains from trade may be realized through selection effects (Melitz 2003) which takes place via markup and profit changes. Second, the distribution of spillover benefits between foreign and domestic firms affects the distribution of gains from trade, thus the welfare effects of globalisation. Third, profit change may have some effect on firm level investment and as a consequence of it, on growth.

The aim of chapter 4 is to contribute to this investigation by addressing the question, whether foreign entry leads to changes in markups of domestic firms. The answer is in the affirmative. Both horizontal and vertical effects on markups are significant. Foreign presence has a negative, disciplinary effect on the markups of competitors and a positive effect on suppliers' margins. These effects are robust to the inclusion of productivity – foreign entry has effect on price-cost margins which is important beyond its effect on productivity. These results show the importance of further research on the relationship between foreign entry, productivity and profitability.

The role of multinationals in Hungary

These questions have an exceptional relevance in transition economies. In these countries, the presence of highly inefficient former socialist enterprises, cheap and relatively highly educated workforce provided a good environment for multinational entry. Privatisation of former state-owned monopolies was an important opportunity to buy both assets and markets. Foreign firms played an unusually important role in the Hungarian privatisation because of the policy decision to sell firms to foreign firms with similar activities (unlike privatisation methods in the Czech Republic or Poland). The relatively stable economic and political environment in Hungary during the 1990s was also beneficial for foreign direct investment. As a consequence of all these factors Hungary was the leading transition economy in terms of FDI inflow during the 1990s; FDI stocks has reached 50 billion Euros in 2005 (MNB 2007). Activities of foreign firms are also very important in terms of employment, output and exports. Foreign-owned firms exported more than

60% of all Hungarian exports in 2000 with employing around 15% of all employees (UNCTAD 2006).

Foreign firms played a very important role in the restructuring of the economy. Obsolete assets and management methods in former socialist enterprises left a lot of opportunities for improvement. The role of foreign firms in restructuring was strengthened further by privatisation strategies which required foreign buyers to invest large sums into implementing state-of-the-art technologies and building public infrastructure.[1] Knowledge related activities of MNEs also contribute significantly to Hungarian research and development: 62.5 percent of business R&D in Hungary was conducted by foreign affiliates (UNCTAD 2005). The great discrepancy between technologies of foreign and domestic firms provides rich possibilities for knowledge transfer in between them in Hungary. This discrepancy, large FDI inflows, large variation among industries in terms of foreign presence and high quality firm-level panel data with a relatively long time dimension suggests Hungary to be an ideal place to investigate externalities between foreign and domestic firms.

The large role of MNEs and the great differences between technologies and working conditions of domestic and foreign firms leads to a heated debate on the benefits or harms of MNEs in Hungary. Firm-level empirical research may unveil the real consequences of foreign activity and provide useful information for policy makers.

[1]A good example for this is the privatisation of the fixed telephony incumbent, Matáv (now T-Com).

References

Aitken Brian J. and Ann E. Harrison (1999): "Do Domestic Firms Benefit From Foreign Direct Investment? Evidence from Venezuela", *American Economic Review,* Vol. 89. pp. 605-618

Antras, Paul (2005): "Property Rights and the International Organization of Production", *American Economic Review,* Vol. 95, pp. 25-32

Belderbos, René; Martin Caree and Boris Lokshin (2004). „Complementarity in R&D Cooperation Strategies", *Review of Industrial Organisation*, Vol. 28, pp. 401-426

Bernard and Jensen (2004), "Exporting and Productivity in the USA", Oxford Review of Economic Policy, 2004, Vol. 20, No. 3. pp. 343-357

Blalock, Garrick and Paul J. Gerler (forthcoming): "Welfare Gains from Foreign Direct Investment through Technology Transfer to Local Suppliers", forthcoming, *Journal of International Economics*

Castellani, Davide and Antonello Zanfei (2006): *Multinational Firms, Innovation and Productivity*, E. Elgar

Coase, R. H. (1937): "The Nature of the Firm", *Economica,* Vol. 4, pp. 386-405

d'Aspremont, C. and A. Jacquemin (1988): "Cooperative and noncooperative R&D in duopoly with spillovers," *American Economic Review*, Vol. 78, pp. 1133-1137.

Dunning, John H. (1981): *International Production and the Multinational Enterprise*, George Allen and Unwin, London

Feenstra, Robert C. (2003): *Advanced International Trade*, Princeton University Press

Foster, Lucia; John Haltiwanger and C. J. Krizan (1998): "Aggregate Productivity Growth: Lessons from Microeconomic Evidence", *NBER Working Paper*, No. 6803

Glass A. Jocelyn and Kamal Saggi (2001): "Innovation and Wage Effects of International Outsourcing", *European Economic Review*, Vol. pp. 67-86

Görg, Holger and David Greenaway (2004): "Much Ado About Nothing: Do Domestic Firms Really Benefit from Foreign Direct Investment?", *World Bank Research Observer*, Vol. 19, pp. 171-197

Greif, A. (2006): *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade*, Cambridge University Press, Cambridge

Grossman, Sanford J. and Oliver D. Hart (1986): "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration", *Journal of Political Economy*, Vol. 94, pp. 691-719

Hall, Robert E. (1988): "The Relation Between Price and Marginal Cost in U.S. Industry", *Journal of Political Economy*, Vol. 96, pp. 921-947

Helpman, Elhanan and Paul Krugman (1985): *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy*, MIT Press, Cambridge

Helpman, Elhanan; Marc J. Melitz and Stephen R. Yeaple (2003): "Export Versus FDI with Heterogeneous Firms", *American Economic Review*, Vol. 94, pp. 300-316

Javorcik, Beata Smarzynska (2004): "Does Foreign Investment Increase the Productivity of Domestic Firms? In Search for Spillovers through Backward Linkages", *American Economic Review*, Vol. 94, pp. 605-627

Javorcik, Beata Smarzynska and Mariana Spatereanu (2008): "To Share or Not To Share: Does Local Participation Matter for Spillovers from Foreign Direct Investment?" *Journal of Development Economics*, Vol. 85, pp. 194-217

Leibenstein, Harvey (1966): "Allocative Efficiency vs. 'X-efficiency' ", *American Economic Review*, Vol. 56, pp. 392-415

Markusen, James R. (2002): "Multinational Firms and the Theory of International Trade", MIT Press, Cambridge

Melitz, Marc J. (2003) "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, Vol. 71, pp. 1695-1725

MNB (2007): *Foreign Direct Investment Hungary, 1995-2005*, Magyar Nemzeti Bank, Budapest

Moran, Theodore H. (2006): *Harnessing Foreign Direct Investment for Development: Policies for Developed and Developing Countries*, Center for Global Development

Mundell, Robert A. (1957): "International Trade and Factor Mobility", *American Economic Review*, Vol. 47, pp. 321-335

Pack, Howard and Kamal Saggi (2001): "Vertical Technology Transfer via International Outsourcing", *Journal of Development Economics*, Vol. 65, pp. 389-415

Sembenelli Alessandro and Georges Siotis (2005): "Foreign Direct Investment, Competitive Pressure and Spillovers. An Empirical Analysis on Spanish Firm Level Data", *Centro Studi Luca d'Agliano Development Studies Working Paper* 169

Spence, Michael (1984): "Cost reduction, Competition and Industry Performance", *Econometrica*, Vol. 52, pp. 101-122

Suzumura, Kotaro (1992): „Cooperative and Noncooperative R&D in an Oligopoly with Spillovers**",** *American Economic Review*, Vol. 82, pp. 1307-1320

UNCTAD World Investment Report 2005, Transnational Corporations and the internalization of R&D, United Nations: New York and Geneva

UNCTAD World Investment Report 2006, FDI from Developing and Transitional Economies, Implications for Development , United Nations: New York and Geneva

UNCTAD (2006): *World Investment Report 2006*

Williamson, Oliver E. (1985): *The Economic Institutions of Capitalism*, Free Press, New York

2 Does Distance Matter in Spillover?[2]

Joint with László Halpern[♣]

Abstract

Our aim in this paper is twofold: to find whether FDI causes horizontal or vertical productivity spillovers to domestically-owned Hungarian manufacturing firms, and to see if distance matters in spillovers. For this exercise we use a large panel of Hungarian firms and different panel models. Consistently with previous research, at the country level we find positive vertical spillovers but no evidence of positive horizontal spillovers. By taking distance into consideration, however, we find positive horizontal spillovers for domestic firms close to foreign owned firms. By constructing spillover measures weighed by distance, we find similar patterns. Our results underline the importance of labour market inflexibility and the local nature of knowledge in the case of horizontal spillovers.

2.1 Introduction

Multinational enterprises play a very important role in a number of countries, including transition economies, and their effects on the host country constitute an increasingly important issue. The widespread use of investment incentives shows that host country governments consider FDI beneficial. Some of the reasoning behind these incentives stems from the belief that domestic firms benefit from the presence of foreign firms through spillover of knowledge and productivity. The empirical findings, however, do not necessarily confirm this belief. The literature survey of Görg and Greenaway (2004) argues that few results show a productivity increase benefit to firms from foreign presence in the same industry. Recent research (e.g. Javorcik, 2004) suggests, however, that suppliers within an industry can benefit if the buyers of their products are foreign-owned. The aim of this paper is twofold. First, a rich panel of Hungarian firms is used to detect significant horizontal or vertical spillover effects in the manufacturing sector. To our knowledge, no comparable dataset has previously been used to study this question in a transition economy.

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The second aim is to identify the effect of distance on spillover. Financial, social and cultural considerations and information problems may limit the mobility of workers between distant firms, what leads to limited knowledge transfer through worker mobility between firms. Both anecdotic evidence and empirical results on the European and Hungarian labour markets underline the importance of limited mobility of workers. A number of recent results suggest that different kinds of knowledge are transferred more effectively by face-to-face communication. Personal relations and face-to-face communication are limited between the employees and managers of distant firms, possibly leading to a lower level of knowledge transfer between them. In the case of vertical spillovers higher transport costs may lead to a smaller probability of establishing supplier-buyer links. Our empirical investigation can also shed light on the significance of different spillover channels. It is clear that imitation, acquisition of human capital and competition work on very different distances. If, for example, spillover is fundamentally a short-distance phenomenon, then we may infer that labour market channels are very important. If, on the other hand, the sign and magnitude of spillover are very similar over short and long distances, the labour market channel must have a rather limited effect.

Database information linking firms to towns enabled alternative spillover measures to be constructed. The 'conventional' spillover measure is the average of foreign presence within an industry (horizontal spillover), or in supplier or customer industries (backward and forward spillover, respectively). Spillover measures can be constructed with weights which are some function of the distance between the firms. Or variables can be restricted to firms within a given distance from foreign affiliates. To the best of our knowledge, no other paper has taken physical distance directly into consideration in measuring spillover effects. These alternative spillover measures make it possible to study several empirical questions. Do measures weighted by some function of distance work better than those weighted only by the size of firm? If the effect of foreign presence decreases with distance, how different functions work? Does the spillover effect work differently in small distances than in larger distances? Is it distance that matters, or county boundaries?

In section 2, we review the related theoretical and empirical literature on spillovers, with emphasis on studies covering transition economies. In section 3 we introduce our data: a large database consisting accounting and financial data of Hungarian firms and a wage survey linking firms to towns. We also argue that possible endogeneity of inputs makes it necessary to check

whether the results are robust for the use of sophisticated panel techniques. In section 4, we present our results on different kinds of spillovers, county boundaries and distance. We also report some robustness checks. Section 5 concludes.

2.2 Spillover and FDI: theory and measurement

The presence of a multinational company can affect the productivity of domestic firms in different ways. A natural characterization of the relationship of two firms can be based on their market relationship. The first possibility is that there is no relationship between them. The second is that the two firms operate on the same product market as competitors. Productivity spillover here is called "horizontal". The third possibility is a supplier-buyer relationship, in which case the spillover is "vertical". Because horizontal spillover of productivity is associated with a different set of market relationships than vertical spillover, it may also occur via different channels, so that different factors may determine the magnitudes of the two types of spillover and different policy instruments may be needed to improve their effects.

The main advantage of categorising relationships between foreign and domestic firms by market relationship (instead of a relationship having greater theoretical meaning) is that it helps construct quantitative spillover measures.

Horizontal spillovers

The theoretical literature on horizontal spillover channels is rather limited; the major source is Görg and Greenaway (2004).

Imitation is the classic of these channels. Imitation means more than just reverse engineering and other forms of imitating a product. FDI is not simply a transfer of production; it is "a composite bundle of capital, technology and know-how" (De Mello, Luiz R. jr., 1997, p.1). Imitation can involve any component of this bundle. The most important forms are imitation of managerial and organizational innovation, and imitation of technology.

The second channel of horizontal spillover is the acquisition of human capital. Since foreign firms need more skilled workers to operate the more sophisticated technology, they have to invest in training. When these workers move from foreign-owned to domestic-owned firms, they may create productivity improvement for the latter. Görg and Greenaway (2004) distinguish two mechanisms. First, there is a direct spillover through complementary workers. Second, there is an

indirect mechanism, when workers move and transfer knowledge between foreign and domestic firms.

The fundamental empirical questions are whether multinationals and domestic firms have different training behaviour, and whether the presence of former workers of multinationals increases the productivity of domestic firms. Several studies have analysed the first question. For example Djankov and Hoekman (2000) analyse firm-level panel data for a transition economy, the Czech Republic. They present the results of a questionnaire survey of managers showing that 62% of employees in foreign firms had undergone some training in the previous two years, while the same was true in only for 18% of domestic firms. Görg and Strobl (2005) use a panel of firms operating in Ghana, using data on the previous experience of the firms' owners. The results suggest that firms run by owners who had worked for multinationals immediately before opening up their own enterprise achieved faster productivity growth.

The third spillover channel is competition. Domestic firms face pressure from competition, forcing them to reduce their X-inefficiency or introduce new technologies. On the other hand, fierce competition can cause domestic firms to lose market share and prevent them from operating at their cost efficient scale. Their productivity may thereby be reduced. For instance, Aitken and Harrison (1999) suggest this explanation for negative spillover from FDI in Venezuela.[3]

Vertical spillovers

Vertical relationships between multinational and domestic firms are of two types. A domestic firm may be the supplier of a multinational, giving rise to "backward" spillovers. Or the domestic firm may be the customer of the multinational, when productivity spillovers are called "forward". The theoretical literature on vertical spillovers is also limited. Javorcik (2004) argues that the most important channels of backward spillover are (i) direct knowledge transfer; (ii) higher requirement for product quality and on-time delivery introduced by multinationals; and (iii) the fact that multinational entry can increase demand for intermediate goods.

[3] One has to mention, that buyer-supplier links are also important within an industry, especially at the level of aggregation we use (NACE-2). Consequently the estimated horizontal spillovers include the effect of these relationships.

What are the determinants of voluntary technological transfer? Which firms are more willing to transfer technology? What policies are effective in enhancing direct vertical technology transfers? What quality of technology is transferred?

Pack and Saggi (2001) analyse these questions. A firm from a developed country (foreign firm) uses the intermediate product of a firm from a less developed country (domestic firm). The foreign firm transfers technology to its domestic supplier. The foreign firm can diffuse this technology to other domestic firms. This may be in the interest of the foreign firm: the technology transfer will cause other potential suppliers to compete with the domestic firm, and prices will go down. In this case (if there is no entrance at the downstream market), the foreign firm benefits from the technology spillover. This mechanism is practically rent extraction by the foreign firm: as prices go down, the foreign firm extracts more rent from the technology.

The most studied of the three channels of vertical linkages is the increased demand. As Markusen and Venables (1999) argue, there are two effects. First, there is a competition effect. As multinationals compete with domestic firms in the downstream sector, the demand of the domestic firms for the intermediate product decreases. Second, the presence of multinational firms creates a demand effect, which means that they create their own demand for the product of the upstream industry. The question is which one of these effects is stronger? The stronger the demand effect compared to the competition effect, the better the situation for the upstream firms. This mainly depends on the degree of backward linkage. If the multinationals use sufficient quantity of intermediate inputs relative to local firms, then the demand effect can outweigh the competition effect.

The role of backward linkages is also emphasised in Rodriguez-Clare (1996), who shows how multinationals benefit the host country if their linkage coefficient is higher than that of the domestic firms. The linkage coefficient is defined as the value of inputs bought by the multinational divided by the number of workers. It is also shown that the linkage effect depends on the distance between the two countries, and their relative level of development, and the complexity of production.

These questions are further analysed in Barrios et al. (2005). Using a simple theoretical model, they demonstrate a U-shaped relationship between foreign presence and the number of domestic firms present. The competition effect, which dominates when foreign presence is small, gives

way to positive externalities as foreign presence increases. Their theoretical prediction is tested empirically for a sample of firms in Ireland.

Regional aspects of spillover

There are several reasons why regions or distances might matter in spillover. As Jacobs (1969) argues, knowledge or tacit knowledge, in contrast to information, is vague, difficult to codify and often only serendipitously recognised. Consequently geographic proximity can be important for transmitting knowledge as face-to-face communication and other kinds of personal interaction are important in this process. Recent estimates of the production function which are summarized in Audretsch et al (2004) suggest that geography plays an important role in knowledge diffusion: the knowledge present in the given region/city is an important input for producing further innovations. Jaffe et al. (1993) show evidence for local spillovers using patent citations; the geographic location of patent citations is similar to the location of the cited patents. An important empirical question for this study is whether geographical distance or regional boundaries matter in knowledge spillovers. On the one hand, Adams and Jaffe (1996) and Adams (2002) show that knowledge spillovers are stronger within a given distance. On the other hand, the density of the social network can have a more pronounced effect than mere distance (on the importance of social networks see Manski, 2000). This suggests that regions, cities or other administrative areas can be the appropriate geographical units for spillover measures if social links are stronger within such regions. Also a number of urban economic papers study the local spillovers within cities or small regions; a review of this literature is Brschi and Lissoni (2001).

Second, if one considers the labour market channel, it is clear that the low mobility of labour can be a strong obstacle for technology spillovers. It is commonly argued that European labour markets are very rigid compared to the labour market in the U.S., and people are less mobile in a geographical sense. Decressin and Fatás (1995) convincingly show that European labour market dynamics are significantly different from that of the U.S. In the first three years following a region-specific shock, most of the shock is absorbed by change in the participation rate, which is achieved through mobility between states in the U.S. It suggests that regional labour markets in Europe are more isolated, and so inter-regional spillovers might be weaker.

When considering vertical productivity spillovers, it is likely that firms choose suppliers close to their plants, so as to minimise transport costs. This suggests that the nature of vertical spillovers

may be local. Whether this is true is discussed to some extent in the vertical linkage literature mentioned above. The relationship between transport costs and location choice of upstream and downstream industries, on the other hand is analysed by Venables (1996). He shows that imperfect competition and transportation costs create backward and forward linkages and that these linkages play a crucial role in the location decision of firms when transport costs are intermediate. Under high transport costs, however, production occurs at both locations and downstream firms buy inputs from upstream firms at the same location.

Empirical findings on horizontal and vertical spillovers

All in all, the distinction based on the product market link between firms has the advantage that it is possible to estimate the sign and magnitude of horizontal and vertical spillovers. For example, following Javorcik (2004), (who pursues the convention in the literature) we can define horizontal spillover as the extent of foreign presence in industry j at year t, weighted by each firm's share in the output of the given sector:

$$Horizontal_{jt} = \frac{\sum_{i\_for\_all\_i\in j} FS_{ijt} * Y_{ijt}}{\sum_{i\_for\_all\_i\in j} Y_{ijt}} \qquad (1)$$

where Y_{ijt} is the value added and FS_{ijt} is the foreign share.

Similarly, Javorcik (2004) defines the backward spillover as the weighted average of foreign presence in the industries supplied by the industry the firm belongs to:

$$\text{Backward}_{jt} = \sum_{k\_if\_k\neq j} \alpha_{jk} \text{Horizontal}_{kt} \qquad (2)$$

where α_{jk} is the proportion of sector j's output to sector k using the input-output matrix. This variable is of course a proxy, as usually we do not know the transactions between individual firms. We can use these variables when estimating a production function and estimate their effect on the total factor productivity.

One of the first applications was by Aitken and Harrison (1999). The authors use Venezuelan panel data to estimate the effect of foreign ownership of each firm and the effect of horizontal spillovers. They find that foreign-owned firms are more productive than domestic-owned ones. On the other hand, they find that the greater the foreign presence in an industry, the less productive domestic firms are, which is an evidence for negative horizontal spillover effects.

There has also been research into spillover effects in developing and developed countries. The main idea of these papers is very similar, but the earlier studies usually use cross-section data and the later ones rely on panel data. Görg and Greenaway (2004) cogently argue the case for using panel data, citing two reasons. First, panel data permit the development of domestic firms' productivity to be investigated over a longer time period. Second, time-invariant productivity differences among sectors, which can be correlated with productivity, cannot be controlled for with cross section data. It is interesting that most studies using panel data were unable to find evidence for positive horizontal spillovers.

In transition economies, measured horizontal spillovers – if any – are negative. Djankov and Hoekman (2000) use a panel database of Czech firms between 1992 and 1996. Their results suggest that the direct effect of foreign ownership is positive, which shows that foreign owners are more willing to transfer technology to their affiliates. Horizontal spillovers, on the other hand, are negative. A comprehensive study for transition economies is Damijan et al. (2003), which use a large panel of more than 8000 firms from 10 transition economies. The authors distinguish between direct effects and horizontal and vertical spillovers. They correct for endogeneity bias using the dynamic system GMM approach. They are unable to show consistent effects in general, demonstrating either the weakness of the database or the lack of spillover effects. For Hungary, they are unable to find any significant spillover effects. Another important study for a transition economy is Javorcik (2004). The author uses a Lithuanian panel of firms to investigate technology transfer through backward linkages, i.e. vertical spillover. She finds significant backward spillover: 15% higher productivity increase for every 1% increase in foreign ownership. On the other hand the horizontal spillover is not significant. Another important contribution analysing vertical spillovers is Girma et al. (2004), which measures horizontal and vertical spillovers in the United Kingdom. The results show that export-oriented domestic firms face significant vertical spillovers.

There is little literature on the regional aspects of spillover. Sjöholm (1999) studies a cross-section of firms in Indonesia. The author constructs spillover measures on the regional level, but fails to find horizontal spillovers within the region. Another important study is Aitken and Harrison (1999), using a panel of firms in Venezuela. The authors find no evidence of horizontal spillover from foreign-owned firms within the given region, but finds negative spillovers for the entire country. Finally, the study of Girma and Wakelin (2002) using firm-level panel data for the

United Kingdom finds positive horizontal spillover from foreign firms within the given region. However, this is only true for firms with a low technological gap vis-à-vis multinationals.

Horizontal and vertical spillovers in Hungary

Literature on Hungary is scarce. Bosco (2001) tries to identify the direct effect of foreign ownership and to estimate the sign and magnitude of horizontal spillover. Unfortunately, the analysis is spoiled by the lack of data. The data used in the study comprised 882 Hungarian firms for the period 1992-1997. The short time period of the data constrains the use of available panel techniques, for example it is impossible to correct for the endogeneity of the inputs. Structural breaks are another potential problem, as throughout the studied period there were fundamental structural changes in the Hungarian economy. The results, however, are similar to those found by other authors: horizontal spillover was found to be insignificant, and negative. The interpretation offered is that the market-stealing effect overwhelms potential technology transfers. She uses another variable – foreign ownership in high-tech industries – as a proxy for potential technology transfer in order to distinguish between the two effects, but since the proxy variable is not significant, it reveals little about technology transfer. This may be due to the weak database or the lack of absorptive capacity in high-tech industries.

The second study on Hungary is Schoors and van der Tol (2002). The key departure from the standard literature is the use of labour productivity instead of total factor productivity. The other drawback is the quality of data used, as the AMADEUS data for Hungary is drawn from a sample which is very small and not representative at all. Even worse, cross-section methodology is used, because there are only two annual observations. The paper examines both horizontal and vertical spillovers, and the authors consider the degree of openness (at industry level) as a determinant of spillover. It is argued that greater openness means greater competition for the given firm, as it has to compete on foreign markets as well. This means that greater openness can be a substitute for greater competition in the domestic market. The authors find positive horizontal spillovers, especially in very open manufacturing sectors. They find strong vertical spillovers, but only in the backward direction; forward spillover is negative.

2.3 Data and estimation strategy

Dataset

Our main source of data is a dataset ('Tax Office Database') consisting of principal financial and accounting data of Hungarian firms, like balance sheet data, revenues and costs. We decided to consider only firms operating in the manufacturing industries, where productivity spillover is most important. Only firms with majority domestic ownership are used for the estimation, in order to avoid complications like structural breaks and selection bias. This seems to be a reasonable decision as the effect of foreign presence on domestic firms is more interesting for public policy purposes. We also exclude firms with any state or municipal ownership, since they often behave somewhat differently from private firms. Formerly state-owned firms enter the sample after privatisation to domestic owners. We hope these exclusions make the results more robust.

We use data between 1996 and 2003, permitting the effective use of panel methods. We use year dummies to address changes in the economy, and also test for structural breaks. Another concern is measurement. In this period inflation was moderate; by using appropriate deflators, we handle most problems related to inflation. Measurement error in capital and labour may remain significant, however.

Firms were linked to towns using the wage survey, regularly conducted by the Hungarian Employment Office, which covers firms employing at least 10 employees. The wage survey is incomplete, though, being heavily biased towards large firms; it includes almost all firms employing at least 500 employees. If a firm operates more than one plant, then we consider the plant with the most employees as the location of the firm. We also know the distance between all Hungarian settlements. 'Distance' means physical distance in kilometres on road, providing a reasonable proxy for transport cost/time.

After all these exclusions, the number of observations by year is reported in Appendix 1. Firms are included only if they were not sold to foreign owners in the studied period, to minimize selection bias.[4] For the vertical measure, we also use the 1998 input-output tables published by the Hungarian Central Statistical Office.

Spillover variables

[4] The main results are robust for including firms, which were acquired by foreigners between 1996 and 2003. The results are also robust for the use of the balanced subsample of this sample.

For the baseline model, the horizontal and vertical measures are calculated according to equations (1) and (2), as it is standard in the literature.[5] In this work we define 'industries' as the NACE-2 level. As the input-output tables are reported on the NACE-2 level, it would be impossible to work with vertical spillovers in a more detailed level of aggregation.

The less conventional part of this paper is the use of measures weighted by a function of distance. The general formula for the modified horizontal measure for a firm at location *h* in sector j is the foreign share in sector j weighted by a function of distance from the given firm:

$$Weighted\_Horizontal_{hjt} = \frac{\sum_{i\_for\_all\_i \in j} FS_{ijt} * Y_{ijt} * f(d_{ih})}{\sum_{i\_for\_all\_i \in j} Y_{ijt} * f(d_{ih})} \qquad (3)$$

where $f(d_{ih})$ is a function of distance between firms i and h (in kilometres). We use functions decreasing in distance, as we expect that the farther the foreign firm, the smaller the spillover. Thus these variables are the weighted versions of the conventional horizontal measure. These variables increase with the greater foreign share, or the closer the foreign firms are to the given firm.

The general formula for the vertical measures is the weighted average of the appropriate weighted horizontal measures:

$$\text{Weighted\_forward}_{hjt} = \sum_k \alpha_{jk} \text{weighted\_horizontal}_{hkt} \qquad (4)$$

where α_{jk} is the proportion of sector *j*'s output to sector *k* using the input-output matrix, as before. The appropriate formula for the backward measure is:

$$\text{Weighted\_backward}_{hjt} = \sum_k \alpha_{kj} \text{Weighted\_horizontal}_{hkt} \qquad (5)$$

We include both the unweighted and weighted measures into the same regression. If the weighted measure is significant, distance matters.[6] Our expectation is the following: for distant firms, the competition is the dominant spillover channel, consequently we expect that the unweighted horizontal measure is negative. Because of labour market inflexibility and the more effective

[5] In calculating these measures, we took into consideration the foreign share in both domestic- and foreign owned firms.
[6] While the two sets of measures are correlated, multicollinearity does not seem to be a problem. First, the correlation is not greater than 0.75. Second, the sign and significance of the weighted measures are similar, if we exclude the unweighted measures from the regressions.

transfer of knowledge by face-to-face communication, we expect that horizontal spillovers are more positive (less negative) among nearby firms. If these channels are important, the weighted horizontal measure should be positive, as it assigns a larger weight for nearby firms. In the case of vertical measures, the main difference between nearby and distant firms is the cost of transport. If transport costs play an important role in supplier choice, we expect a positive sign for the weighted vertical measures.

We use three weighting functions in the empirical exercise. The first function is: $f_1(d) = \frac{1}{1+d/100}$ which assumes that the spillover effect declines hyperbolically. Thus for two firms in the same location the weight is 1; if the distance of two firms is 100 km, the weight is 0.5. We find the use of this kind of function a useful starting point as it is decreasing and convex. The convexity should be intuitive, because a 1 km difference matters more in the very vicinity of a firm than far away from it. The slope of this function seems reasonable: the greatest distance in Hungary between two firms is about 500 km, in which case the weight is 1/6. Thus every firm enters the measure with a non-negligible weight, but the function is significantly different from the unweighted one. The other two functions of distance are very similar in shape to the first one. $f_2(d) = \frac{1}{(1+d/100)^2}$ have very similar properties but declining somewhat faster.

We also construct complementary spillover measures which only take into consideration the firms within (outside) a given distance from the firm. For this purpose, we use two complementary weighting functions. One weighting function is the close-weight: this function assigns a weight of one if the distance between the two firms is smaller than, say 25 km, and a weight of zero otherwise. Similarly, the far-weight function assigns a weight of zero, if the distance between the two firms is smaller than, say 25 km, and a weight of one otherwise. We calculate the spillover measures using these two weighting functions, and then include them into the same regression.

The relevant question is whether the marginal effect of the foreign acquisition of a firm with a turnover of EUR 1 million is independent from the location of the firm. However the direct comparison of the close-distance and far-distance measures is not appropriate for this purpose. Suppose for example that there is one firm (with a turnover of EUR 1 million) within 25 km distance from a domestic firm, and there are 10 firms (with a total turnover EUR 10 million)

outside 25 km distance from a domestic firm. If the foreign firm with a revenue of EUR 1 million is acquired by a MNE within the 25 km circle, the close-weight measure will increase by 1; if the same happens with a firm outside the circle, the far-weight measure will increase by only 0.1. If the marginal effect of a foreign acquisition of a firm of EUR 1 million turnover is independent from the location of the acquired firm, the estimated coefficient of the close-weight measure will be 10 time larger than the coefficient of the far-weight measure. Thus to make the comparison of the marginal effects meaningful, one should normalize the close-weight (and far-weight) measures with the ratio of turnover within (outside) the given distance and the total turnover in the country. This normalization has the additional advantage that the measurement unit of the normalized measure is the same as the measurement unit of the national spillover measure: the proportion of the turnover of foreign owned firms from the total turnover of the industry.[7] We used these normalized measures in all the regressions reported.

If their coefficients of these normalized measures are significantly different, distance matters. Our expectation is that close-weight measures are more positive than far-weight measures.

We use the same approach for administrative regions, e.g. counties. In Hungary, there are 19 counties (and the capital, Budapest). It is tempting to consider a county as an economic unit for several reasons. First, the transport infrastructure is organised within a county, and so it is easier to reach localities within a county than outside it. Second, most of the economic actions take place in the largest city of the county, which also has several links to other localities in the county. This phenomenon was magnified by the pre-1990 policy of local (usually county) monopolies in

[7] Formally the total horizontal measure can be decomposed in the following way:

$$\text{Horizontal} = \frac{\sum_{\text{within}} FS_{it} Y_{it} + \sum_{\text{outside}} FS_{it} Y_{it}}{\sum_{\text{within}} Y_{it} + \sum_{\text{outside}} Y_{it}} = \frac{\sum_{\text{within}} FS_{it} Y_{it}}{\sum_{\text{within}} Y_{it} + \sum_{\text{outside}} Y_{it}} + \frac{\sum_{\text{outside}} FS_{it} Y_{it}}{\sum_{\text{within}} Y_{it} + \sum_{\text{outside}} Y_{it}} =$$

$$\frac{\sum_{\text{within}} FS_{it} Y_{it}}{\sum_{\text{within}} Y_{it}} \cdot \frac{\sum_{\text{within}} Y_{it}}{\sum_{\text{within}} Y_{it} + \sum_{\text{outside}} Y_{it}} + \frac{\sum_{\text{outside}} FS_{it} Y_{it}}{\sum_{\text{outside}} Y_{it}} \cdot \frac{\sum_{\text{outside}} Y_{it}}{\sum_{\text{within}} Y_{it} + \sum_{\text{outside}} Y_{it}} =$$

$$= \text{close\_weight} \cdot \frac{\sum_{\text{within}} Y_{it}}{\sum_{\text{within}} Y_{it} + \sum_{\text{outside}} Y_{it}} + \text{far\_weight} \cdot \frac{\sum_{\text{outside}} Y_{it}}{\sum_{\text{within}} Y_{it} + \sum_{\text{outside}} Y_{it}}$$

. A similar approach can be used in the case of vertical spillovers.

most industries. Altogether, the infrastructure and some historical factors suggest that economic linkages may be much stronger within a county than between counties.

Estimation strategy

The usual way of assessing spillovers is to estimate a production function in which the total factor productivity depends on the spillover measures (e.g. Aitken and Harrison, 1999; Bosco, 2001). The estimated equation is:

$$\ln Y_{it} = \alpha + \beta_k \ln K_{it} + \beta_l \ln L_{it} + \beta_H Horizontal_{it} + \beta_V Vertical_{it} + \delta_t + \mu_i + \varepsilon_{it} \qquad (6)$$

where Y_{it} is the added value of firm i in year t, deflated by the firm-specific Producer Price Index[8], K_{it} is the deflated value of the book value of capital, L_{it} is the number of employees (full-time equivalent), $Horizontal_{it}$ and $Vertical_{it}$ are the sector-specific spillover measures, δ_t is the year-specific effect, μ_i is the firm specific fixed effect and ε_{it} is the idiosyncratic shock. We also include a full set of time dummies to control for industry-wide macro fluctuations. We estimate (6) by fixed effects.[9]

Recent econometric advances in the field of production function estimation underline the importance of the potential endogeneity of firm inputs, as firms may observe a part of the idiosyncratic shock unobserved by the econometrician when choosing their labour inputs. A recent development is the use of semiparametric estimation procedures, such as those suggested by Olley and Pakes (1996) and, more recently, by Levinsohn and Petrin (2003). An important application in the spillover literature is Javorcik (2004). These procedures use an observable variable (investment in the case of Olley and Pakes, 1996 and intermediate inputs in Levinsohn and Petrin, 2003) to control for unobservables. With the Levinsohn-Petrin method, the productivity shock is estimated by a semiparametric approach from the intermediate input choice of the firm, and then the endogeneity of the labour input is corrected by using the estimated shocks. This procedure leads to consistent estimates of the TFP.

[8] It is firm-specific, because it is the weighted average of the industry specific export and domestic producer price indices.

[9] While qualitatively OLS results are very similar, by using the Hausman test one can reject the null of no correlation between the fixed effects and the regressors suggesting that OLS may lead to inconsistent estimates. Fixed effects also eliminate industry-specific fixed effects what diminishes reverse causality problems, e.g. foreign firms choose sectors with low/high productivity.

Thus to check whether our results are biased as a consequence of the endogeneity problem, we re-estimate all specifications by using the Levinsohn-Petrin corrections. We apply a two-step procedure. In the first step, we employ the Levinsohn-Petrin[10] estimator (the estimated TFP is denoted by $\overline{\text{TFP}_{it}}$). In the second step we use the estimated TFP as the dependent variable and run the following regression:

$$\overline{TFP_{it}} = \alpha + \beta_H Horizontal_{it} + \beta_V Vertical_{it} + \mu_i + \delta_t + \varepsilon_{it} \qquad (7)$$

We estimate this equation with the fixed effects estimator, including a full set of time dummies.

2.4 Results

Baseline results

Table 1 reports the baseline results. In specification (1) we present the horizontal and (backward) vertical measures. Our results are in line with the above mentioned results in the literature. The coefficient of the horizontal spillover measure is small and insignificant, suggesting the lack of positive intra-industry spillovers. The vertical measure is large, positive and significant, showing that suppliers are able to benefit from the presence of foreign owned firms in downstream industries. In (2) we re-estimate this equation by using the Levinsohn-Petrin correction. Interestingly the estimated spillover effects are much larger in absolute value. The fundamental conclusion, however, is unchanged: suppliers of foreign firms do benefit from their presence, while competitors do not.

[10] We prefer the Levinsohn-Petrin estimator because investment data is highly unreliable in transition economies. Also reported investment is zero for a significant number of observations.

Table 1 Baseline estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	baseline		*forward measure included*		*Foreign share included*		*Excluding firms with less than 30 employees*		*Excluding firms with more than 200 employees*		*Lagged spillover variables*	
	FE	LP	FE	LP	FE	LP	FE	LP	FE	LP	FE	LP
Vertical	0.840	2.962	0.837	2.737	0.841	2.669	1.059	3.179	0.906	2.643		
	(0.092)***	(0.249)***	(0.092)***	(0.249)***	(0.092)***	(0.255)***	(0.103)***	(0.300)***	(0.099)***	(0.259)***		
Horizontal	-0.090	-0.346	-0.091	-1.006	-0.092	-0.365	-0.120	-1.095	-0.136	-0.561		
	(0.108)	(0.340)	(0.109)	(0.414)**	(0.109)	(0.345)	(0.123)	(0.541)**	(0.119)	(0.384)		
Forward			0.032	-1.677								
			(0.507)	(1.290)								
foreign share					0.055	0.271						
					(0.149)	(0.364)						
lagged vertical											0.522	2.073
											(0.089)***	(0.241)***
lagged horizontal											-0.031	-0.114
											(0.117)	(0.392)
Observations	15185	15185	15185	15185	15185	15185	10801	10801	12901	12901	11503	11503
Number of id	2987	2987	2987	2987	2987	2987	2216	2216	2714	2714	2908	2908
R-squared	0.35	0.06	0.35	0.05	0.35	0.04	0.33	0.06	0.33	0.05	0.33	0.06
P-value: H_0: vertical within 100 km=horizontal outside 100 km[1]			0.623	0.084	0.623	0.084	0.334	0.245	0.454	0.615	0.394	0.755
P-value: H_0: horizontal within 100 km=horizontal outside 100 km[1]			0.002	0.019	0.003	0.019	0.007	0.15	0.002	0.069	0.025	0.485
P-value: H_0: weighted vertical=0[2]			0.496	0.580	0.498	0.581	0.565	0.537	0.317	0.997	0.808	0.815
P-value: H_0: weighted horizontal=0[2]			0.045	0.000	0.047	0.000	0.151	0.001	0.043	0.001	0.299	0.305

Robust standard errors in parentheses. Firm and year fixed effects are included.

FE: fixed effects, LP: two-step Levinsohn-Petrin estimator.

* significant at 10%; ** significant at 5%; *** significant at 1%

[1] these values are calculated by decomposing the vertical and horizontal measures into within- and outside measures in the specifications above, and testing the equalitiy of the coefficients

[2] These values are calculated by including the weighted vertical and horizontal measures (weight: weight: 1/(1+d/100)) into the regressions above

In specifications (3) and (4) we also include the forward spillover measure. As it is obvious, this variable is insignificant, and its inclusion does not change the coefficients of the other two measures. As the forward variable is insignificant in other specifications as well, we will omit it to reduce the extent of multicollinearity among the regressors. In the next two specifications we add the foreign share of the given firm. As the sample used during the estimation consists only of firms the majority of which are owned by domestic investors, we do not expect this variable to be an important determinant of productivity. The results suggest that this variable behaves as expected: it is positive and insignificant. In specifications (7)-(10) we study whether the results are robust to the exclusion of small or large firms. The results suggest, that there is no important difference along this dimension in spillover effects. Finally, in (11)-(12) we check whether simultaneity is a problem, or whether spillovers take time to materialize. For this, we include the lagged values of the spillover measures into the estimating equation instead of their contemporary values. While the absolute value of the point estimates is smaller in this case, the pattern is robust to this modification.

Weighted measures

In the first six columns of Table 2 we include both the weighted and unweighted measures to see whether distance matters.[11] In all specifications the weighted horizontal measure is significant. The weighted vertical measure is not significant. This suggests that distance matters for horizontal spillover. The unweighted horizontal spillover is always negative, while the weighted measures are positive. As the weighted measures are decreasing in distance, this pattern suggests that horizontal spillover is a decreasing function of distance. It is appealing intuitively: positive labour market spillovers and face-to-face technology transfer play an important role in small distances while in larger distances the negative competition effect dominates. The fact that distance does not seem to matter in vertical spillover suggests the limited role of transport costs in supplier choice.

[11] If one includes only the weighted measures, their coefficient estimates are very similar.

Table 2 Distance-weighted and adminstrative unit-specific measures

	(1)	(2)	(3)	(4)	(5)	(6)
	weight: 1/(1+d/100)		*weight: 1/(1+d/100)^2*		*unit: county*	
	FE	LP	FE	LP	FE	LP
Vertical	0.535	3.395	0.737	3.042		
	(0.453)	(1.402)**	(0.213)***	(0.655)***		
Horizontal	-0.854	-5.090	-0.437	-2.260		
	(0.407)**	(1.313)***	(0.206)**	(0.645)***		
weighted vertical	0.307	-0.745	0.102	-0.400		
	(0.449)	(1.369)	(0.197)	(0.600)		
weighted horizontal	0.781	4.888	0.370	2.070		
	(0.391)**	(1.247)***	(0.178)**	(0.541)***		
within-unit vertical					0.964	0.914
					(0.146)***	(0.095)***
within-unit horizontal					0.101	-0.232
					(0.412)	(0.140)*
outside-unit vertical					0.920	0.913
					(0.094)***	(0.095)***
outside-unit horizontal					-0.122	-0.097
					(0.116)	(0.113)
p-value. H_0: within-unit vertical=outside-unit vertical					0.697	0.388
p-value. H_0: within-unit horizontal=outside-unit horizontal					0.599	0.201
Observations	15185	15185	15185	15185	15185	15185
Number of id	2987	2987	2987	2987	2987	2987
R-squared	0.35	0.04	0.35	0.04	0.35	0.04

Robust standard errors in parentheses. Firm and year fixed effects are included.

FE: fixed effects, LP: two-step Levinsohn-Petrin estimator. d is distance in kilometers.

* significant at 10%; ** significant at 5%; *** significant at 1%

County boundaries and within-distance measures

The last two columns of Table 2 present results on the within- and outside county measures. The rows below the coefficient estimates include the p-values from the tests of equality of the within- and outside county measures. Both the within- and outside county vertical spillover measures are positive and significant, and they are very similar to each other. The horizontal spillover measures are insignificant. These results suggest that county boundaries do not play an important role in the determination of spillover effects.

It turns out that physical distance is important. Different specifications in Table 3 present the estimates of close-weight and far-weight measures with different thresholds. The close-weight horizontal measures appear stronger in all specification than the far-weight measures, and for the 75 km and 100 km thresholds the difference is significant at least at the 5% level. Figure 1 presents the coefficient estimates for a greater number of thresholds. The results are intuitively appealing. The coefficient of the close-weight measure is decreasing with distance, as more and more distant firms can be found within the boundary. Similarly, the far-weight measure is also decreasing with distance, as at large thresholds only the farthest firms are included into the far-weight measure, which only affect the firm through competition.

One cannot see such a consistent pattern in case of vertical spillovers. The close-distance and far-distance measures are not different significantly. Figure 2 presents the results for a greater number of thresholds. The point estimates of the close-weight measure are strongly increasing for small distances. The most probable explanation for this seemingly counter-intuitive result is the very high noise in the close-weight measure. As we cannot observe the actual transactions between the firms, we always use the national input-output matrix as the source of weights. While this matrix is appropriate at the national level, in very small distances it can become a very poor proxy for the actual transactions between firms. We suspect that this is the explanation for the very small (but positive) coefficients in short distances. For larger distances, the national input-output matrix becomes a reasonable proxy for the (average) actual transactions, and its coefficient becomes statistically equal with the far-distance measure.

Table 3. Within- and outside-distance measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	distance: 25 km		*distance: 50 km*		*distance: 75 km*		*distance: 100 km*	
	FE	LP	FE	LP	FE	LP	FE	LP
within distance vertical	0.355	-0.315	0.663	1.215	0.760	1.702	0.919	2.122
	(0.334)	(1.370)	(0.224)***	(0.804)	(0.183)***	(0.569)***	(0.158)***	(0.432)***
within distance horizontal	1.581	2.588	0.479	1.970	0.576	1.555	0.456	1.195
	(0.793)**	(3.017)	(0.374)	(1.306)	(0.253)**	(0.944)*	(0.207)**	(0.739)
outside distance vertical	0.882	2.844	0.881	2.936	0.875	2.943	0.835	2.953
	(0.095)***	(0.285)***	(0.097)***	(0.300)***	(0.099)***	(0.300)***	(0.102)***	(0.290)***
outside distance horizontal	-0.115	-0.317	-0.126	-0.483	-0.236	-0.736	-0.303	-0.939
	(0.110)	(0.336)	(0.115)	(0.355)	(0.123)*	(0.378)*	(0.131)**	(0.420)**
p-value. H_0: within-unit vertical=outside-unit vertical	0.132	0.032	0.355	0.060	0.555	0.062	0.623	0.084
p-value. H_0: within-unit horizontal=outside-unit horizontal	0.035	0.335	0.129	0.074	0.005	0.029	0.002	0.018
Observations	15181	15181	15181	15181	15181	15181	15181	15181
Number of id	2987	2987	2987	2987	2987	2987	2987	2987
R-squared	0.35	0.04	0.35	0.04	0.35	0.04	0.35	0.04

Robust standard errors in parentheses. Firm and year fixed effects are included.

FE: fixed effects, LP: two-step Levinsohn-Petrin estimator.

* significant at 10%; ** significant at 5%; *** significant at 1%

Figure 1. The effect of distance on horizontal spillover measures

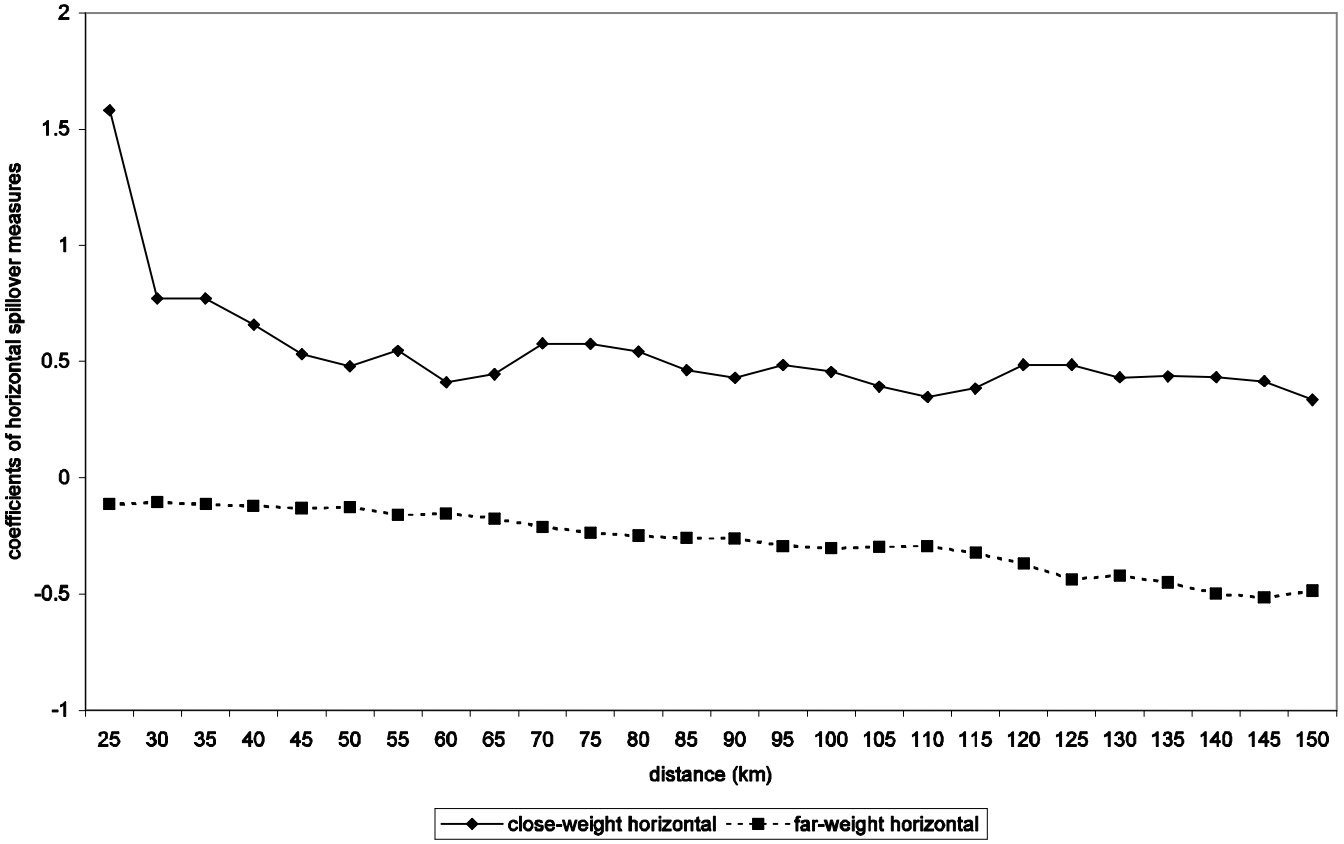
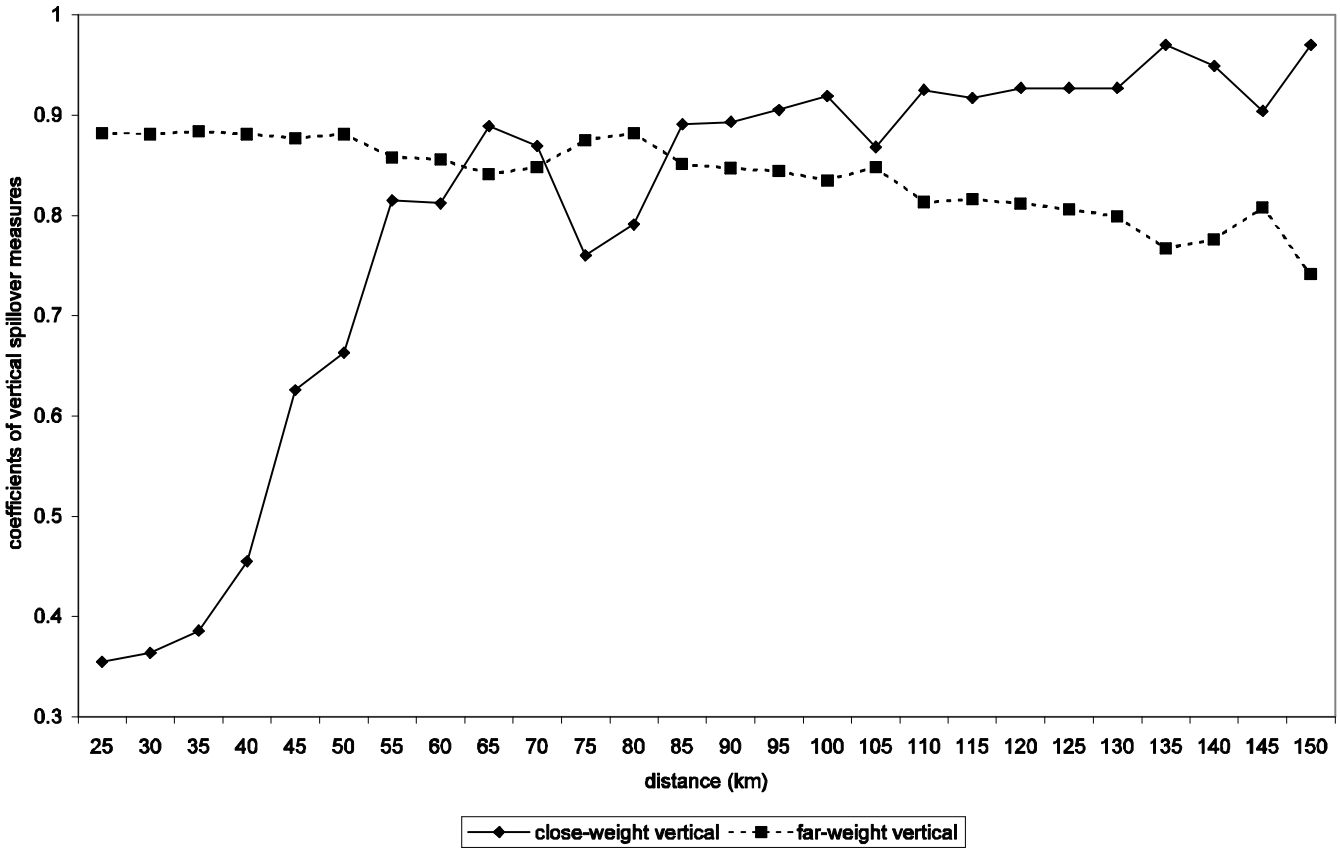


Figure 2. The effect of distance on vertical spillover measures



These results reassure our previous findings on distance-weighted measures. The two main conclusions are (i) distance matters for horizontal spillovers (ii) in short distances, horizontal spillover is more positive than in large distances.

Further robustness checks

We tested extensively the robustness of the main results. First, in all the specifications in Table 1 we tested whether the main conclusions about the role of distance are robust. For this, we re-estimated all specifications twice. First, we included the within- and outside 100 km measures instead of the country-wide measures. The p-values of the equality of the coefficients for the horizontal and vertical measures are reported in the first two rows below the regressions. Second, we included one of the weighted measures (weight: 1/(1+d/100)) besides the unweighted measures. The last two rows report the significance levels of the horizontal and vertical weighted measures, respectively. These tests support our previous findings.

In Appendix 2 and 3 we report a number of further robustness checks. First we test whether serious structural changes in the economy led to any change in our results. For this we include the interaction of the spillover variables and a dummy variable which is 1 after 1997 and 0 otherwise.[12] The results suggest that vertical spillovers have become stronger after 1997. In specifications (3)-(4) we test the very appealing idea that state-owned firms benefit less from foreign presence, including the interaction of the spillover measures and a dummy showing whether the firm was state-owned. The estimates suggest no (economic or statistical) difference between state-owned and privately owned firms.[13]

Our next concern was whether firms with higher 'absorptive capacity' or higher productivity behave differently. For empirical tractability, we estimated the initial TFP of the firms (meaning the TFP in the first year they enter the sample) by OLS. Then we included this variable and its interactions with the spillover variables into the estimating equations. The results suggest that initial productivity of the firms is an important determinant of productivity and spillover. The estimates of the spillover variables are robust to this change. In (7) and (8) we tested whether the results are robust for the inclusion of market concentration, proxied by the Hirschman-Herfindahl

[12] While the choice of 1998 is arbitrary to some extent, this was an election year with important changes in economic policy. Also with this choice the effects of the very important macroeconomic stabilization in 1995 are excluded. It does not affect the results significantly. Only yers near the middle of the period can be used, as the series is not long enough otherwise.

[13] This can be a the consequence of the fact that because of privatisation, only very few firms remained state-owned after the middle of the 1990s. There are about 50-80 firms int he sample after 1997, which are large and relatively productive firms.

index at the NACE-4 level. The interaction of this variable with the spillover measures is insignificant. In the last four specifications we use two different selections of firms characterised as domestic. Changing the threshold does not affect the results.

2.5 Summary and conclusions

This paper contributes to the literature on the productivity externalities of multinationals. For this exercise we use a large firm level panel dataset. First, consistently with previous literature, we find evidence for positive vertical spillovers, but not for positive horizontal spillovers. Second, we address the question, whether distance between foreign and domestic firms plays an important role in determining the magnitude of the spillover effect. The main theoretical motivation for this is the possibility of labour market inflexibilities and the importance of face-to-face communication in technology transfer. For this exercise two strategies are used. First, we construct spillover measures weighted by distance. The significance of the weighted horizontal measure suggests that in the case of horizontal spillover distance matters. The sign of the variables is very intuitive: horizontal spillover is decreasing with distance. We reach similar results by a second approach. Two complementary variables are constructed. The close-weight measures summarize foreign presence within a given distance from the firm, while the far-weight measures summarize foreign presence in distant firms. The coefficients of these two variables are significantly different in the case of horizontal measures, suggesting that the magnitude of horizontal spillover is decreasing with distance.

The theoretical importance of these results is that they provide evidence for the working of different spillover channels. Spillover via labour mobility may play an important role in smaller distances, while competition is the dominant channel in longer distances. The results may affect policy design/evaluation: the geographical distribution of FDI may importantly influence the magnitude of spillover effects.

References

Adams, J. D. and Jaffe, A. B. (1996). 'Bounding the effects of R & D: an investigation using matched firm and establishment data', *RAND Journal of Economics*, 27, pp. 700-721.

Adams, James D. (2002). 'Comparative localization of academic and industrial spillovers', *Journal of Economic Geography*, 2, pp. 253-278.

Aitken, Brian and Harrison, Ann E. (1999). 'Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela', *American Economic Review*, 89, pp. 605-618.

Audretsch, David B. and Feldman, Maryann P. (2004). 'Knowledge Spillovers and the Geography of Innovation', in Henderson, V. and Thisse, J. F. (eds.), *Handbook of Regional and Urban Economics, Volume 4 : Cities and Geography*, Amsterdam, New York: North-Holland.

Barrios, Salvador; Görg, Holger and Strobl, Eric (2005). 'Foreign direct investment, competition and industrial development in the host country', *European Economic Review*, 49, pp. 1761-1789.

Bosco, Maria Giovanna (2001). 'Does FDI contribute to technological spillovers and growth? A panel data analysis of Hungarian firms', *Transnational Corporations*, 10, pp. 43-67.

Breschi, Stefano and Lissoni, Francesco, (2001) "Knowledge Spillovers and Local Innovation Systems: A Critical Survey" . *Industrial and Corporate Change*, Vol. 10, No. 4, pp. 975-1005

Damijan, Joze P; Knell Mark; Majcen, Boris and Rojec, Matija (2003). 'Technology Transfer through FDI in Top-10 Transition Countries: How Important are Direct Effects, horizontal and Vertical Spillovers?', *William Davidson Working Paper Number* 549, William Davidson Institute at University of Michigan Business School, www.bus.umich.edu.

Decressin, Jörg and Fatás, Antonio (1995). 'Regional Labor Market Dynamics in Europe', *European Economic Review*, 39, pp. 1627-1655.

De Mello, Luiz R. jr. (1997). Foreign Direct Investment in Developing Countries and Growth: A Selective Survey. *Journal of Development Studies* 34: 1–34.

Djankov, Simeon and Hoekman, Bernard (2000). 'Foreign Investment and Productivity Growth in Czech Enterprises', *World Bank Economic Review*, 14, 49-64.

Girma, Sourafel; Görg, Holger and Pisu, Mauro (2004). 'The role of exporting and linkages for productivity spillovers from FDI', *GEP Research Paper Series*, no. 04/30, University of Nottingham, www.nottingham.ac.uk.

Girma, Sourafel and Wakelin, Katherine (2002). Trade, Investment, Migration and Labour Markets, in: David Greenaway, Richard Upward and Katherine Wakelin (eds.), *Are there regional spillovers from FDI in the UK?*, Basingstoke, UK: MacMillan.

Görg, Holger and Greenaway, David, 'Much Ado About Nothing? (2004). Do Domestic Firms Really Benefit from Foreign direct Investment?' *World Bank Research Observer*, 19, pp. 171-197.

Görg, Holger and Strobl, Eric (2005). 'Spillover From Foreign Firms Through Worker Mobility: An Empirical Investigation', *Scandinavian Journal of Economics*, 74, pp. 215-237

Jacobs, J. (1969). *The Economy of Cities*, New York: Random House.

Jaffe, Adam B, Trajtenberg, Manuel and Henderson, Rebecca (1993). 'Geographic localization of knowledge spillovers as evidenced by patent citations', *Quarterly Journal of Economics*, 108, pp. 577-598.

Javorcik, Beata Smarzynska (2004). 'Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages', *The American Economic Review*, 94, pp. 605-627.

Levinsohn, J. and Petrin, A. (2003). 'Estimating production functions using inputs to control for unobservables', *Review of Economic Studies*, 70, 317-342.

Markusen, James R. and Venables, Anthony J. (1999). 'Foreign Direct Investment as a catalyst for industrial development', *European Economic Review*, 43, pp. 335-356.

Olley, Steven G. and Pakes, Ariel (1996). 'The Dynamics of Productivity in the Telecommunication Equipment Industry', *Econometrica*, 64, pp. 1263-97.

Pack, Howard and Saggi, Kamal (2001) 'Vertical technology transfer via international outsourcing', *Journal of International Economics*, 65, pp. 389-415.

Rodriguez-Clare, Andres (1996). 'Multinationals, Linkages and Economic Development', *The American Review*, 86, pp. 852-873.

Schoors, Koen and van der Tol, Bartoldus (2002). 'Foreign direct investment spillovers within and between sectors: Evidence from Hungarian data', Working Papers of Faculty of Economics and Business Adminstration, Ghent University, Belgium no. 02/157, Gent University, www.FEB.UGent.be

Sjöholm, Fredrick (1999) 'Technology Gap, Competition and Spillovers from Direct Foreign Investment: Evidence from Establishment Data', *Journal of Development Studies*, 36, pp. 53-73.

Venables, Anthony J. (1996). 'Equilibrium locations of vertically linked industries', *International Economic Review*, 37, pp. 341-359

Appendix

Appendix 1 Sample size

	domestic firms	foreign firms	number of employees<30 (domestic)	number of employees> 200 (domestic)
1996	1,566	655	322	301
1997	1,760	696	379	328
1998	1,880	728	417	336
1999	2,015	776	554	287
2000	2,320	931	759	290
2001	2,241	943	751	279
2002	1,319	788	226	248
2003	2,449	1,197	1,009	223
Total	15,550	6,714	4,417	2,292

Appendix 2 Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)
	Structural break: 1998		*structural break: state-owned firms*		*structual break: initial tfp*	
	FE	LP	FE	LP	FE	LP
Vertical	0.125	0.571	0.830	2.646	0.900	2.579
	(0.189)	(0.489)	(0.094)***	(0.260)***	(0.101)***	(0.270)***
horizontal	-0.060	-0.706	-0.089	-0.365	-0.128	-0.655
	(0.158)	(0.510)	(0.110)	(0.349)	(0.129)	(0.377)*
vertical*(year>1997)	0.209	0.429				
	(0.071)***	(0.167)**				
horizontal*(year>1997)	0.015	0.457				
	(0.103)	(0.329)				
vertical*(state-owned)			-0.000	-0.000		
			(0.000)	(0.000)		
horizontal*(state-owned)			0.000	0.000		
			(0.000)	(0.000)		
vertical*initial tfp					-0.527	0.822
					(0.242)**	(0.639)
horizontal* initial tfp					0.314	1.320
					(0.278)	(0.695)*
initial tfp					0.449	-0.309
					(0.134)***	(0.361)
Observations	15185	15185	15185	15185	15185	15185
Number of id	2987	2987	2987	2987	2987	2987
R-squared	0.35	0.04	0.35	0.04	0.35	0.05
P-value: H_0: vertical within 100 km=horizontal outside 100 km[1]	0.475	0.121	0.613	0.086	0.057	0.993
P-value: H_0: horizontal within 100 km=horizontal outside 100 km[1]	0.003	0.021	0.002	0.018	0.006	0.116
P-value: H_0: weighted vertical=0[2]	0.405	0.711	0.505	0.577	0.956	0.297
P-value: H_0: weighted horizontal=0[2]	0.077	0.000	0.045	0.000	0.225	0.003

Robust standard errors in parentheses. Firm and year fixed effects are included.

FE: fixed effects, LP: two-step Levinsohn-Petrin estimator.

* significant at 10%; ** significant at 5%; *** significant at 1%

[1] these values are calculated by decomposing the vertical and horizontal measures into within- and outside measures in the specifications above, and testing the equality of the coefficients

[2] These values are calculated by including the weighted vertical and horizontal measures (weight: weight: 1/(1+d/100)) into the regressions above

Appendix 3 Further robustness checks

	(7)	(8)	(9)	(10)	(11)	(12)
	structural break: concentration		*firms: at least 75% domestic owned*		*firms: 100% domestic owned*	
	FE	LP	FE	LP	FE	LP
Vertical	0.841	2.520	0.872	2.605	0.897	2.646
	(0.109)***	(0.291)***	(0.094)***	(0.258)***	(0.095)***	(0.261)***
Horizontal	-0.153	-1.099	-0.126	-0.517	-0.127	-0.448
	(0.117)	(0.384)***	(0.108)	(0.347)	(0.110)	(0.341)
vertical*hhi	0.000	0.017				
	(0.006)	(0.017)				
horizontal*hhi	0.004	0.002				
	(0.004)	(0.015)				
Hhi	-0.001	-0.010				
	(0.003)	(0.010)				
Observations	15137	15137	14415	14415	14149	14149
Number of id	2987	2987	2896	2896	2862	2862
R-squared	0.35	0.05	0.35	0.04	0.36	0.04
P-value: H_0: vertical within 100 km=horizontal outside 100 km[1]	0.628	0.066	0.236	0.154	0.349	0.192
P-value: H_0: horizontal within 100 km=horizontal outside 100 km[1]	0.003	0.020	0.002	0.027	0.004	0.045
P-value: H_0: weighted vertical=0[2]	0.441	0.597	0.561	0.408	0.785	0.334
P-value: H_0: weighted horizontal=0[2]	0.037	0.000	0.056	0.000	0.061	0.000

Robust standard errors in parentheses. Firm and year fixed effects are included.

FE: fixed effects, LP: two-step Levinsohn-Petrin estimator.

* significant at 10%; ** significant at 5%; *** significant at 1%

[1] these values are calculated by decomposing the vertical and horizontal measures into within- and outside measures in the specifications above, and testing the equalitiy of the coefficients

[2] These values are calculated by including the weighted vertical and horizontal measures (weight: weight: 1/(1+d/100)) into the regressions above

3 The productivity spillover potential of foreign-owned firms: Firm-level evidence for Hungary

Joint with Holger Görg[♦] and Alexander Hijzen[♠]

Abstract

This paper analyses the potential for productivity spillovers from inward foreign direct investment using administrative panel data on firms for Hungary. The productivity spillovers potential (PSP) is expected to be a function of the importance of firm-specific assets (FSA) within multinationals and the extent to which they are transferred to foreign affiliates. We hypothesise that the presence of FSA is related to observable characteristics of the production process of foreign affiliates. We further explore the role of competition in explaining productivity spillovers within industries. First, we show that PSP is importantly related to the production technology of the sectors and foreign affiliates as well. Firms that relocate labour-intensive activities to Hungary to exploit differences in labour costs are unlikely to generate productivity spillovers, while PSP increases in the capital intensity of foreign affiliates. Second, we find that foreign presence tends to affect the productivity of domestic firms negatively whenever MNEs produce for the domestic market.

3.1 Introduction

There seems to be a widely held assumption on the part of policy makers that inward foreign direct investment (FDI) brings benefits over and above the additional investment to the host country. In particular, multinational enterprises (MNEs) are seen as being vehicles for inflow of new technology, which may "spill over" to domestic firms and, hence, foster development and assist catching up in less developed economies. Furthermore, MNEs introduce higher levels of competition in the economy. On the other hand, it is also possible that domestic firms are forced to decrease their production below the minimal efficient scale, which leads to decreasing productivity. Both arguments may be particularly relevant for transition economies

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which, after opening up markets aim at increasing productivity growth and levels of competition in the economy.

The inflow of foreign knowledge may benefit domestic firms as they may learn from multinationals, allowing them to upgrade their own production process and as a result increase productivity. The theoretical argument for why one may expect such "productivity spillovers", as they are usually referred to, from foreign multinationals is straightforward. Given the multinationals' limited knowledge of the local market, and distance from their parent firm, they are generally at a disadvantage compared with local firms in the host country. Hence, multinationals will only be able to locate profitably abroad if they have some sort of offsetting advantage. This takes the form of a "firm specific asset" (FSA), such as superior production technique, know-how or management strategy, which has at least to some extent the characteristics of a public good and enables the firm to locate profitably abroad (Caves, 1996). These FSAs can be transferred at low or zero cost between subsidiaries of the same firm.

The possibility of productivity spillovers arises because multinationals may find it difficult to protect a leakage of an FSA to other firms in the host country. The public good characteristics imply that once the FSA is out on the external market it can be used by other firms as well, due to it being to some extent non-rival and non-excludable. The inability of the multinationals to protect the asset is due to a number of reasons. Firstly, labour may move from multinationals to domestic firms, taking with them some of the knowledge of the FSA. Secondly, domestic firms supplying to or purchasing inputs from multinationals may be exposed to the superior technology used in the foreign firm. Thirdly, domestic firms may be in competition with multinationals on the final product market, hence being able to learn from the foreign competitor. These mechanisms may be particularly important in transition economies, which are likely to have fairly high levels of human capital but lack up to date technology and management practices. The crux however of transition is the introduction of market discipline to domestic firms and this may be the main virtue of foreign entry in a transition context.

However, while foreign competition can be a stimulant for domestic productivity it may also easily lead to the fall of productivity of domestic firms. Strong competition drives down the market shares of domestic firms, consequently they may not be able to enjoy economies of scale; their productivity may decrease. This explanation was suggested by Aitken and Harrison (1999). Also, firms in transition economies used to produce very low quality and

obsolete goods. Competition of foreign firms may force them to produce more up to date products. As these firms are not experienced in the production of these goods, changing their production may also lead to a temporary productivity decrease. It is an important empirical question, whether the positive effects are stronger. It is easily possible, that the relative strength of the above mentioned forces was changing as the transition proceeded, and that firms with different attributes were affected differently.

The aim of the present paper is twofold. First, we attempt to improve our understanding of productivity spillovers potential (PSP) in the industry by looking at the role of FSA in foreign plants. In this paper the proxy for PSP is the technology used by the MNEs. Second, we further explore the role of competition, one of three channels through which productivity spillovers may occur, in explaining productivity spillovers within industries. We analyse the potential of productivity spillovers as well as the role of competition therein using firm-level data for the period 1992-2003 for Hungary. Note that as Hungary is a leading transition economy, during the sample period fundamental changes took place. Because of this, we examine whether the estimates are different in different phases of transition. We will now motivate each of those aims in more detail.

Surprisingly little attention has been paid in the literature to the potential for productivity spillovers based on the importance of FSA of foreign owned affiliates. So far one generally seems to have taken the presence of FSA for granted and assumed that the PSP is simply proportional to the output presence of foreign-owned firms in the industry.[14] Presumably, this is due to the idea that FSA are unobservable. In the present paper we hypothesise that i) there exists substantial heterogeneity in the importance of FSA across multinationals generally, and particularly, in the extent to which FSA are transferred to foreign affiliates[15], ii) the heterogeneous role of FSA in foreign affiliates is related to observable characteristics of the production process of foreign affiliates. Indeed, it has been well established in both the theoretical and empirical literature that multinationals are more technologically advanced among a number of observable dimensions. More particularly, we expect that the potential of productivity spillovers increases in the capital intensity of foreign multinationals in the

[14] Some notable recent exceptions are Castellani and Zanfei (2006, Ch. 6) and Sembenelli and Siotis (2005) who show that spillovers depend on the R&D intensity of multinationals, using data for Italy and Spain, repectively. Another related paper is Javorcik and Spatareanu (2003) who show that the magnitude of spillovers differs between wholly-owned and partly-owned foreign investment projects using Romanian data.

[15] In particular, we would expect that the importance of FSA within multinationals and the extent to which they are transferred to foreign affiliates is expected to depend importantly on whether the FDI is of the horizontal or of the vertical type (Markusen, 2002). For FDI of the former type we would expect the role of FSA in foreign affiliates to be much more important.

industry. This approach may shed light on the importance of the different spillover mechanisms, and also lead to important policy lessons about the optimal policy vis-à-vis FDI.

Furthermore, the literature on productivity spillovers in transition economies so far has failed to appropriately disentangle the potential competition effect associated with FDI and the positive productivity effect that may arise when foreign firms fail to effectively protect their FSA. We attempt to decompose the different effects of foreign ownership on productivity by distinguishing between the local presence of MNE and their presence in export markets. The rationale is that we may expect stronger competition effects from domestic market oriented FDI, whereas multinationals that are export oriented may generate positive knowledge spillovers.[16] We also distinguish domestic firms into exporters and non-exporters. The assumption is that the latter are more likely to be in competition with domestic market oriented multinationals. By contrast, the former may avoid such competition. Also, in as far as exporters are generally found to be more technology intensive and productive than non-exporters (e.g., Bernard and Jensen, 1999) we would expect the former to be better able to assimilate the knowledge transferred by multinationals and, hence, may be more likely to benefit from productivity spillovers.

Our results suggest that one should be careful not to exaggerate the positive role of foreign firms in enhancing the productivity of domestic firms in transition economies. We find that productivity spillovers depend on its potential, the degree of competition and absorptive capacity. First, we show that the productivity spillover potential is importantly related to the production technology of foreign affiliates. Firms that relocate labour-intensive activities to Hungary to exploit differences in labour costs are unlikely to generate positive productivity spillovers, while PSP increases in the capital intensity of foreign affiliates. Second, we find that foreign presence tends to affect the productivity of domestic firms negatively whenever they compete in the same market, be it the local or export market. Finally, larger exporting firms appear better able to absorb the PSP in the industry.

The remainder of this paper is structured as follows. In Section 2 we give a brief overview of the evidence on productivity spillovers highlighting also studies that focus explicitly on transition economies. In Section 3 we briefly discuss the data. In Section 4 we set out the econometric methodology. Section 5 presents and discusses the main results. Section 6 analyses the generality of our results by splitting the sample along a number of different dimensions. Finally, Section 7 provides some concluding remarks.

[16] Girma et al. (2005) provide a similar approach using data for the UK.

3.2 Evidence on productivity spillovers

Over the last thirty years, a large body of evidence has been amassed in terms of studies of horizontal productivity spillovers for many developing, transition and developed countries. Much econometric work has been completed that provides, at best, mixed results as to the importance of spillovers. There is some supportive evidence from case studies of spillover benefits to domestic firms (e.g., Moran 2001) although there is, even at that level, disagreement in particular instances.[17] A number of explanations have been offered to explain these mixed results, including methodological differences (Görg and Strobl, 2001) and country characteristics (Lipsey and Sjöholm, 2005). Rather than reviewing all of these papers we focus on a number of particular econometric studies, which can serve to highlight the main arguments.[18]

Aitken and Harrison (1999) use plant level panel data for Venezuela covering the period 1976 to 1989. Estimating an augmented Cobb-Douglas production function and controlling for plant level fixed effects they find some evidence that the presence of foreign multinationals in the same industry has had negative effects on the productivity of domestic firms. They attribute this to a negative competition effect. Domestic firms compete with multinationals on domestic product markets. When multinationals enter, they capture business from domestic firms which due to increasing returns to scale reduces their output and forces them up their average cost curve, reducing productivity. They argue that these effects seem to have more than outweighed any potentially positive productivity spillovers.

By contrast, using data for a developed economy, namely the US, Keller and Yeaple (2003) find that even in a high-income developed country, domestic firms are able to gain in terms of productivity improvements from the presence of foreign multinationals in the same industry. They use firm level panel data for the years 1987 to 1996 and find evidence for substantial horizontal spillovers from multinationals. One of their explanations for such large effects is their measurement of FDI activity in an industry, which is based on the industry classification

[17] For example, Larrain, Lopez-Calva and Rodriguez-Claré (2000) conclude that the location of Intel in Costa Rica has had positive effects on the local economy, Hanson (2000) argues that there is little evidence for spillovers from Intel on domestic firms. Hanson (2000) also argues that the location of Ford and General Motors in Brazil have failed to show the expected spillover benefits.

[18] A more detailed discussion of a long list of spillover studies is provided by Görg and Greenaway (2004).

of the activity of the affiliates' employees, rather than the classification of the affiliate as a whole (by its main line of business).

Turning to the evidence for horizontal productivity spillovers in transition economies a number of studies are worth mentioning. Konings (2001) investigates firm level panel data for Bulgaria, Romania and Poland over the period 1993 to 1997. The data are obtained from the Amadeus database and, hence, includes a sample of large firms. Using a similar approach to Aitken and Harrison (1999) he finds no evidence for positive spillovers from multinationals to domestic plants in any of the countries. Rather, his estimates suggest that in Bulgaria and Romania there are negative effects from the presence of multinationals. Konings, similar to Aitken and Harrison (1999) attributes this to negative competition effects. Djankov and Hoekman (1999) and Zukowska-Gagelmann (2003) come to similar conclusions in their analysis of spillover effects using firm level data for the Czech Republic and Poland, respectively.

Damijan et al. (2003) use firm level data for eight transition countries, Bulgaria, Czech Republic, Estonia, Hungary, Poland, Romania, Slovak Republich and Slovenia. Apart from Estonia and Slovenia, all data are obtained from the Amadeus database. They find some evidence for positive spillovers only for Romania. For other countries, the spillover effect is either statistically insignificant or negative.

The paper by Javorcik (2004) extends the standard approach of searching for horizontal spillovers by developing the idea that spillovers are more likely to occur through vertical relationships, rather than horizontally as has been the predominant view in the literature. Using firm level panel data for Lithuania for 1996 – 2000 she finds evidence consistent with her conjecture. Domestic firms in sector *j* increase their productivity following the establishment of multinationals in industries which are being supplied by *j*. She refers to this as spillovers through backward linkages. While the evidence on such backward linkages is robust to a number of amendments, there is no robust evidence that domestic firms benefit from horizontal spillovers from multinationals.

Studies that focus specifically on Hungary are scarce. Bosco (2001) analyses the direct and spillover effects of foreign ownership for the period 1992-1997. She finds that horizontal spillovers are either insignificant, or negative. The interpretation offered is that the market-stealing effect overwhelms potential technology transfers. Schoors and Van der Tol (2002) look both at intra-industry spillovers ('horizontal') and inter-industry spillovers ('vertical'). The authors find positive evidence of horizontal spillovers, especially in industries

characterised by high levels of foreign competition. They find also evidence of vertical spillovers, but only in the context of backward linkages. However, due to data limitations they are constrained to cross-sectional analysis and are therefore not able to control for time-invariant fixed effects.

3.3 Data

For the analysis of intra-industry productivity spillovers due the presence of foreign multinationals we make use data for Hungary for the period 1992-2003. The Hungarian data comprise approximately 20%-30% of all manufacturing firms which account for about 90% of sales (and 98% of exports). It is officially reported balance sheet data. These data represent a considerable improvement to the data that have been used in previous studies for Hungary both in terms of sample size and data quality, and it is one of the best used for studying spillovers in a transition economy. Foreign ownership is defined as the share of equity held in foreign hands.

Table 1 provides some summary statistics on the main variables of interest used in this study. In general, foreign-owned firms tend to be larger, more capital-intensive and have a higher propensity to export than their domestic counterparts. They also grow more quickly in terms of both size and productivity. These differences are also observed when distinguishing between non-exporting and exporting firms. However, it is worthwhile noting that the differences are to some extent driven by the higher propensity to export of foreign-owned firms. Domestic exporting firms appear to be larger than non-exporting foreign-owned firms. Foreign-owned non-exporting firms dominate their domestic exporting counterparts in terms of capital-intensity and performance measures.

Table 1:

Summary Statistics

	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
	Domestic- owned firms			Foreign-owned firms		
ALL						
Value added	41986	69.29	1065.78	12371	313.40	1877.91
Employment	41986	103.80	371.34	12371	211.75	581.36
Intermediate inputs	41986	140.17	1308.47	12371	1058.48	11954.08
Fixed assets	41986	99.30	2268.67	12371	419.13	2925.70
Exports	41986	67.45	625.20	12371	1083.36	13811.34
%D value added	35486	0.03	0.51	10746	0.12	0.55
DOM						
Value added	14812	14.07	31.64	535	27.79	38.39
Employment	14812	32.65	59.96	535	43.77	54.05
Intermediate inputs	14812	25.51	58.19	535	39.14	60.16
Fixed assets	14812	11.62	37.30	535	48.68	163.03
Exports	14812	0.00	0.00	535	0.00	0.00
%D value added	12165	0.03	0.51	433	0.10	0.63
EXP						
Value added	11203	173.79	2048.55	8466	401.92	2255.56
Employment	11203	228.17	616.97	8466	260.11	685.36
Intermediate inputs	11203	331.80	2345.80	8466	1446.48	14429.12
Fixed assets	11203	284.93	4380.84	8466	540.31	3516.98
Exports	11203	207.12	1127.46	8466	1538.22	16673.72
%D value added	9557	0.04	0.49	7375	0.14	0.54
SW						
Value added	15971	47.19	175.19	3370	136.37	317.95
Employment	15971	82.54	276.01	3370	116.94	202.30
Intermediate inputs	15971	112.09	774.18	3370	245.57	598.22
Fixed assets	15971	50.40	184.93	3370	173.53	475.98
Exports	15971	32.03	341.78	3370	112.67	449.46
%D value added	13764	0.03	0.51	2938	0.10	0.55

Notes: Value added, intermediate inputs, fixed assets are real variables, we use 2000 as the basis year.

3.4 Econometric methodology

To investigate intra-industry productivity spillovers due to the presence of foreign multinationals we assume that the presence of foreign firms in an industry affects total factor productivity of domestic firms in the same industry. This, in line with the literature, can be

represented in the following way using an augmented Cobb-Douglas specification of a production function for firm *i* in industry *j* at time *t*,

$$\ln y_{ijt} = \alpha_o + \sum_{m=1}^{M} \beta_m \ln z_{ijt} + \sum_{f=1}^{F} \gamma_f FPI^{f}{}_{jt} + d_i + d_j + d_t + \varepsilon_{it} \qquad (1)$$

We assume two factors of production *z*: labour (L) and capital (K).[19] y_{ijt} is real value added. Labour is measured by the number of employees and capital by fixed assets. All nominal variables are deflated using an appropriate producer price index. FPI^{f} represents indices of foreign presence. The regression includes a full set of industry and time dummies (*d*). The error term consists of a time-invariant firm specific effect and a remaining white noise error term. The first error component is purged by using a within transformation. The second error component is clustered around industries in order to take account of the fact that our variables of interest are constant within industries (Moulton, 1990). Finally, the regressions are only conducted for domestic firms to prevent any bias in the results due to cherry-picking behaviour by acquiring firms.

In the recent productivity measurement literature the endogeneity of input choices is a central concern. A standard solution to this problem is to use the semi-parametric approach proposed by Levinsohn and Petrin (2003). Based on this methodology, we use a two-step method. In the first step, we estimate the basic un-augmented production function

$$\ln y_{ijt} = \alpha_{ijt} + \sum_{m=1}^{M} \beta_m \ln z_{ijt} + \varepsilon_{it} \qquad (2)$$

separately for every two digit industry using a semi-parametric approach. Then we calculate the total factor productivity for firm *i* as a residual using the estimated coefficients ($\overline{TFP_{ijt}} = \ln y_{ijt} - \sum_{m=1}^{M} \beta_m \ln z_{ijt}$), and use this estimate as the dependent variable in the second step, where we estimate the effect of the different foreign presence indices on the productivity of domestic firms:

$$\overline{TFP_{ijt}} = \alpha_0 + \sum_{f=1}^{F} FPI^{f}{}_{jt} + d_j + d_t + \varepsilon_{it} \qquad (3)$$

[19] In alternative regressions we estimated production functions using output, capital and labour. Results of these estimations are largely similar to those reported below.

Another important concern in the productivity literature is the problem of simultaneity. To correct for this, we also estimate the model with lagged explanatory variables (Aitken and Harrison, 1996) as a robustness check.

The regression is extended with relevant indicators of foreign presence, constructed at the 4-digit level of NACE industry classification. The Foreign Presence Index (*FPI*) is obtained by dividing the sum of turnover produced by multinationals over total turnover in industry *j*.

$$FPI_{jt} = \frac{\sum_{i=1}^{F} y_{ijt}^{f}}{\sum_{i=1}^{N} y_{ijt}} \qquad (4)$$

The overview in the previous section concluded that the evidence on intra-industry spillovers is ambiguous. A potential explanation could be that foreign presence is associated with offsetting effects. In an effort to disentangle the different effects we exploit information on both input and output side of foreign-owned firms: i) we analyse the role of production technology in foreign affiliates to analyse the potential of productivity spillovers, ii) we analyse the role of competition as a channel of productivity spillover. While previous work for a number of developed countries has taken account of the output market orientation of foreign firms no efforts have been made to explicitly analyse the role of PSP based on the production technology of foreign firms.

In order to analyse how and to what extent the PSP of multinationals is related to the production technology in foreign affiliates we add two interaction terms to the FPI index. The first of these variables characterise the average capital intensity of the sector (NACE-2)[20] multiplied by the foreign presence index in the industry (NACE4):

$$CI_{jt}^{ind} = FPI_{jt} \frac{\sum_{i=1}^{N} K_{ijt}}{\sum_{i=1}^{N} L_{ijt}} \qquad (5)$$

Our prediction is that in capital intensive sectors the PSP of multinationals is more important than in labour intensive industries. This higher PSP may facilitate stronger spillovers of technological nature.

[20] To use the average capital intensity at the 4-digit level would be a less exogenous measure, as there are very few firms in some industries.

We have to note, however, that not only the attributes of the sector matter, but also the characteristics of the foreign affiliates are important. It is often mentioned in Hungary, that while the sectoral composition of FDI is favourable, as great amount of FDI arrive into high-tech sectors, the within-sector composition of it is not, because high-tech firms locate only low value added activities into Hungary. To look into this, we also construct a measure, which characterize the composition of FDI relative to industry average.

$$CI_{jt}^{firm} = FPI_{jt}\left(\frac{\sum_{i=1}^{F} K_{ijt}^{f}}{\sum_{i=1}^{F} L_{ijt}^{f}} \Big/ \frac{\sum_{i=1}^{N} K_{ijt}}{\sum_{i=1}^{N} L_{ijt}}\right) \qquad (6)$$

Thus this variable measures the capital intensity of foreign firms in the NACE-4 industry relative to the sectoral average, multiplied by the foreign presence index.

The coefficient on FPI should then be interpreted as the productivity spillover arising from multinationals in that industry had they been using only labour in the production process. The interaction terms show how the spillover effect changes in the average capital intensity of the sector and the multinationals, respectively. These measures thus explicitly take account of the production technology of multinational firms in their foreign plants.

In an effort to disentangle the different effects of foreign presence we may also exploit information on the output or market orientation of foreign-owned firms. For this purpose we construct a measure for foreign presence in the domestic market and one for foreign presence in the export market (Girma et al., 2005). The assumption is that a negative competition effect is strongest from domestic market oriented FDI, while export oriented FDI may be more likely to lead to positive spillovers.

The Foreign Presence Index in the domestic market (FPI^D) is given by

$$FPI_{jt}^{D} = \frac{\sum_{i=1}^{F} y_{ijt}^{f} - x_{ijt}^{f}}{\sum_{i=1}^{N} y_{ijt} - x_{ijt}} \qquad (7)$$

where y is total output and x is total exports at the level of firm *i*. Similarly, the Foreign Presence Index in the export market (FPI^E) is calculated as

$$FPI_{jt}^{F} = \frac{\sum_{i=1}^{F} x_{ijt}^{f}}{\sum_{i=1}^{N} x_{ijt}} \qquad (8)$$

Following Girma et al. (2005) we also explore the role of the export activity of domestic firms in determining spillovers. The rationale for this distinction is the expectation that competition effects are different between these two types of firms and multinationals as exporters are seen to be less likely to be in competition with domestic market oriented FDI and, hence, should be less exposed to a potentially negative competition effect.. Also, export activity of domestic firms can be seen as being an indicator of firms' absorptive capacity, with exporters being expected to be better able to benefit from spillovers due to their being linked into foreign networks through exporting activities. Consequently, we run each specification for non-exporting firms (DOM), permanent exporters (EXP) and firms that switch between exporting and non-exporting (SW) in addition to using the full sample (ALL).

3.5 Results

Table 2 reports the baseline results using the aggregate index of foreign presence across domestic non-exporting, domestic exporting, domestic switching firms. In the upper panel of the table we report the results of estimating equation (1) in its simplest form using a fixed effects estimator, while the middle panel reports estimates using the two-step Levinsohn-Petrin (2003) technique (equations 2 and 3).

The two estimators yield very similar results. The estimates suggest that horizontal productivity spillovers are either insignificant or negative. For never exporting firms the estimated coefficient is statistically significant and negative, which suggests that these firms are least able to adapt to the changing economic conditions; they are not able to benefit from the presence of more advanced technology, but are hurt by foreign competition in their industry. The fact that the foreign presence index is insignificant in the other columns does not necessarily imply that productivity spillovers are not important for these firms. A potential explanation could be that foreign presence is associated with offsetting positive (spillover) and negative (competition) effects.

Table 2:

Basic regression results by export activity

	FIXED EFFECTS			
	ALL	DOM	EXP	SW
K	0.699***	0.672***	0.686***	0.715***
	(0.016)	(0.023)	(0.033)	(0.024)
L	0.176***	0.175***	0.184***	0.173***
	(0.007)	(0.011)	(0.014)	(0.011)
FPI	-0.006	-0.104**	0.032	-0.017
	(0.036)	(0.045)	(0.071)	(0.046)
N	41815	14703	11190	15922
R^2	0.41	0.38	0.40	0.47
	LEVINSOHN-PETRIN			
	ALL	DOM	EXP	SW
FPI	-0.052	-0.156***	0.012	-0.070
	(0.033)	(0.041)	(0.071)	(0.047)
N	41815	14703	11190	15922
R^2	0.02	0.05	0.06	0.03
	LEVINSOHN-PETRIN with lagged explanatory variables			
	ALL	DOM	EXP	SW
FPI	-0.073**	-0.148***	-0.006	-0.072
	(0.036)	(0.046)	(0.064)	(0.051)
N	34527	11770	9397	13360
R^2	0.02	0.05	0.03	0.03

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

The bottom panel reports regressions with lagged explanatory variables in order to alleviate a potential endogeneity problem of the FDI variable. The results show that there are no qualitative changes in the estimates. The only important difference is that the coefficient of lagged FDI is significantly negative in the estimation using all firms, perhaps suggesting that some spillover effects may take time to materialize.[21]

We also analyse whether the spillover effects differ in different phases of transition. To see this, we split the time period into two: between 1992-1997 and 1998-2003. The estimates suggest that exporting firms were able to benefit from spillovers in the earlier period, while in the second period all types of firms were hurt by foreign competition. This finding suggests that in earlier phases of transition strong technology transfer took place between MNEs and the more innovative and dynamic Hungarian firms, while in the later phases competition became more important.

Table 3:

Differences across time

	1992-1997				***1998-2003***			
	ALL	DOM	EXP	SW	ALL	DOM	EXP	SW
FPI	0.049	-0.101	0.195**	-0.029	-0.128***	-0.132***	-0.172**	-0.110
	(0.052)	(0.090)	(0.080)	(0.055)	(0.038)	(0.043)	(0.067)	(0.067)
N	15885	4597	4717	6571	25930	10106	6473	9351
R^2	0.01	0.02	0.10	0.02	0.04	0.07	0.02	0.04

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

In an effort to disentangle the different effects we exploit information on the input side of foreign-owned firms to analyse the role of production technology in foreign affiliates in the potential of productivity spillovers. The results are represented in Table 4. The effect for foreign firms is much more positive than for never exporting firms. Once we control for the production technology of foreign firms we find that productivity spillovers are markedly different in different sectors. The more labour intensive the sector is, the lower the PSP of MNEs, and the more negative the spillover effect is. This is true for the whole sample, but the effect seems is only statistically significant for exporting firms. Hence, the impact of foreign

[21] Another robustness check is presented in Appendix A. The concern here is the presence of selection effects. It is easily possible, that foreign investors cherry-pick the best firms, thus the best firms will leave our panel of domestic owned firms. To avoid this, we dropped all firms which were acquired at any point in time by an MNE. This reduces the number of observation by nearly 2000. The main results are robust to this procedure, suggesting that selection is not a serious problem.

presence on the productivity of domestic firms is more positive the higher the capital-intensity of production. In labour intensive sectors technology transfer is less important, and the negative competition effect dominates. This is often hypothesised in the literature, but to the best of our knowledge no direct evidence has been provided to sustain this claim. Interestingly the labour intensity of MNEs relative to sectoral average does not appear to be significant for the whole sample. The technology used in the sector is the main determinant of the magnitude of spillover effects.

Table 4:

Regression results by labour intensity of MNEs

	ALL	DOM	EXP	SW
FPI	0.007	-0.105*	0.119	-0.048
	(0.044)	(0.057)	(0.101)	(0.054)
*FPI*labour intensity of sector*	-0.152***	-0.049	-0.302***	-0.063
	(0.049)	(0.088)	(0.090)	(0.057)
*FPI*labour intensity of MNEs relative to sector mean*	-0.012	-0.048	0.013	-0.020
	(0.026)	(0.032)	(0.035)	(0.036)
N	40166	14261	10652	15253
R^2	0.02	0.05	0.05	0.03

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

In Tables 5 and 6 we analyse the role of production technology in some more detail.[22] Table 5 splits the sample according to observations for the earlier and latter years of transition. We find that in the earlier phase of transition the production technology of the sector was only important for exporting firms, and not for others. In this earlier period foreign presence affected exporting and non-exporting firms significantly differently. This result corraborates our previous finding: in the earlier period, exporting firms were able to learn from MNEs, but only in capital-intensive sectors, where the PSP of MNEs was more important. In the second sub-period the FPI on its own is statistically insignificant for all types of firms. However firms in more capital intensive sectors benefit from the presence of MNEs. In this sub-period, not only is the nature of the sector important, but also the production technology of entering MNEs, as indicated by the coefficients on the second interaction term. Firms that relocate labour-intensive activities to Hungary to exploit differences in labour costs are unlikely to

[22] Our main conclusions are also robust to using lagged explanatory variables; see Appendix B.

generate technology spillovers, while at the same time they are expected to intensify competition for domestic firms and bid up wages in local labour markets.

Table 5:

Regression results for different periods

	1992-1997				*1998-2003*			
	ALL	DOM	EXP	SW	ALL	DOM	EXP	SW
FPI	0.090	-0.093	0.322***	-0.014	-0.031	-0.010	-0.051	-0.040
	(0.066)	(0.109)	(0.099)	(0.080)	(0.052)	(0.065)	(0.075)	(0.079)
*FPI*labour intensity of sector*	-0.067	0.043	-0.336***	0.016	-0.214***	-0.259***	-0.236***	-0.179***
	(0.045)	(0.097)	(0.086)	(0.044)	(0.041)	(0.074)	(0.077)	(0.064)
*FPI*labour intensity of MNEs relative to sector mean*	0.006	-0.029	0.038	-0.006	-0.056**	-0.043	-0.022	-0.087**
	(0.030)	(0.048)	(0.053)	(0.036)	(0.025)	(0.039)	(0.025)	(0.038)
N	15042	4438	4392	6212	25104	9823	6248	9033
R^2	0.01	0.03	0.10	0.01	0.04	0.07	0.03	0.05

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

We also split the sample by firm size in Table 6. This split is motivated by Aitken and Harrison (1999) who suggest that small firms may have lower absorptive capacity and are thus less able to benefit from technology transfer. Small firms are firms that employ less than average number of employees, and large firms employ more than this.[23] While the pattern for small firms is similar to the pattern in the baseline model, in the case of larger firms the sector seems to be less important than the technology of the particular MNEs that enter. This finding suggests that the productivity of smaller firms is mainly determined by industry conditions (thus pecuniary externalities, like product and input prices), while technological externalities may play a more important role in the case of larger firms. These firms may have more resources to copy the technology or product or marketing strategy of a particular MNE, thus the production technology of these firms may affect larger domestic firms more directly. For large exporting firms, we find that the more capital intensive the MNEs are, the more domestic firms can benefit from their presence. Interestingly, for large, non-exporting firms the coefficient of the interaction term is positive and highly significant. The class of large non-exporting manufacturing firms represents a small group of unreformed former communist firms. The number of these firms was decreasing heavily as time, as they either studied how

[23] We also used experienced with other thresholds: the median number of employees and 250 employees. The results were very similar.

to export, or went under. One possible explanation is that these firms were not able to absorb any knowledge from capital-intensive MNEs, only from labour-intensive ones.

To conclude, production technology and thus PSP of MNEs is an important determinant of productivity spillovers. While overall the capital intensity of the sector appears to be more important than the capital intensity of firms, in later stages of transition and especially for large firms the production technology of the MNEs seems to matter. The results suggest that the composition of FDI might be more important, than its sheer size: FDI in capital intensive sectors and of high-tech firms may induce positive spillovers.

Table 6:

Distinguishing small and large firms

	SMALL FIRMS				***LARGE FIRMS***			
	ALL	DOM	EXP	SW	ALL	DOM	EXP	SW
FPI	-0.055	-0.116**	0.029	-0.066	-0.112	-0.139	-0.151	-0.094
	(0.039)	(0.058)	(0.099)	(0.059)	(0.075)	(0.211)	(0.106)	(0.108)
*FPI*labour intensity of sector*	-0.107**	-0.026	-0.262**	-0.075	0.056	-0.386	0.036	0.112
	(0.050)	(0.089)	(0.101)	(0.058)	(0.062)	(0.449)	(0.082)	(0.099)
*FPI*labour intensity of MNEs relative to sector mean*	-0.011	-0.064*	0.022	-0.009	-0.074*	0.382***	-0.095***	-0.085
	(0.025)	(0.033)	(0.032)	(0.035)	(0.044)	(0.141)	(0.036)	(0.094)
N	31910	13476	5837	12597	7373	700	4269	2404
R^2	0.03	0.06	0.07	0.03	0.06	0.24	0.09	0.10

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

In Table 7 we turn our attention to the role of competition in explaining productivity spillovers. For this purpose we decompose our measure of foreign presence into the foreign presence in the domestic and export market. Overall, it appears that foreign presence tends to affect the productivity of all types of domestic firms negatively when foreign firms produce for the domestic market; and there are no spillovers from export platforms. This difference only significant (at 5 percent level), however for the whole sample. These results differ somewhat from previous findings for developed economies such as the UK where domestic exporting firms generally appear to benefit from export-oriented MNEs in their markets. This is usually explained by pointing at the role of knowledge of foreign markets that may spillover to domestic exporters. The difference in the case of Hungary might be explained by the different nature of the products being exported. In developed economies both domestic

firms and affiliates of MNEs export very similar products, while in Hungary it is likely that the exports of domestic firms are markedly different from the exports of MNEs. Most exporting Hungarian manufacturing firms export low value-added homogenous goods, while MNEs mainly export high value-added, highly differentiated goods. This fundamental difference may explain the lack of spillovers from export platforms.

Table 7:

Regression results by export and domestic market orientation MNEs

	ALL	DOM	EXP	SW
FPI^D	-0.151***	-0.080	-0.145	-0.175**
	(0.056)	(0.074)	(0.115)	(0.086)
FPI^X	-0.008	-0.056*	0.002	-0.013
	(0.027)	(0.031)	(0.065)	(0.040)
p-value ($FPI^D = FPI^X$)	0.044	0.789	0.379	0.134
N	41541	14496	11190	15855
R^2	0.02	0.05	0.06	0.03

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

3.6 Concluding remarks

This paper analysed the presence of productivity spillovers from inward foreign direct investment in Hungary. We attempted to improve our understanding of the potential of productivity spillovers in the industry by looking at the role of FSA in foreign plants. Empirically, this was implemented exploiting data on capital intensity of production used by multinationals. Second, we explored the role of competition, one of three channels through which productivity spillovers may occur, in explaining productivity spillovers within industries.

On average we do not find any evidence for positive horizontal productivity spillovers from foreign affiliates to domestic firms. In an effort to decompose any offsetting effects our first aim was to capture PSP in the industry. We show that PSP is importantly related to the average production technology of foreign affiliates in an industry. In labour-intensive sectors, FDI is unlikely to generate productivity spillovers, while at the same time it is expected to intensify competition for domestic firms and bid up wages in local labour markets. However,

PSP increases in the average capital intensity of industries. While the characteristics of the industry seem to be more important than the attributes of multinationals relative to industry average, for large domestic firms the technology of the MNEs seem to be more important than the industry average. This role of capital intensity has often been hypothesised in the literature, but to the best of our knowledge no direct evidence has been provided to sustain this claim.

In order to analyse the role of competition in explaining productivity spillovers we decompose our measure of foreign presence into the foreign presence in the domestic and export market. Overall, it appears that foreign presence tends to affect the productivity of all types of domestic firms negatively when foreign firms produce to the domestic market; and there are no spillovers from export platforms. These results differ somewhat from previous findings for developed economies such as the UK where domestic exporting firms generally appear to benefit from export-oriented MNEs in their markets. The difference in the case of Hungary might be explained by the different nature of the products being exported by domestic firms and MNEs.

This study also presents a number of useful insights for policy-makers. First of all, one should be careful not exaggerate the positive effects of foreign affiliates on the productivity of domestic firms. Second, the potential of productivity spillovers depends importantly on the average production technology of foreign plants in the industry. The majority of all domestic firms operate in industries for which PSP is actually negative. This might provide a rationale for a different policy mix in labour intensive and capital intensive sectors. Alternatively, and perhaps more usefully, one could design policies that target specific types of foreign direct investment. Multinational firms that relocate labour-intensive activities to transition activities are not expected to yield important productivity spillovers, while the negative effect of such moves on existing domestic firms could be substantial.

References

Aitken, B and A.E. Harrison (1999), "Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela?", *American Economic Review*, vol. 89, pp. 605-18.

Bernard, A. and Jensen, J. (1999), Exceptional exporter performance: Cause, effect or both?, *Journal of International Economics*, 47, 1-25.

Bosco, Maria Giovanna (2001), "Does FDI Contribute to Technological Spillovers and Growth? A Panel Data Analysis of Hungarian Firms", *Transnational Corporations*, vol. 10, pp. 43-68.

Castellani, Davide and Antonello Zanfei (2006), *Multinational firms, innovation and productivity*. Edward Elgar: Cheltenham.

Damijan, Joze P., Mark Knell, Boris Majcen and Matija Rojec (2003): The role of FDI, R&D accumulation and trade in transferring technology to transition countries, *Economic Systems*, Vol. 27, pp. 189-204

Djankov, Simeon and Bernard Hoekman (1999), Foreign investment and productivity growth in Czech enterprises, *World Bank Economic Review*, Vol. 14, pp. 49-64.

Girma, Sourafel, Holger Görg and Mauro Pisu (2005), Exporting, linkages and productivity spillovers from foreign direct investment, GEP Research Paper, University of Nottingham

Görg, Holger and David Greenaway (2004), "Much ado about nothing? Do domestic firms really benefit from foreign direct investment?", *World Bank Research Observer*, Vol. 19, pp. 171-197.

Görg, Holger and Eric Strobl (2001): "Multinational Companies and Productivity Spillovers: A Meta-analysis". *Economic Journal*, Vol. 111, pp. F723-F739.

Hanson, Gordon H. (2000): "Should Countries Promote Foreign Direct Investment", mimeo, University of Michigan.

Javorcik, Beata Smarzynska (2004): "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages", *American Economic Review*, Vol. 94, No. 3., pp. 605-627

Javorcik, Beata Smarzynska and Mariana Spatereanu (2008): "To Share or Not To Share: Does Local Participation Matter for Spillovers from Foreign Direct Investment?" *Journal of Development Economics*, Vol. 85, pp. 194-217

Keller, Wolfgang and Stephen Yeaple (2003): "Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States", GEP Research Paper 03/03, University of Nottingham.

Konings, Josef (2001)**, "**The Effects of Foreign Direct Investment on Domestic Firms: Evidence from Firm Level Panel Data in Emerging Economies**",** *Economics of Transition*, Vol. 9, No. 3.

Larrain, Felipe B., Luis F. Lopez-Calva and Andres Rodriguez-Clare (2000), "Intel: A Case Study of Foreign Direct Investment in Central America", Center for International Development Working Paper no. 58, Harvard University.

Lipsey, Robert E. and Fredrik Sjöholm (2005), The impact of inward FDI on host countries: why such different answers?, in Moran, Theodore H., Edward M. Graham and Magnus

Blomström (eds.), *Does Foreign Direct Investment promote development?* Washington DC: Institute for International Economics

Markusen, J.R. (2002) *Multinational firms and the theory of international trade*, MIT Press: Cambridge, MA.

Moulton, B. R (1990). "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Unit", *The Review of Economics and Statistics*, Vol.2(2), pp. 334-38.

Schoors K., and Bartoldus Van der Tol (2002), "Foreign Direct Investment Spillovers within and between Sectors. Evidence from Hungarian Data", Ghent University Working Paper, 2002/157.

Sembenelli A. and G. Siotis (2005), "Foreign Direct Investment, Competitive Pressure and Spillovers. An Empirical Analysis of Spanish Firm Level Data", CEPR Discussion Paper

Zukowska-Gagelmann, Katarzyna (2001): Productivity spillovers from foreign direct investment in Poland, *Economic Systems*, Vol. 25

Appendix

Appendix A: Results on always domestic firms

	BASELINE MODEL			
	ALL	DOM	EXP	SW
FPI	-0.045	-0.135***	-0.001	-0.041
	(0.035)	(0.043)	(0.081)	(0.048)
N	39598	14465	10065	15068
R^2	0.02	0.05	0.05	0.02
	WITH LABOUR INTENSITY OF MNEs			
	ALL	DOM	EXP	SW
FPI	-0.002	-0.087	0.104	-0.042
	(0.045)	(0.057)	(0.111)	(0.059)
*FPI*labour intensity of sector*	-0.169***	-0.077	-0.362***	-0.070
	(0.050)	(0.084)	(0.094)	(0.058)
*FPI*labour intensity of MNEs relative to sector mean*	0.014	-0.036	0.047	0.008
	(0.022)	(0.033)	(0.030)	(0.034)
N	38089	14029	9611	14449
R^2	0.02	0.06	0.05	0.03

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

Appendix B:

Robustness check with lagged explanatory variables

	LAGGED EXPLANATORY VARIABLES			
	ALL	DOM	EXP	SW
FPI	-0.085**	-0.152***	0.009	-0.088*
	(0.039)	(0.051)	(0.081)	(0.051)
*FPI*labour intensity of sector*	-0.069*	0.013	-0.163**	-0.045
	(0.041)	(0.077)	(0.070)	(0.062)
*FPI*labour intensity of MNEs relative to sector mean*	0.008	-0.016	0.004	0.010
	(0.019)	(0.025)	(0.035)	(0.026)
N	32847	11338	8833	12676
R^2	0.02	0.06	0.03	0.03

Notes: *, **, *** indicate statistically significant at 10%, 5% and 1% respectively. Robust standard errors in parentheses. Regressions include full set of industry, region and time dummies. FPI indices at 4-digit industry. Error terms are clustered around 4-digit industries.

4 Do Vertical Spillovers from FDI Lead to Changes in Markups? Firm-level Evidence from Hungary[24]

Abstract

This study analyses the relationship between foreign presence and price-cost margins of domestic competitors, and the inter-industry effect, e.g. the effect of foreign entry on domestic firms in supplier industries. By controlling for productivity and input demand, I try to distinguish empirically between theoretical explanations. For this exercise a large panel of Hungarian firms is used consisting of data for 1995-2003. Besides fixed effects, I use dynamic panel models to handle the persistence of price-cost margins and the possible endogeneity of explanatory variables. The empirical results show in a robust way that the effect of FDI on domestic competitors is strong and negative. The effect of foreign presence on supplier industries seems to be positive. Productivity change appears to be an important determinant of markup change, but foreign presence remains significant even after controlling for productivity change.

4.1 Introduction

In a number of countries, there are serious concerns about the effects of globalisation in general, and the effects of FDI in particular. An important question in this area is the effect of multinationals on domestic firms. While there is a large literature on the productivity effects of MNEs on host country competitors and suppliers, the effect of FDI on profits or price-cost margins of domestic firms has been addressed only in very few studies. While a couple of papers have analysed the effect of MNEs on price-cost margins of domestic competitors, to the best of my knowledge there is no study addressing the question of foreign firms on host country supplier industries. This question seems to be relevant, however, as studies of productivity spillovers suggest, that vertical spillovers between foreign firms and their suppliers appears to be more important, than horizontal spillovers. Also, models of vertical linkages suggest, that the entry of foreign firms may have an important effect through changes in demand for intermediate products. Another relevant channel can be the greater bargaining power of foreign customers relative to domestic ones.

[24] Applied Economics Quarterly, Vol. 53 No. 2 pp. 197-218

While to take all these effects into account in a theoretical model is beyond the reach of this paper, the empirical relationship between foreign presence in downstream industries and markups in upstream industries can be addressed relatively easily, which is the aim of this study. The main contribution to the literature is that I not only analyse the relationship between foreign presence and price-cost margins of domestic competitors, but also the inter-industry effect, e.g. the effect of foreign entry on domestic firms in suppliers industries. I also discuss the literature which can be related to this question, and try to distinguish empirically between theoretical explanations. Second, to the best of my knowledge this is the first study addressing the relationship between foreign presence and markups in a transition economy at all. This is not only interesting because transition economies may differ from established market economies, but because the great inflows of FDI provide a good opportunity to identify such effects. For this exercise I use a large panel of Hungarian firms, consisting of data for 1995-2003. Third, besides fixed effects, by using dynamic panel models I take into account the persistence of price-cost margins, while without this, the specification tests show that the equations are misspecified. This modelling technique may yield more reliable estimates than static panel models.

There are a number of limitations of this approach. Fist, the proxy used for the markup is calculated by using balance-sheet data on costs, which is a relatively poor proxy of economic costs. Also, the applied procedure does not reflect variations in the quality of goods, which may vary substantially during the transition process. Second, unfortunately some dimensions of the industrial dynamics after the entry of multinationals cannot be addressed by the dataset at hand. For example entry and exit cannot be observed reliably. Also, potential backward vertical integration of multinationals cannot be measured in this dataset. Because of the relatively small sample size I do not measure the determinants of markups of the multinationals separately.

There are three competing descriptions for the effect of foreign firms on their suppliers' price-cost margins. First, if the demand of foreign firms for intermediate goods is different from that of domestic firms, foreign entry may lead to change in the demand for the product of domestic upstream firms. If large fixed costs or economies of scale are present, this effect can lead to a change in the markups of domestic suppliers. If this is the only effect taking place, controlling for the change in input demand should explain most of the action. The second possible explanation is that foreign firms have stronger bargaining power than domestic firm vis-à-vis their suppliers. This may lead to change in the price-cost margins of domestic firms.

Third, productivity spillovers can take place through voluntary or involuntary technology transfer, labour mobility or different incentives provided by foreign firms to their suppliers. Consequently the increased productivity of domestic firms may lead to an increase in their markups, if firms do not have to pass on the productivity gain to consumers in the form of lower prices. If this is the main channel of markup change, however, controlling for productivity should explain markup changes.

The empirical results show in a robust way that the effect of FDI on domestic competitors is strong and negative. The effect of foreign presence on supplier industries seems to be positive. Productivity change appears to be an important determinant of markup change, but foreign presence remains significant even after controlling for productivity change. Demand for intermediate goods seems to be a less important determinant of price-cost margins.

The remaining part of this paper is structured in the following way. Section 2 discusses the theoretical underpinnings of the relationship between foreign entry and changes in markups of domestic firms, with an emphasis on the key variables and main empirical predictions. Section 3 shows that markup change related to foreign presence may cause problems for productivity estimation. Section 4 reviews the empirical results in this area, and also in the closely related area of productivity spillovers from FDI. Section 5 describes the dataset and the variables used for the estimation. Section 6 discusses the results, and Section 7 concludes.

4.2 Theory

In this chapter the most important theoretical models concerning the relationship between foreign presence and price-cost margins will be discussed.

Standard Industrial Organisation Modelling of Horizontal Effects

Standard industrial organisation models provide a natural point of departure in analysing the horizontal competitive effects of FDI. For the vertical effects, however, one has to model more than one industry, to which I turn in the next subsection.

These models refer to situations, in which an MNE is already exporting to the host market, and FDI means that this foreign firm makes a greenfield investment or acquires an already existing firm. The main results of this approach are summarized by Maioli et al. (2006). These authors argue that one has to distinguish sharply between greenfield investment and acquisition. In the former case the foreign firm can sell its product in the host country without

paying the transportation cost, but the number of competitors remains unchanged. Because of this, competition intensifies: the MNE increases its quantity in the case of Cournot-competition and lower its price under Bertrand competition. Consequently, prices fall, which leads to a decrease in the price-cost margins of domestic firms.

The situation is completely different if the MNE enters by acquiring an already operating firm. In this case two firms practically merge. The literature on horizontal merger (e.g. Salant et al., 1983; Deneckere and Davidson, 1985) argues that in this case the MNE becomes less aggressive, and asks a higher price. Because of this the residual demand of competitors shifts outside, thus they can benefit from the foreign entry. This statement is fairly general, but it is not true in all oligopolistic models.

These results suggest that foreign entry may have very different horizontal effect depending on its form. Maioli et al. (2006) also shows that this distinction is important empirically as well: greenfield FDI has a discipline effect on price-cost margins, whilst non-greenfield investment increases margins.

Vertical Linkages Modelling

While standard IO models deal with the horizontal effects of FDI, vertical linkages models provide a rationale for inter-industry effects. These models, however, not only improve our understanding of the vertical effect, but they are also important in analysing the horizontal effect, because the entry of foreign firms has not only direct (i.e. competition) effect, but also indirect horizontal effects through factor prices. In these models, an upstream and a downstream industry are modelled, and the multinational enters the downstream (final good) industry.

Markusen and Venables (1999) model this situation in a compact way by assuming monopolistic competition in both industries. Consider first the vertical effect. The entry of the multinational affects suppliers through two channels. First, there is a competition effect. As multinationals compete with domestic firms in the downstream sector the demand of the domestic firms for the intermediate product decreases. Second, the presence of multinational firms creates a demand effect, which means that they create their own demand for the product of the upstream industry. The question is: which one of these effects is stronger? The stronger the demand effect compared to the competition effect, the better the situation for the upstream firms. This mainly depends on the degree of backward linkage. If the multinationals use a sufficient quantity of intermediate inputs relative to local firms, the demand effect can

outweigh the competition effect. In this case the price-cost margin of domestic suppliers may increase; otherwise it should decrease. This leads to the prediction that the input coefficient should affect positively suppliers' price-cost margins.

The horizontal effect of foreign entry also takes place through two channels. First, the direct effect is the competition effect, which is the same as that analysed in the previous subsection. Vertical linkages models, however, take into consideration the effect through factor prices as well. If the vertical effect is such, that intermediate good prices fall, domestic downstream firms are able to buy inputs cheaper, thus the indirect effect on competitors' price-cost margins is positive. On the other hand, if the price of the intermediate good increases, the indirect effect is negative. The total effect is the sum of the direct and indirect effects. While the sign of the total effect is ambiguous, one can formulate a prediction regarding the effect of input coefficient. The greater the input demand, the higher the input price is, thus the lower the competitors' profit is.

The role of backward linkages is also emphasised in Rodriguez-Clare (1996), who shows how multinationals benefit the host country if their linkage coefficient is higher than that of the domestic firms. The linkage coefficient is defined as the value of inputs bought by the multinational divided by the number of workers. It is also shown that the linkage effect depends on the distance between the two countries, and their relative level of development, and the complexity of production.

These questions are further analysed in Barrios et al. (2005). Using a simple theoretical model, they demonstrate a U-shaped relationship between foreign presence and the number of domestic firms present. The competition effect, which dominates when foreign presence is small, gives way to positive externalities as foreign presence increases. Their theoretical prediction is tested empirically for a sample of firms in Ireland.

All in all, in vertical linkages models the differencia of foreign firms is that their input coefficient is different from that of foreign firms. The vertical effect of foreign entry depends mainly on changes in input demand: if it increases after foreign entry, suppliers benefit; otherwise their price-cost margins should decrease. Unfortunately these models do not lead to an unambiguous prediction about the horizontal or vertical effect of foreign presence. They suggest however that demand for intermediate goods should play a key role in determining the empirical effect of foreign entry on price-cost margins, and the theory also predicts what its sign should be. Thus in the empirical part of the paper I will add this variable to the model as well to test if it is significant and if it has the predicted sign.

Bargaining Power

A common concern regarding MNEs is that their bargaining power is very strong vis-à-vis small domestic suppliers. While bargaining power is not important in perfectly competitive markets, the relationship between multinationals and suppliers is far from this abstract vertical relationship. One of the authors who studied the complexity of these relationships was Moran (2001), who has shown plenty of examples that these relationships not only include selling of goods, but also personal relationship, training and technology transfer. Also, one can find plenty of evidence for this in the management literature (e.g. Gadde and Snehota, 2000; Kotabe et al. 2003). In such long-term relationship, the bargaining power of the parties may have a serious effect on the distribution of the rents.

A widely held belief is that bargaining power of MNEs is greater than that of domestic firms; not only because the size of multinationals relative to domestic downstream firms, but also their better outside options. MNEs have long lasting relationships with suppliers in foreign countries, or possibly they even own upstream firms in other countries. Because of these well-established links, they can easily (with a low transaction cost) turn to these alternative suppliers. Consequently MNEs are in a great advantage compared to domestic firms when bargaining with local upstream firms.

On the other hand it is also possible that domestic firms have an information advantage vis-à-vis multinationals, as they know the firms operating in the given economy better. Also managers of domestic firms may have closer personal relationships with workers or managers of competitors or suppliers. If domestic downstream firms are able to use this information advantage effectively in the bargaining process with suppliers, it is possible that domestic firms are able to reach better deals with suppliers than the MNEs.

All in all, there are several arguments for the case that the bargaining power of domestic and foreign owned firms vis-à-vis suppliers is different. While the sign of the difference is not clear from the theoretical considerations, one suspects that the advantages of foreign firms are greater than the information advantage of domestic firms. One can find this argument even more convincing, if one takes into account the fact that the information asymmetry between domestic and foreign downstream firms decreases as time goes by. Thus one can argue that

the presence of bargaining power differences may lead to a decrease in domestic suppliers' profits when foreign presence increases in downstream industries.

Spillover Effects

There is a large literature concerning productivity spillovers from foreign to domestic firms, which is surveyed by Görg and Greenaway (2004). This survey argues that few results show a productivity increase benefit to firms from foreign presence in the same industry (horizontal productivity spillover). Recent research (e.g. Javorcik, 2004) suggests, however, that suppliers within an industry can benefit if the buyers of their products are foreign-owned (vertical productivity spillover). Javorcik (2004) argues that the most important channels of backward productivity spillover are (i) direct knowledge transfer (ii) higher requirement for product quality and on-time delivery introduced by multinationals and (iii) the fact that multinational entry can increase demand for intermediate goods. The third channel was already discussed in section 2.2 but one has to keep in mind, that vertical linkages affect productivity and markups simultaneously. The first two channels are of direct relevance here: strong positive vertical spillovers may increase the markups of domestic suppliers. The relationship between the productivity change and markups is a complex one: it is a function of upstream and downstream market structure, relative bargaining power of suppliers and purchasers, the nature of technology transferred etc.[25]

The complex simultaneous relationship of market power and productivity spillover suggests that modelling this problem is very difficult. However a very important empirical question is if foreign firms only affect domestic suppliers' markups by productivity spillover, or the other channels mentioned in the previous subsections are also relevant. In this paper I use as simple method to test for this.[26] If only productivity spillovers matter, then the effect of foreign firms takes place only indirectly through productivity change. Consequently, if one controls for productivity change besides foreign presence when explaining price-cost margins, and both are significant, then the presence of foreign firms may affect domestic firms not only through productivity spillovers. If the effect of foreign presence, on the other hand, is insignificant when productivity change is included besides foreign presence, then the main channel of markup change is productivity spillover.

[25] One example for this complex relationship is Pack and Saggi (2001).
[26] While I correct for the endogeneity of productivity change by using dynamic panel models, the simple linear specification may be too simplistic to reflect the complex interrelationship between markups and productivity. The database at hand, however does not allow for a more sophisticated estimation procedure.

To conclude this section, the Table 1 summarizes the predicted empirical effect of different variables on price-cost margins.

Table 1: The Predicted Effect of Key variables in Different Models

	Foreign presence impact on competitors	Foreign presence impact on upstream industries	Other key variables
Standard IO model	Acquisition: + Greenfield: -		Concentration
Vertical linkages	?	?	Input demand
Bargaining power	0	-	
Spillovers	0 / -	+	Productivity

4.3 The potential empirical relevance of markup change in spillover estimation

An important empirical motivation for studying the relationship between foreign presence and markups is the possibility of biased spillover estimates when competition is imperfect. If foreign entry affects markups of domestic firms, then this effect will appear in the estimates of TFP-change, leading to biased spillover estimates. This reasoning suggests that if foreign entry affects both markups and productivity of domestic firms, both effects should be taken into account. In this respect, Chapter 4 provides both theoretical arguments and empirical evidence for the relevance of this problem, showing that foreign presence is related to markups of both competitors and suppliers.

To show the potential biass in spillover estimates formally, consider the usual regression framework to estimate spillover effects (e.g. Görg and Greenaway, 2004). It is assumed that the spillover measures affect the TFP of domestic firms: $TFP(Spill_{it}, D_{it})$. Thus a production function is estimated:

$$\begin{aligned} \ln y_{it} &= \alpha_k \ln k_{it} + \alpha_l \ln l_{it} + \alpha_s Spill_{it} + \alpha_d D_{it} + \eta_i + \varepsilon_{it} = \\ &= \alpha_k \ln k_{it} + \alpha_l \ln l_{it} + TFP(Spill_{it}, D_{it}) \end{aligned}, \qquad (1)$$

where y_{it} is added value, k_{it} is capital, l_{it} is labour input, $Spill_{it}$ denotes the foreign presence variables, D_{it} is a set of dummy and other relevant variables, η_i is firm fixed effect and ε_{it} is

the ideosyncratric shock. To get rid of firm fixed effects and to solve potential endogeneity problems, the production function is estimated after differentiation (or fixed effects transformation):

$$d\ln y_{it} = \alpha_k d\ln k_{it} + \alpha_l d\ln l_{it} + \alpha_s dSpill_{it} + \alpha_d dD_{it\,i} + d\varepsilon_{it} = \\ = \alpha_k d\ln k_{it} + \alpha_l d\ln l_{it} + Solow\_residual(D_{it}, Spill_{it}) \quad (2)$$

α_s is interpreted as the effect of foreign presence on the productivity of domestic firms, thus the spillover effect.

However, in the case of imperfect competition the Solow-residual cannot be interpreted as the measure of technological change, as Hall (1988) argues. Consider a firm with a linear homogenous production function: $F(L_t, K_t)E_t$, where E_t shows the productive efficiency. If there is imperfect competition, the Solow residual can be decomposed in the following way:

$$SR_t = (d\ln y_t - d\ln k_t) - \alpha_t(d\ln l_t - d\ln k_t) = B(d\ln y_t - d\ln k_t) + (1-B)d\ln e_t \quad (3)$$

where B is the Lerner index. The Solow-residual is the sum of a markup and a technology factor.

If we plug this formula into (2), we get:

$$d\ln y_{it} = \alpha_k d\ln k_{it} + \alpha_l d\ln l_{it} + \alpha_d dD_{it\,i} + B_{it}(d\ln y_{it} - d\ln k_{it}) + (1-B_{it})d\ln e_{it} \quad (4)$$

If foreign presence affects both the markup and the technological facor of domestic firms, both B and $d\ln e_t$ is a function of foreign presence:

$$d\ln y_{it} = \alpha_k d\ln k_{it} + \alpha_l d\ln l_{it} + \alpha_d dD_{it\,i} + B_{it}(Spill_{it})(d\ln y_{it} - d\ln k_{it}) \\ + (1 - B_{it}(Spill_{it}))d\ln e_{it}(Spill_{it}) \quad (5)$$

As an example, we may specify a simple linear functional form for B:

$$B_{it} = \gamma_0 + \gamma_1 Spill_{it}$$

$$d\ln y_{it} = \alpha_k d\ln k_{it} + \alpha_l d\ln l_{it} + \alpha_d dD_{it\,i} + \gamma_0(d\ln y_{it} - d\ln k_{it}) + \\ \gamma_1 Spill_{it} * (d\ln y_{it} - d\ln k_{it}) + (1 - \gamma_0 - \gamma_1 Spill_{it})d\ln e_{it}(Spill_{it}) \quad (6)$$

All the right-hand side variables in (6) can be observed, but this equation cannot be consistently estimated by OLS. Several variables are endogenous: $Spill_{it} * (d\ln y_{it} - d\ln k_{it})$ is correlated with the error term, as the technological change is correlated with the foreign

presence if there is technology transfer. Second, as Hall (1988) argues $(d \ln y_{it} - d \ln k_{it})$ is also positively correlated with the error term.

If we compare (2) and (6), it is clear that a significant α_s in (2) is not necessary a sign of a relationship between the productivity of a firm and foreign presence, but it can show that there is some relationship between the markup of domestic firms and foreign presence. If e_{it} is independent from foreign presence, but γ_1 is not zero, then the estimated α_s can also be different from zero. This means that the usual approach in the literature leads to biased and inconsistent spillover estimates if the presence of foreign firms is correlated with the markup of domestic firms. It is easily possible, that foreign presence has a negative effect on markups but a positive effect on productivity. In this case the estimated horizontal spillover effect can be anything: negative, positive or insignificant.

Another important point is that this fact does not depend on the direction of causation: if there is correlation between these variables, the problem can appear. The second remark is that this cannot be solved by controlling with different variables (like industry dummies) for markup in (5); the interaction of spillovers and markups should be taken into account in empirical work.

All in all, this chapter provides evidence for the empirical importance of this problem. These results may motivate future research on the relationship of imperfect competition and spillover estimation.

4.4 Review of the Empirical Literature

FDI and Markups

While there is a large literature investigating the effect of import competition on markups, which is surveyed by Tybout (2001), there are only a few papers on the effect of FDI on markups. These papers all focus on the horizontal effects; to my knowledge there is no paper analysing vertical effects.

Chung (2001) considers industry-level data for the United States, and finds that inward FDI has a negative effect on markups. The dependent variable is estimated using the Hall (1988) method. He emphasizes the heterogeneity of FDI, arguing that different strategy is optimal for 'good' and 'bad' foreign firms. In his model of endogenous location choice, bad firms are

more willing to locate near domestic firms than good firms. The empirical results show that price-cost margins fall even more when foreign investments locate further away from domestic firms, which is in line with the endogenous location choice model.

Co (2001) also uses industry-level data for the U.S. She distinguishes between greenfield and non-greenfield FDI. Her results, in a clear contrast to Chung (2001), show that both kinds of FDI increase markups of domestic firms. However, this is only true for industries, which are competitive enough: after some critical value of concentration, the effect of FDI becomes negative.

While the mentioned studies use industry-level data, with firm-level data one can handle the heterogeneity of firms more effectively. Sembenelli and Siotis (2002) use a panel of Spanish firms. They do not distinguish between greenfield and acquisition FDI. They find, that for R&D intensive industries FDI increases margins of domestic firms, but this is not true in the case of non-R&D intensive sectors. Maioli et al. (2006) use even more disaggregated, plant-level data from the United Kingdom. Their dataset allows the authors to distinguish between greenfield and non-greenfield FDI. Their results are in line with the predictions from the simple IO model: greenfield FDI decreases, while non-greenfield FDI increases the price-cost margins of domestic firms.

This study contributes to this literature in three ways. First, this is the first study analysing the effect of FDI on markups of domestic firms in a transition economy. Second, previous studies analyse the horizontal effect of FDI only, while I also include the foreign presence in downstream industries. In this respect, I also try to distinguish between different channels. Third, by testing formally for the autocorrelation of residuals in static panel models, I show that markups are persistent phenomena, thus dynamic panel models are more adequate to model markups empirically.

Empirical Results on Spillovers

From the theoretical part it should be clear, that productivity spillovers may play an important role in determining the effect of foreign firm on the markups of domestic suppliers. Here I briefly review the main results of this literature, with an emphasis on vertical linkages and transition economies.

I follow the literature when defining the spillover measures (see for example Javorcik, 2004). First, one can define horizontal spillover as the extent of foreign presence (in terms of foreign

equity participation) in industry j at year t weighted by each firm's share in the output of the given sector:

$$\text{Horizontal}_{jt} = \frac{\sum_{i\_for\_all\_i \in j} FS_{it} * Y_{it}}{\sum_{i\_for\_all\_i \in j} Y_{it}} \quad (1)$$

where Y_{ijt} is turnover and FS_{ijt} is the foreign equity share. In this paper, industry means NACE-2 sectors, as the input-output tables are only available at this level of aggregation.

Similarly, one can define the backward spillover as the weighted average of foreign presence in the industries supplied by the industry the firm belongs to (excluding the firm's industry):

$$Backward_{jt} = \sum_{k\_if\_k \neq j} \alpha_{jk} Horizontal_{kt} \quad (2)$$

where α_{jk} is the proportion of sector j's output supplied to sector k using the input-output matrix. For this measure, I use the 1998 input-output tables[27] published by the Hungarian Central Statistical Office. The weights are calculated excluding products supplied for final consumption and imports of intermediate goods. Inputs supplied within the two-digit sector are excluded, as they are already included in the horizontal measure. The greater the foreign presence in the supplied industry, and the larger the share of intermediaries supplied to industries with higher foreign presence, the larger this variable is.

Similarly, the forward measure reflects foreign equity share in upstream industries:

$$\text{Forward}_{jt} = \sum_{k\_if\_k \neq j} \alpha_{kj} \text{Horizontal}_{kt} . \quad (3)$$

These variables represent the share of foreign companies in output, which could generate externalities.

An important application is the study by Aitken and Harrison (1999). The authors use Venezuelan panel data to estimate the effect of foreign ownership and the effect of horizontal spillovers. They find that foreign-owned firms are more productive than domestic-owned ones. On the other hand, they find that the greater the foreign presence in an industry, the less productive domestic firms are which is an evidence for negative horizontal spillover effects.

There has been research for spillover effects both in developing and developed countries. The main idea of these papers is very similar, but the earlier studies usually use cross-section data

[27] Because only this input-output table is available, the invariance of it is assumed. As this is a poor proxy of actual transactions, the insignificance of the vertical variables may only reflect the rapid changes in the economy in this respect.

and the later ones panel data. Görg and Greenaway (2004) cogently argue the case for using panel data, citing two reasons. First, panel data permits the development of domestic firms' productivity to be investigated over a longer time period. Second, time-invariant productivity differences among sectors, which can be correlated with productivity, cannot be controlled for with cross section data. It is interesting that most studies using panel data were unable to find evidence for positive horizontal spillovers.

In transition economies, measured horizontal spillovers – if any – are negative. Djankov and Hoekman (2000) use a panel database of Czech firms between 1992 and 1996. Their results suggest that the direct effect of foreign ownership is positive, which shows that foreign owners are more willing to transfer technology to their affiliates. Horizontal spillovers, on the other hand, are negative. Zukowska-Gagelmann (2003) comes to similar conclusions in her analysis of spillover effects using firm level data for Poland. Another important study for a transition economy is Javorcik (2004). The author uses a Lithuanian panel of firms to investigate technology transfer through backward linkages, i.e. vertical spillover. She finds significant backward spillover: 15% higher productivity increase for every one-standard-deviation increase in foreign ownersip. On the other hand the horizontal spillover is not significant.

Literature on Hungary is scarce. Bosco (2001) identifies the direct effect of foreign ownership and estimates the sign and magnitude of horizontal spillover. The results are similar to those found by other authors: horizontal spillover was found insignificant and negative. The interpretation offered is that the market-stealing effect overwhelms potential technology transfers.

The second study on Hungary is Schoors and van der Tol (2002). The key departure from the standard literature is the use of labour productivity instead of total factor productivity. A cross-section methodology is used, because there are only two annual observations. The authors find positive horizontal spillovers, especially in very open manufacturing sectors. They find strong vertical spillovers, but surprisingly, only in the forward direction; backward spillover is negative.

In Halpern and Muraközy (2007) we use the same database as in this study, to analyse horizontal and vertical productivity spillovers, and correct for endogeneity of inputs by dynamic panel methods. We find positive vertical spillovers and insignificant or negative horizontal spillovers.

4.5 Empirical Modelling

Data and Variables

The main source of data is an administratively collected dataset ('Tax Office Database') consisting of principal financial and accounting data of Hungarian firms, like balance sheet data, revenues and costs. I decided to consider only firms operating in the manufacturing industries. I use data between 1992 and 2003, permitting the effective use of dynamic panel methods. I use up the first two years as instruments, and one year of observations is lost because of differencing. This time span is very long in a transition economy, where fundamental changes cause structural breaks in the production function and even changes in the marginal effect of the variables. I use year dummies to address some of these issues, and check for structural breaks by estimating for different subsamples.[28]

After all these exclusions, the number of observations used in the estimation process by year is reported in Table 2. In the sys-GMM case firms are only included if at least four observations are available. Because of this, the sample size differs substantially between the two estimation procedures.[29]

Table 2: Number of Observations by Year

Year	Fixed effects	Sys-GMM
1993	596	
1994	993	
1995	1,323	433
1996	1,516	642
1997	1,535	819
1998	1,701	935
1999	1,644	1,026
2000	1,878	1,113
2001	2,177	1,083
2002	1,369	843
2003	1,835	991
Total	16,567	7,885

[28] Another concern is measurement. Since inflation was very high and volatile in the first half of the period, accounting measures of fixed assets are highly unreliable. Unfortunately I could not find any reliable method to solve this problem.

[29] The fixed effects results are very similar if one estimates the model on the sample used for the sys-GMM estimation.

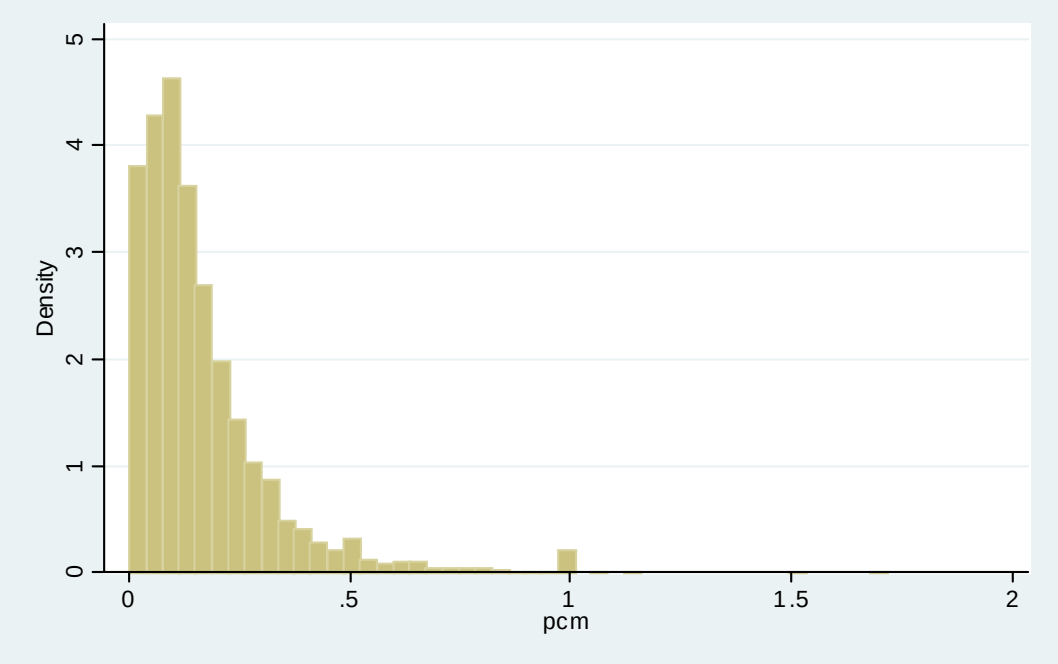
The price-cost margin is calculated as standard in the literature (e.g. Co, 2001; Maioli et al., 2006):

PCM = (value added – payroll)/(value added + cost of intermediate inputs) (3)

There are several advantages and drawbacks of the use of this variable. The main theoretical problem is that the price-cost margin is not a reasonable approximation of the Lerner-index unless one assumes constant unit costs and constant returns to scale (Tybout, 2001). The alternative procedures, however, lead to even more serious problems. The method of Roeger (1995), based on the difference between the primal and the dual Solow-residuals, which was already used in a number of studies (e.g. Konings et al, 2001; Görg and Warzynski, 2003), is not suitable for producing firm-level markups. On the other hand, with such a method, the use of sophisticated panel methods seems to be very problematic. In the absence of firm level price data, the variable proposed in (3) seems to be the most sensible choice.

The distribution of price-cost margins is reported in Figure 1.

Figure 1: The Distribution of Price-cost Margins



This distribution is close to lognormal, while some outliers are also present. The evolution of this variable shows, that in most of the industries the markup is more or less stable. There are some industries, however, in which great fluctuation took place (because of government

intervention) in the studied period, e.g. tobacco and petrol. Because of this, I have excluded these industries from the estimation.

The main variables are the horizontal and vertical measures of foreign presence, which are defined as in equations (1) to (3). Some summary statistics about the importance of vertical linkages can be found in table 3. The ratio of intermediate inputs and turnover is similar for domestic and foreign owned firms, but slightly higher for domestic firms. This ratio was between 0.54 and 0.66 in the studied period, and it was increasing for both categories of firms. From a slightly different sample of firms about one can infer summary statistics about importing. Importing is more important for foreign firms, which import roughly a third of their intermediate inputs. These figures show that multinationals spent about the 40% of their total turnover on intermediate goods at the domestic market in the period under study.

Table 3. The Importance of Backward Linkages

	Intermediate inputs/turnover		***import/intermediate inputs***	
year	***domestic***	***foreign***	***domestic***	***Foreign***
1992	0.542	0.541	0.103	0.312
1993	0.548	0.537	0.125	0.282
1994	0.564	0.540	0.130	0.307
1995	0.582	0.548	0.140	0.288
1996	0.587	0.544	0.137	0.295
1997	0.589	0.539	0.139	0.319
1998	0.589	0.549	0.159	0.370
1999	0.592	0.541	0.152	0.361
2000	0.603	0.559	0.164	0.366
2001	0.661	0.645	0.150	0.344
2002	0.659	0.635	0.154	0.346
2003	0.660	0.637	0.161	0.372

In addition to the backward and horizontal measures, I also include the forward measure, which is a proxy of foreign presence in upstream industries. As foreign firms may produce higher quality goods, the expected sign of this variable is positive.

As it should be clear from the theoretical discussion of spillovers, it is possible, that productivity change is an important determinant of markups. In order to disentangle the direct effect of foreign presence from its indirect effect through productivity I use two measures of productivity. First I include *labour productivity* in the estimating equation. While labour productivity is less sensible than total factor productivity from the theoretical point of view it

is much easier to calculate. Also, as I control for capital intensity as well, the difference between the two measures should not be that important. Because of the theoretical problems with labour productivity, I also use *TFP* in some of the specifications. The TFP is estimated in the sample of all firms, assuming firm fixed effects, using NACE-4 level price levels for deflating capital and added value.

As it was mentioned, vertical linkages models predict that an important determinant of domestic firms' price-cost margin may be demand for intermediate goods. To analyse this, I have generated two variables. First, *horizontal input* is a NACE-2 variable, measuring the real input demand of the given industry. Thus the variable is:

$$Horizontal\_input_{jt} = \sum_{i \in j} mat_{it} / p_{jt} ,$$

Where j denotes (NACE-2) industries, i denotes firms, mat_{it} is the materials purchased by firm i in period t, and p_{jt} is an industry-level deflator in period t[30]. This variable should proxy the indirect effect on competitors through factor prices in the model of Markusen and Venables (1999).

Backward input is the demand for the given industries product by other manufacturing firms. This variable is constructed very similarly to the backward foreign presence measure:

$$Backward\_input = \sum_{k\_if\_k \neq j} \alpha_{jk} Horizontal\_input_{kt}$$

where α_{jk} is the proportion of sector j's output supplied to sector k using the input-output matrix. Of course, because the input-output matrix is only available at NACE-2 level of aggregation, *backward input* is also a NACE-2 level variable. During the estimation, the logarithm of these variables is used. These measures are very weak proxies indeed, because the weights are unchanged as only one input-output matrix is available (for 1998).

The control variables are very similar to those used in Maioli et al. (2006), in which paper the motivation for the inclusion of these variables is discussed in more detail. First, I include the *Herfindahl*-index of the NACE-4 industry to control for concentration. *Import penetration* measures the percentage of imports from total sales in the NACE-4 industry, thus it proxies import pressure. My a priori expectation is that import pressure should reduce markups, but

[30] Unfortunately the deflator for intermediate inputs is not available at the industry level, consequently the final goods price index was used.

the empirical evidence on this topic is mixed (see Tybout, 2001, for a survey). *Capital-output ratio* is real tangible assets divided by real gross output. This variable should be included, because the price-cost margin refers to fixed costs as well, and this variable corrects for it. I also include *firm size* in the estimating equation, which is the logarithm of number of employees. This variable is an alternative measure of market power and corrects to some extent for nonconstant returns to scale.

Table 4 reports the summary statistics of the variables, for the observations used in the estimation procedure.

Table 4: Summary Statistics[31]

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*	*Expected sign*	*Level of aggregation*
Horzontal	16,567	0.271	0.104	0	0.711	Table 1	NACE-2
Backward	16,567	0.248	0.035	0.156	0.365	Table 1	NACE-2
Forward	16,567	0.502	0.121	0.041	0.734	+	NACE-2
Herfindahl-index	16,567	0.123	0.153	0.006	1	+	NACE-4
Market share	16,567	0.052	0.125	1.84E-05	1	+	Firm
Import penetration	16,567	0	0.236	0	0.990	-	Firm
Capital-output ratio	16,567	0	0.347	0	9.333	+	Firm
log(employees)	16,567	4.547	1.186	0	9.522	-	Firm
Labour productivity (billion HUF)	16,564	0.00003	0.0001	4.67E-07	0.007	+	NACE-4
TFP	16,560	0.00036	0.452	-1.892	2.870	+	NACE-2
log(Backward input, million HUF)	16,567	11.659	0.623	9.681	12.940	-	NACE-2
log(Horizontal input, million HUF)	16,567	8.654	1.246	0.602	13.885	+	NACE-2

Estimation Strategy

A simple and relatively robust way for estimation is the fixed-effect estimator.[32] However there are two key problems, which are not addressed by the fixed effects estimator. First most of the explanatory variables of price-cost margins are endogenous, as productivity/profit shocks or unobserved heterogeneity may affect firm size, technology choice, and entry or exit decisions (on theory, see Hoppenhayn, 1992, Erikson and Pakes, 1995, Melitz, 2003). Because of this, one has to find suitable instruments for these variables.

[31] Nominal variables are deflated using 1992 prices.
[32] The Hausman-test rejects the null that random effects estimation is appropriate.

The second main concern is the persistence of margins. Previous empirical literature has shown that both productivity and prices seem to be highly persistent (for some of these issues, see Bartelsman and Doms, 2000; Foster et al. 2005). Because these variables might be important determinants of price-cost margins, one can also expect that margins are also highly persistent. The testing is possible. First, residual autocorrelation tests in static panel models of the main equation show strong, positive and significant autocorrelation. Second, the included lagged dependent variable in the dynamic panel models estimated had always a positive coefficient exceeding 0.5, and it is highly significant. Arellano and Bond (1991) and Blundell and Bond (1999) show, that in this case the omission of the lagged dependent variable from the estimation procedure may lead to biased and inconsistent estimates. Consequently I use the sys-GMM method proposed by Blundell and Bond (1999).

The empirical model is the following:

$$PCM_{it} = \beta X_{it} + (\eta_i + \nu_{it} + m_{it}), \qquad (4)$$

where PCM_{it} is the price-cost margin of firms i in period t, X_{it} denotes the variables of interest, and the error component. There are three error components: η_i is the firm-specific effect, ν_{it} is the firm-level (possibly autocorrelated) productivity shock, and m_{it} is the uncorrelated firm-level shock. The error components have the following properties:

$$\nu_{it} = \rho \nu_{i,t-1} + e_{it}$$
$$e_{it}, m_{it} \sim MA(0)$$

thus ν_{it} follows an AR(1) process.

For estimating this model, I use the following common factor representation:

$$PCM_{it} = \beta X_{it} - \rho\beta X_{i,t-1} + \rho PCM_{i,t-1} + (\eta_i^* + \omega_{it}), \qquad (6)$$

where $\eta_i^* = \eta_i(1-\rho)$ and $\omega_{it} = e_{it} + m_{it} - \rho m_{i,t-1}$. Thus in the estimated equation, I include the lagged level of the explanatory variables as well.

There are two dynamic panel estimation procedures frequently used in the literature. The first is the Arellano-Bond (or diff-GMM) estimator, proposed by Arellano and Bond (1991). In this procedure, the equation is differenced, and then previous levels of the explanatory variables are used as instruments for the differenced explanatory variables in a GMM procedure. Blundell and Bond (1999) suggest using other moment restrictions as well to overcome some shortcomings of the diff-GMM estimator. In their procedure, the variables in

levels are instrumented by the variables in first differences besides the moment restrictions used in the diff-GMM estimator. The authors call this the system-GMM (or sys-GMM) procedure. The validity of this procedure requires the first moments of the explanatory variables to be time-invariant (conditional on time dummies). The authors show that the sys-GMM procedure can dramatically improve the finite-sample properties of the estimation.

Besides fixed effects, I apply the sys-GMM procedure. In the dynamic panel specification I handle all explanatory variables as endogenous.

4.6 Results

The main results are summarized in Table 5-6. Industry heterogeneity is handled by including separate trends for different NACE-2 industries. I also control for time fixed effects by year dummies.

Table 5 reports the results for the baseline regression, when no productivity or input demand measures are included. Specification (1) includes the fixed effects estimates. The main results are the following. The horizontal effect is strong and negative, and it is significant when all firms are included. This suggests a strong competition effect: the entry of foreign firms has a strong disciplinary effect on domestic firms. This result is in line with previous studies, which used firm- or establishment data: Sembenelli and Siotis (2002) find a similar result for Spanish manufacturing firms in not R&D intensive industries, and Maioli et al. (2006) also find negative effect in the case of greenfield investments, but positive effects for acquisitions. Unfortunately the dataset does not allow me to distinguish between the two variants of entry: in Hungary, the dominant effect seems to be negative.

The backward variable has a positive coefficient. This positive result is in line with strong productivity spillover effects: domestic upstream firms may increase their productivity if they supply industries with strong foreign presence, and they are also able to increase their markups. This estimate has a strong policy message as well: domestic suppliers may benefit from foreign presence, and foreign firms are not able to expropriate them. The results provide no evidence for forward spillover effects, as the forward measure is insignificant.

Interestingly the Herfindahl index has a negative sign. This may be a result of the endogeneity of some other variables. Firm size has the expected negative sign.

Specification (2) presents the sys-GMM estimates. The Hansen test for overidentification suggests that one cannot reject the null, that the orthogonality conditions are satisfied. Second, the autocorrelation tests suggest the presence of first order-, but no second order autocorrelation, in which case dynamic panel models should provide consistent results. In (2), the control variables lose their significance. The horizontal variable is significant and negative providing further evidence for the disciplinary effect of foreign competition. The backward measure is insignificant.

Specifications (2)-(6) provide some robustness checks. In (3)-(4) I restrict the sample to privately owned firms, as it is possible that state-owned firms behave differently. In (5) and (6) I include the lagged spillover variables instead of the contemporaneous ones, as it is possible that spillovers take some time to materialize. The main conclusion is that the results are robust to these changes in the fixed effects case, but the estimates are insignificant when estimating with sys-GMM.

In (7)-(8) I include the import penetration as well, to see whether it is an important disciplinary factor. This variable is insignificant, thus the estimates provide no evidence for this hypothesis.

If the relationship between FDI and markups of suppliers can be explained primarily by productivity spillovers, then one should control for productivity, and check if the coefficient of foreign presence becomes insignificant. Table 6 presents the results of regressions, when productivity is included. I use two different measures of productivity: in specifications (1) and (2), TFP is included, and in (3) and (4) labour productivity. Both productivity measures are positive and highly significant in all specifications, as expected.

The backward measure is positive and significant in the FE specifications, while the horizontal measures remain negative, although when controlling for TFP, it becomes insignificant in the sys-GMM specification. Thus while productivity is important, foreign presence seems to have some effect beyond productivity spillover. The significance of the foreign presence measures suggests, however, that productivity spillover is not the only explanation for the relationship between foreign entry and markup change. Importantly, in the case of TFP, the capital-output ratio also becomes significant. More capital-intensive firms are able to realize higher markups when controlling for productivity.

In specifications (5)-(6), I also control for changes in input demand, investigating if vertical linkages models are relevant empirically in explaining markup changes of host country firms.

The input demand variables are significantly negative in the FE specification, but in the sys-GMM case only the horizontal variable is significant (only at 10%). This provides some evidence for the importance of vertical linkages. The inclusion of these variables, however does not have a significant effect on the estimates of the other variables.

TABLE 5

BASELINE ESTIMATES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	***sys-GMM***	***FE, privately owned firms***	***sys-GMM, privately firms***	***FE***	***sys-GMM***	***FE***	***sys-GMM***
backward	0.186**	0.088	0.145*	0.198			0.191**	0.219
	(0.074)	(0.313)	(0.087)	(0.355)			(0.074)	(0.292)
forward	-0.008	0.109	-0.017	0.023			-0.005	0.051
	(0.023)	(0.116)	(0.027)	(0.139)			(0.023)	(0.113)
horizontal	-0.056***	-0.167**	-0.061***	-0.169*			-0.056***	-0.210***
	(0.017)	(0.080)	(0.019)	(0.094)			(0.017)	(0.079)
lagged backward					0.173**	0.102		
					(0.085)	(0.120)		
lagged forward					0.017	0.027		
					(0.028)	(0.038)		
lagged horizontal					-0.079***	-0.011		
					(0.019)	(0.025)		
Herfindahl-index	-0.036***	0.055	-0.043***	0.041	-0.030**	0.057	-0.036***	0.056
	(0.011)	(0.046)	(0.012)	(0.054)	(0.012)	(0.053)	(0.011)	(0.049)
market share	0.012	0.002	0.015	0.009	0.011	-0.008	0.014*	0.006
	(0.008)	(0.024)	(0.010)	(0.027)	(0.009)	(0.025)	(0.008)	(0.025)
capital-output ratio	0.003	-0.014	0.005	-0.010	-0.012*	-0.021	0.003	-0.031
	(0.005)	(0.025)	(0.006)	(0.027)	(0.006)	(0.027)	(0.005)	(0.026)
log(employees)	-0.031***	0.009	-0.031***	0.023	-0.034***	0.019	-0.031***	-0.002
	(0.003)	(0.023)	(0.004)	(0.024)	(0.004)	(0.025)	(0.003)	(0.021)
inport penetration							-0.004	-0.013
							(0.005)	(0.013)
Observations	16567	7885	14837	7047	11251	7885	16567	7885
Number of id	4549	2275	4310	2121	3059	2275	4549	2275
R-squared	0.07		0.07		0.08		0.07	
p-value for Hansen test		0.16		0.31		0.39		0.15
p-value for Arellano-Bond test for AR(1) in residuals		0.00		0.00		0.00		0.00
p-value for Arellano-Bond test for AR(2) in residuals		0.44		0.32		0.48		0.40

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 6

THE EFFECT OF PRODUCTIVITY

	(1) ***FE***	(2) ***sys-GMM***	(3) ***FE***	(4) ***sys-GMM***	(5) ***FE***	(6) ***sys-GMM***
backward	0.174***	0.378*	0.181**	0.214	0.226***	0.277*
	(0.057)	(0.206)	(0.074)	(0.278)	(0.057)	(0.154)
forward	-0.010	-0.033	-0.004	0.030	0.002	-0.010
	(0.019)	(0.078)	(0.023)	(0.107)	(0.019)	(0.073)
horizontal	-0.091***	-0.079	-0.062***	-0.147**	-0.032**	-0.078
	(0.014)	(0.054)	(0.017)	(0.068)	(0.015)	(0.053)
Herfindahl-index	-0.028***	0.043	-0.039***	0.052	-0.018**	0.041
	(0.009)	(0.031)	(0.011)	(0.043)	(0.008)	(0.027)
market share	0.000	-0.009	0.007	0.009	-0.013*	-0.022
	(0.006)	(0.016)	(0.008)	(0.013)	(0.007)	(0.018)
capital-output ratio	0.071***	0.052***	0.004	-0.025	0.072***	0.052***
	(0.005)	(0.020)	(0.005)	(0.025)	(0.005)	(0.019)
log(employees)	-0.025***	0.011	-0.035***	-0.007	-0.022***	0.008
	(0.005)	(0.015)	(0.003)	(0.018)	(0.005)	(0.014)
import penetration	0.002	0.001	-0.004	-0.013	0.001	-0.001
	(0.004)	(0.009)	(0.005)	(0.012)	(0.004)	(0.009)
tfp	0.176***	0.200***			0.178***	0.204***
	(0.005)	(0.013)			(0.005)	(0.011)
labour productivity			74.733***	68.559***		
			(20.147)	(24.158)		
input usage of downstream firms					-0.024***	0.006
					(0.004)	(0.024)
input usage of firms in the industry					-0.007***	-0.008*
					(0.001)	(0.005)
Observations	16560	7882	16564	7884	16560	7882
Number of id	4547	2275	4548	2275	4547	2275
R-squared	0.41		0.08		0.42	
p-value for Hansen test		0.05		0.12		0.01
p-value for Arellano-Bond test for AR(1) in residuals		0.00		0.00		0.00
p-value for Arellano-Bond test for AR(2) in residuals		0.08		0.36		0.07

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

All in all, the effect of FDI on suppliers' and competitors' margin seems to be present even after controlling for productivity and input demand. This seems to be an important effect, simple models are not able to explain this phenomenon. There are a number of possible explanations, naturally. One is that controlling for productivity is not the appropriate method to control for productivity spillovers, as productivity increases because of technology transfer may affect markups differently, compared to other kinds of productivity growth. This heterogeneity of productivity growth may explain the significance of the backward measure. Second, the relationship between foreign customers and domestic suppliers may be very different in several respects from the relationship between domestic customers and domestic suppliers Third, it is possible, that some interactions of the possible channels should be taken into account in theoretical and empirical modelling.

4.7 Conclusions

The main concern of this study was whether foreign presence affects the price-cost margins of upstream firms and competitors. While a great number of studies have analysed productivity spillovers, the theoretical and empirical relationship between the two phenomena is not clear.

There are several theoretical approaches, which are relevant when studying this question. Industrial organisation models were extended to include more than one industry. In these models, the explanation behind the relationship between foreign presence and the markups of suppliers is the change in the demand for the intermediate good generated by foreign entry. Second, productivity spillovers may also take place, which may affect suppliers' markups. Third, bargaining power and the structure of the relationship between foreign customers and domestic suppliers may be very different from the vertical relationship between domestic firms.

In the empirical part of the paper, I have modelled the price-cost margin process with fixed effects and dynamic panel models, as persistence of the relevant variables may bias static panel estimates. The main result is that foreign entry has a disciplinary effect on competitors, but it increases the markups of suppliers. When trying to explain these phenomena, different controls were applied. First, while productivity seems to be an important determinant of suppliers' markups, foreign presence also remains important. The effect of the demand of intermediate goods does not seem to be important.

These results suggest that foreign presence has an effect on domestic suppliers' markups in itself, and the mechanism behind this phenomenon cannot be easily explained. This shows the importance of further theoretical and empirical research.

References

Aitken, Brian and Harrison, Ann E. (1999). 'Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela', *American Economic Review*, 89, pp. 605—618

Arellano, Manuel and Bond, Stephen (1991). 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations', *Review of Economic Studies*, 58, pp. 277—297

Barrios, Salvador, Görg, Holger and Strobl, Eric (2005). 'Foreign direct investment, competition and industrial development in the host country', *European Economic Review*, vol. 49, pp. 1761—1789.

Bartelsman, Eric J., Mark Doms (2000). ´Understanding Productivity: Lessons from Longitudinal Microdata', *Journal of Economic Literature*, 38. pp. 569-594.

Blundell, Richard and Bond, Steve (1999) 'GMM Estimation with Persistent Panel Data: an Application to Production Functions', IFS Working Papers, vol. 99/04, Institute of Fiscal Studies, www.ifs.org.uk.

Bosco, Maria Giovanna (2001). 'Does FDI contribute to technological spillovers and growth? A panel data analysis of Hungarian firms', *Transnational Corporations*, 10, pp. 43—67.

Co, C. Y. (2001), 'Trade, Foreign Direct Investment and Industry Performance', *International Journal of Industrial Organisation*, 19(1-2), pp. 163-183.

Chung, Wilbur (2001). `Mode, Size, and Location of Foreign Direct Investment and Industry Markups', *Journal of Economic Behavior and Organisation*, 45, pp.185-211.

Deneckere R., and C. Davidson (1985), 'Incentives to Form Coalitions with Bertrand Competition', *Rand Journal of Economics*, 16(4), pp. 473-486.

Djankov, Simeon and Hoekman, Bernard (2000). 'Foreign Investment and Productivity Growth in Czech Enterprises', *World Bank Economic Review*, 14, 49—64

Ericson, R. and A. Pakes (1995), 'Markov-Perfect Industry Dynamics: A Framework for Empirical Work', *Review of Economic Studies*, 62, pp. 53-82.

Foster, L., J. Haltiwanger, and C. Syverson (2005), 'Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?', *NBER Working Paper*, No. 11555, August.

Gadde, L.-E., I. Snehota (2000). 'Making the Most of Supplier Relationships', *Industrial Marketing Management*, 29, pp. 305-316

Görg, Holger and Greenaway, David (2004). 'Much Ado About Nothing? Do Domestic Firms Really Benefit from Foreign direct Investment?' *World Bank Research Observer*, 19, pp. 171—197.

Görg, Holger and Frederic Warzynski (2003). 'Price Cost Margins and Exporting Behaviour: Evidence from Firm-level Data', *GEP Research Paper* 2003/24, University of Nottingham

Hall, Robert E. (1988). ´The Relation Between Price and Marginal Cost in US Industry', *Journal of Political Economy*, 96, pp. 921-947.

Halpern, László and Balázs Muraközy (2007): "Does Distance Matter in Spillover", *Economics of Transition*, 15(4), 2007, pp. 781–805.

Hopenhayn, H. A. (1992), 'Entry, Exit, and Firm Dynamics in Long Run Equilibrium', *Econometrica*, 60, pp. 1127-1150.

Javorcik, Beata Smarzynska (2004). 'Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages', *The American Economic Review*, 94, pp. 605—627.

Konings, Jozef, Patric Van Cayseele, Frederic Warzinsky (2001). 'The dynamics of Industrial Mark-ups in Two Small Open Economies: Does National Competition Policy Matter', *International Journal of Industrial Organisation*, 19, pp. 845-859.

Kotabe, Masaaki, Xavier Martin, Hiroshi Domoto (2003). ´Gaining from vertical partnerships: knowledge transfer, relationship duration, and supplier performance improvement in the U.S. and Japanese automotive industries', *Strategic Management Journal*, 24, pp. 293-316

Maioli, Sara, Ben Ferret, Sourafel Girma, Holger Görg (2006). 'Trade, FDI, and Plant-level Price-Cost Margins in the UK', *GEP Working Paper 2006/16*

Markusen, James R. and Venables, Anthony J. (1999). 'Foreign Direct Investment as a catalyst for industrial development', *European Economic Review*, 43, pp. 335—356.

Melitz, M. J. (2003), 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity', *Econometrica*, 71, pp. 1695-1725.

Moran, Theodore H. (2001). *´Parental supervision: The new paradigm for foreign direct investment and development*' Washington, DC: Institute for International Economics

Pack, Howard and Kamal Saggi (2001) 'Vertical technology transfer via international outsourcing', *Journal of Development Economics*, 65, pp. 389-415.

Rodriguez-Clare, Andres (1996). 'Multinationals, Linkages and Economic Development', *The American Review*, 86, pp. 852—873.

Roeger, Werner (1995). 'Can Imperfect Competition Explain Differences Between Primal an Dual Productivity Measures. Estimates for US Manufacturing', *Journal of Political Economy*, 103, pp. 316-330.

Salant, S. W., S. Switzer and R. J. Reynolds (1983), 'Losses from Horizontal Merger: The Effects of an Exogenous Change in Industry Structure on Cournot-Nash Equilibrium', *The Quarterly Journal of Economics*, 98(2), pp. 185-199.

Schoors, Koen and van der Tol, Bartoldus (2002). 'Foreign direct investment spillovers within and between sectors: Evidence from Hungarian data', Working Papers of Faculty of Economics and Business Adminstration, Ghent University, Belgium no. 02/157, Ghent University, www.FEB.UGent.be

Sembenelli, A. and G. Siotis (2002), "Foreign Direct Investment, Competitive Pressure and Spillovers. An Empirical Analysis on Spanish Firm Level Data, *Centro Studi Luca d'Agliano Development Studies Working Paper*, No. 169, and *CEPR WP* No. 4903, Feb. 2005.

Tybout, James R. (2001). ´Plant- and Firm-level Evidence on "New Trade" Theories', *NBER Working Paper*, No. 8418, August.

Zukowska-Gagelmann, Katarzyna (2002). ´Productivity Spillovers from Foreign Direct Investment in Poland', *Economic Systems*, 24(3): 223-56.

Appendix: Data and productivity estimates

The main database used in this work is the Hungarian Tax and Financial Control Administration (APEH) panel, which consists of financial and accounting information of a large number of Hungarian firms. The data is not publicly available. The Institute of Economics of Hungarian Academy of Sciences (IEHAS) was granted the right to use this dataset for research purpose. Details about access and replicability of computed research results obtained using this dataset within IEHAS are available on request.

Throughout this work productivity is estimated basically with two methods: fixed effects and the Levinsohn-Petrin procedure. In both cases, the dependent variable is log real added value, and the inputs are log real capital assets and log employment. In this appendix, I present the coefficients estimated without time dummies to see the evolution of productivity through time. The estimated equation is:

$$\ln y_{it} = \beta_K \ln k_{it} + \beta_L \ln l_{it} + \eta_i + \varepsilon_{it}$$

where y_{it} is real added value of firm i in year t, k_{it} is real fixed assets and l_{it} is the number of employees, η_i is firm fixed effect and ε_{it} is the random residual.

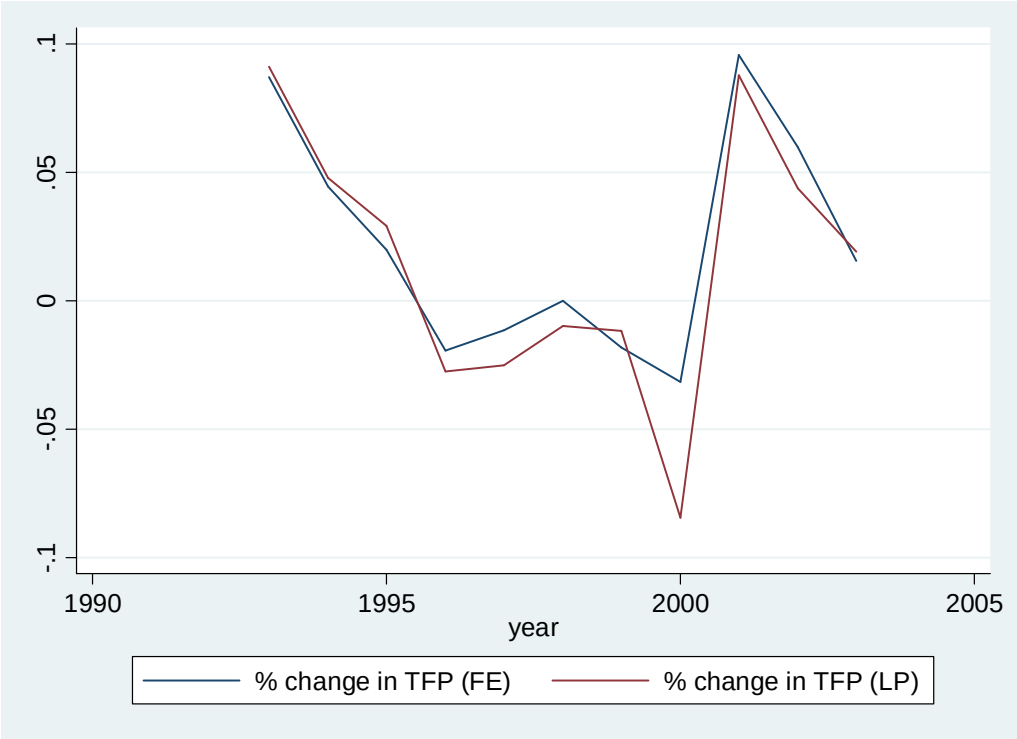
The estimated coefficients are presented in Table A1

Table A1: estimated coefficients

		Estimated coefficients			
		Levinsohn-Petrin		Fixed effects	
nace2	Number of firms	Capital	Labour	Capital	Labour
15	8650	0.210	0.456	0.182	0.709
16	67	0.812	-0.041	0.364	0.953
17	2243	0.167	0.490	0.173	0.726
18	4382	0.236	0.687	0.133	0.777
19	1712	0.281	0.720	0.189	0.705
20	2839	0.245	0.492	0.182	0.718
21	833	0.253	0.341	0.242	0.635
22	3208	0.151	0.403	0.176	0.598
23	24	0.794	-0.678	1.169	1.075
24	1620	0.540	0.306	0.301	0.662
25	3136	0.270	0.445	0.225	0.697
26	2265	0.172	0.445	0.154	0.850
27	931	0.403	0.473	0.146	0.744
28	7489	0.272	0.496	0.233	0.676
29	5359	0.309	0.498	0.198	0.684
30	266	0.356	0.111	0.336	0.888
31	2159	0.277	0.531	0.240	0.898
32	1228	0.263	0.515	0.227	0.692
33	1575	0.362	0.403	0.170	0.731
34	1095	0.557	0.463	0.154	0.963
35	367	0.171	0.531	0.205	0.803
36	2734	0.178	0.517	0.193	0.707
37	175	0.338	0.558	0.157	0.656

The yearly percentage change of average productivity is presented in Figure A1.

Figure A1: Yearly change in average productivity



Differences in productivity between domestic and majority foreign-owned firm are presented in Figure A2 (using the Levinsohn-Petrin estimates) suggesting great differences in technology.

Figure A2: Evolution of (log) TFP for domestic and foreign firms

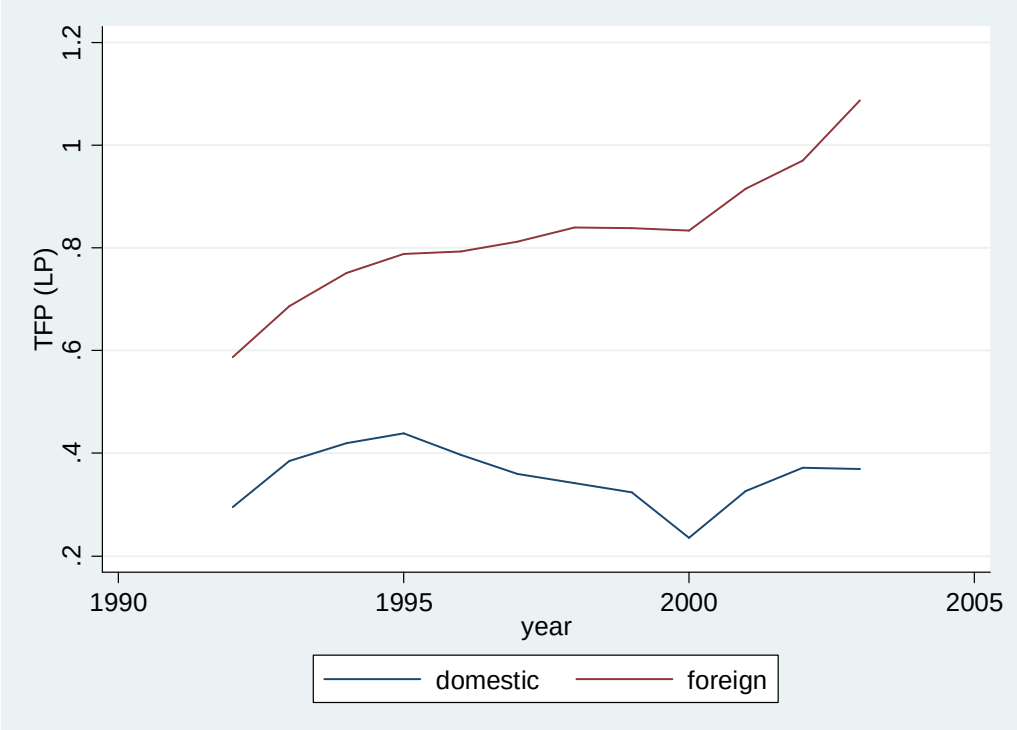


Figure A3 compares the productivity of large (employment>200) and small firms.

Figure A3: Evolution of log TFP, small and large firms