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Abstract

Technology spillovers from foreign to domestic firms in emerging economies are considered to be the most important channel through which Foreign Direct Investment (FDI) influence the host economy. Empirical evidence about the existence, magnitude and direction of FDI-related spillovers in these countries is contradictory pointing to the necessity of conducting more econometric studies using firm-level data. We conduct an econometric analysis to assess the impact of FDI-related horizontal technology spillovers on output growth of domestic firms in the Turkish manufacturing industry over 2003-2006. When a broad definition of foreign ownership is adopted, our findings suggest that horizontal spillovers occur from foreign to local firms in the sector of activity. Export-oriented firms do not benefit from these spillovers in contrast to firms producing mainly for the domestic market. However, when foreign ownership is defined according to whether the minority or majority of capital is detained by the foreign partner, horizontal spillovers seem to originate from foreign firms with majority or full foreign ownership while no such effect is associated with minority-owned foreign firms.

Keywords: Foreign Direct Investment (FDI), multinational corporations, foreign ownership, productivity, technology spillovers, knowledge spillovers, horizontal spillovers, Turkey.

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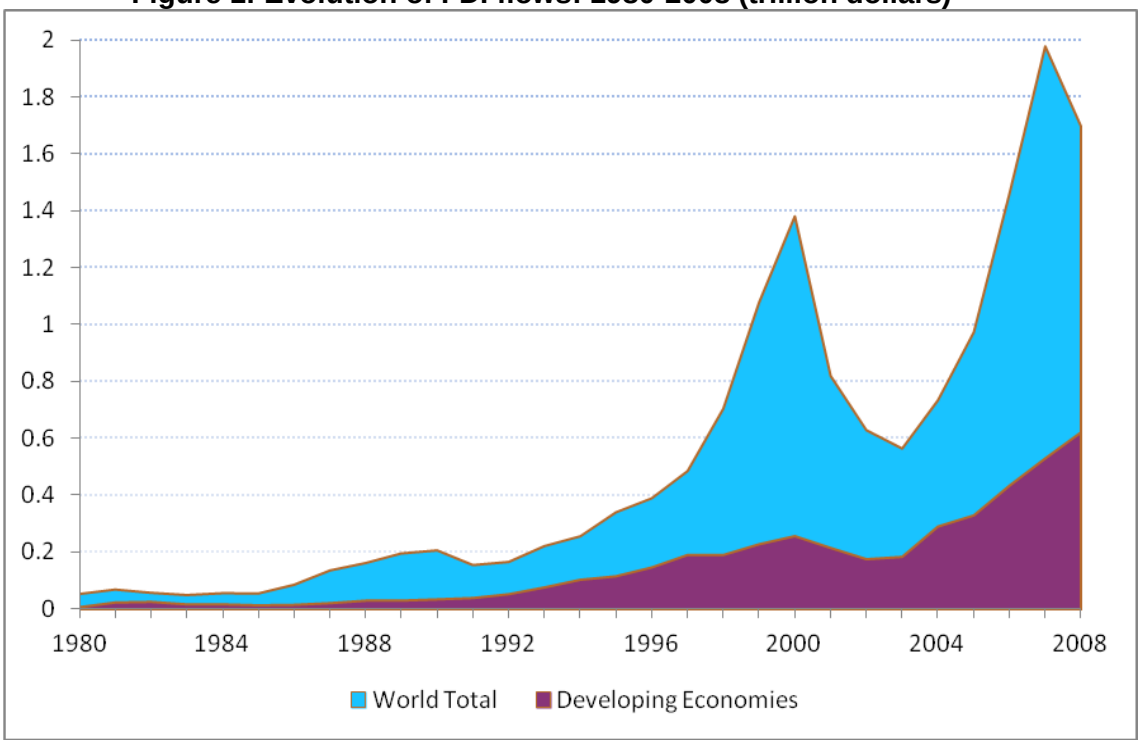
1. Introduction

Since the 1980s, Foreign Direct Investment (FDI) flows have increased significantly worldwide and at the same time the share of these flows going into developing countries has followed an upward trend. By the year 2008, developing countries constituted the destination of the one third of total FDI flows and the amount involved reached 600 billion US dollars (see Figure 1). A small yet increasing part of these FDI flows towards developing countries also led multinational firms to conduct R&D activities therein (UNCTAD 2005).

FDI may affect the economy of a host country through its impact on employment creation, foreign exchange earnings, capital accumulation and by the usage of more advanced equipment and technology. However, it has been pointed out recently that the most important channel through which FDI may impact on developing economies is situated on the technology side. Indeed, the major contribution of FDI to a developing economy consists in fostering technology transfer by bringing and diffusing new technologies, knowledge, and skills to the recipient country. The transfer of the intangible from foreign to local firms is referred to as "FDI-based technology or knowledge spillovers". These spillovers can be horizontal (intra-industry) or vertical spillovers (inter-industry) depending whether they are disseminated within or outside the sector of activity of foreign firms that trigger these spillovers.

After pursuing inward-oriented economic policies based on an import-substitution development strategy implemented through Five-Year Development Plans since the 1960s, Turkey switched to outward-oriented policies after a severe balance of payment crisis in the early 1980s. These policies consisted mainly in removing gradually import quotas and custom duties, attracting foreign investment, promoting exports, minimizing state intervention and liberalizing

Figure 1: Evolution of FDI flows: 1980-2008 (trillion dollars)



Source: UNCTAD (2010).

international capital flows, which occurred in 1989. The signature of a Customs Union agreement with the European Union in 1995 contributed to a further liberalization of its economy.

The first law on foreign capital was enacted in 1954. Although this law was initiated with the intention of providing a more attractive environment for foreign investors, due to the restrictive measures it entailed[3], it served the initial purpose only partially. From 1950 to 1980 the cumulative authorized FDI had reached only $229 million (Öniş, 1994). Other reasons that have contributed to the relatively poor FDI performance in Turkey are red tape (Erdilek, 1982) and more generally the negative attitude of policy makers operating under an import substitution industrialization strategy. After the government initiated a stabilization program in 1980 that paved the way to an open economy, the legislative background was also reorganized to eliminate favoritism among foreign investors, local content requirements, minimum export requirements and restrictions on transfer of capital and profits (Erdilek, 1986; Akpınar, 2001).

[3] Such as domestic content and minimum export requirements, restrictions put on the share of foreign capital in total equity and compulsory authorization to be obtained from local authorities before investment.

In addition to changes in the regulatory framework, privatization of state economic enterprises, liberalization of the financial system, elimination of restrictions on foreign exchange, establishment of a stock exchange and heavy investment in telecommunications technology all contributed to the development of a favorable environment for FDI throughout the 1980s. However, in the following decade, two major economic crises in 1994 and 1999 as well as reliance on short term capital flows resulted in a relatively poor FDI performance. When we look at the 2000s, we see a much more favorable environment for foreign investors with a strongly regulated financial system, a low inflation rate and the establishment of a Coordination Council for the Improvement of the Investment Climate. Following the enactment of the new foreign capital law in June 2003, minimum capital requirements and permits were eliminated; the ownership of property by foreigners without any restrictions, the right to international arbitration and employment of expatriates were granted. Partly as a result of these measures a sharp rise occurred in FDI from 0.71 % of GDP in 2003 to 5% in 2005 which was followed by a fall after 2006 (Figure 3).

Note that efforts to open up the Turkish economy were not enough initially to attract more FDI. Until the year 2000, annual FDI flows to Turkey were rather low (below US$ 1 billion) compared to other emerging economies (UNCTAD, 2005). Total cumulative net FDI inflows were nearly US$ 9.7 billion between 1974 and 1999, corresponding to an annual average of US$ 370 million. From 2000 onwards there has been an important increase in the FDI flows (annual average of US$ 9 billion between 2000 and 2008) especially after the Turkish government has started to liberalize its investment policy. As illustrated in Figure 2, FDI inflows peaked in 2007.

In this chapter, our objective is to examine whether the rapid increase in FDI flows since the year 2000 impacted on the productivity of Turkish manufacturing firms through materialization of intra-industry FDI-related technology or knowledge spillovers. This is all the more important

Figure 2: Net FDI inflows in Turkey

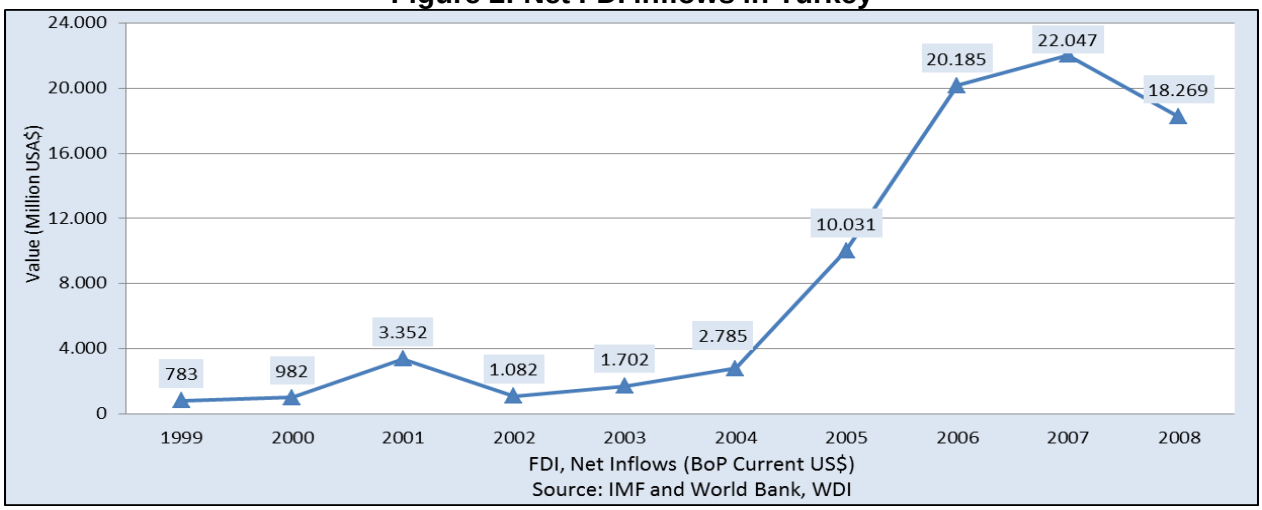
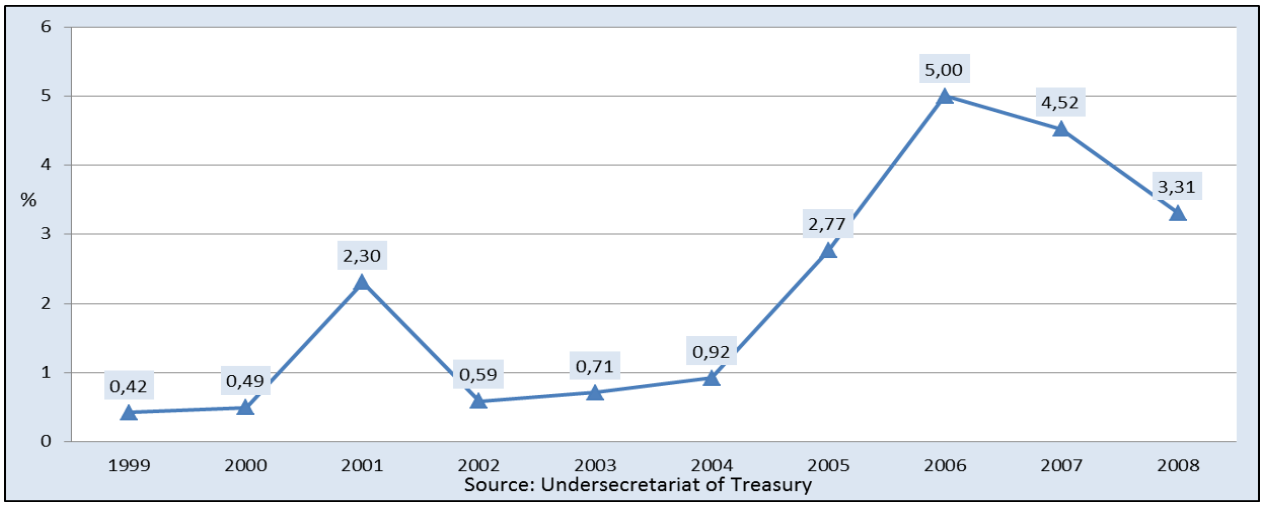


Figure 3: Evolution of the FDI/GDP ratio in Turkey: 1998-2008 (%)



since available studies on this issue for the Turkish economy all concern the pre-2001 period whereas our dataset covers the more recent 2003-2006 period[4]. In the remaining part of this study, we first examine the theory behind the existence and the impact of FDI-related technology spillovers in developing countries. In the third section, the dataset and the model used as well as the econometric estimation method adopted are explained. The fourth section is devoted to the analysis of econometric findings while the last section recapitulates and suggests some further research avenues.

[4] See Pamukçu et al. (2006) and Pamukçu & Taymaz (2009) for a presentation and discussion of these studies.

2. FDI-related technology or knowledge spillovers in developing countries[5]

Transnational corporations (TNCs) prefer to set up affiliates overseas rather than export directly or license their product or technology due, inter alia, to problems encountered in protecting their proprietary knowledge. Thus TNCs internalize certain transactions to protect their brand names, technology, and marketing advantages. Although TNCs wish to retain technology internally or to charge a market price for transfers to third parties, positive externalities in the form of technology spillovers may be created. This transfer and diffusion of technology is one of the important contributions of FDI to the host country. A TNC brings its production technology, its access to global production and distribution networks, and its know-how and experience by investing in the host country. The diffusion of technology may lead to improvements in the productivity of domestic firms in ways that do not allow the TNC to capture all the related benefits.

The technology transfer triggered by TNCs toward developing countries may affect directly or indirectly the productivity level of the host country. The *direct effect* is located in the foreign firms that invest abroad: it may occur either through import of machinery or through know-how, knowledge and licenses -or both-and impact positively on the productivity levels of foreign firms, hence on the aggregate productivity level of the host country. In other terms, the direct effect consists in newly established foreign firms recording a higher productivity level than in their domestic counterparts, a situation that leads to an increase in the overall productivity level in the host country.

The *indirect effects* of FDI are exerted on *domestic firms* and may lead to an increase in their productivity level or an improvement in the quality of their products, or both. The indirect effects represent a kind of unintended technology transfers occurring form foreign to domestic firms. These technology spillovers related with FDI are classified in three categories: horizontal, vertical and labour spillovers[6]. Horizontal spillovers are spillovers from foreign to domestic firms

[5] This section is based on Pamukçu and Taymaz (2009). The terms 'technology-related spillovers' and 'knowledge-related spillovers' will be used interchangeably in the sequel.

[6] Our focus here is on the impact of FDI-related knowledge spillovers on the productivity of domestic firms. FDI can also generate spillovers that impact the wages and the export activities (decision or quantity) of domestic firms: see Gorg and Greenaway (2004).

operating in the same industry or in the same region, while vertical spillovers are defined as spillovers from foreign to domestic firms operating in vertically-related industries, either from foreign suppliers to domestic users (forward linkages) or from foreign users to domestic suppliers (backward linkages)[7]. Spillovers through employment by domestic firms of workers who worked previously for foreign firms are called labour spillovers. These three types of spillovers can occur mainly through the following channels: demonstration/imitation, labour mobility, competition, and backward and forward linkages with domestic firms.

Demonstration/imitation effects: According to Blomström and Kokko (1998), as TNC affiliates become major players in the domestic market, domestic firms will be forced to adopt newer and more advanced technologies and use the existing resources of the firm more efficiently in order to survive[8]. Spillovers may take place when domestic firms improve their efficiency by copying technologies of foreign affiliates operating in the domestic market via the observation channel. Either demonstration of TNCs or imitation by domestic firms is the most evident spillover channel according to Das (1987) and Wang &Blomström (1992). After the observation of a product innovation or a new form of organization adapted to local conditions, local entrepreneurs may attempt to imitate the innovation. The introduction of a new technology into a given market may be too expensive and risky for a domestic firm to undertake, due to the costs inherent in acquiring its knowledge and the uncertainty of the results that may be obtained. However, as domestic firms interact with existing technology users; this interaction reduces their innovation and imitation costs. Thus, information is diffused, uncertainty is reduced, and imitation levels increase, leading finally to an improvement in total factor productivity[9]. Imitation of the technology either by reverse engineering or any other way works mainly among firms within same industries and referred as intra-industry spillovers.

Labour mobility: The second channel is related to the possibility of hiring workers previously employed in TMCs and who have knowledge and experience of the technology and who are able

[7] These spillovers will not be analyzed here: see Javorcik (2004) and Saggi (2005).
[8] Either because they operate on an inefficient scale; that is, there exists idle resources which are not used in production process in the firm, or because they produce their output with inefficient combinations of inputs.
[9] Helpman (1999).

to apply this in that firm by domestic firms[10]. Domestic firms' internalization of improved management practices and organizational efficiency of TNCs is expected to be the result of training of local employees in TNCs[11]. Even supporting staff acquires skills, attitudes and ideas on the job through exposure to modern organization forms and international quality standards. These people make a significant contribution by raising productivity when working for domestic firms or when setting up new entrepreneurial businesses. The productivity improvements caused by the movement of labour from TNCs to other existing or new domestic firms are realized through two mechanisms: through direct spillover to workers engaged in the same type of job and through knowledge carried by workers who move to another firm.

Nevertheless, a possible negative impact might arise through this channel, as TNCs may attract the best workers away from domestic firms by offering higher wages and leaving them with less-skilled employees[12]. The market-stealing effect and the skill-stealing effect could be large enough to offset the positive effect of FDI. Also, the influence of labour mobility on the efficiency of domestic firms is difficult to evaluate, as it involves tracking the workers in order to investigate their impact on the productivity of other workers[13]. For this reason, if TNCs and domestic firms compete in the same labor market, domestic firms may have to pay higher wages to attract workers.

Competition: When TNCs decide to penetrate a new market directly through investing in the country, they tend to bring with them more sophisticated technology and superior managerial practice enabling them to compete with domestic firms who tend to be more familiar with the consumer preferences and business practices in the local market[14]. Since FDI promotes efficiency through the economy by increasing competition in domestic industries, an increased competition induced by TNCs becomes the third channel of spillovers from FDI[15]. Technology advances due to increased competition may involve both intra- and inter-industries spillovers. Competition with TNCs may force domestic firms to increase their competitiveness by reforming management

[10] Fosfuri et al. (2001) and Glass & Saggi (2002).
[11] Globerman (1979).
[12] Girma et al. (2001) and Sinani & Meyer, (2004).
[13] Saggi (2002).
[14] Blomstrom and Sjoholm (1999).
[15] Markusen & Venables (1999) and Wang &Blomström (1992).

styles and updating production technology. While competition between TNCs and domestic firms in the domestic economy is an incentive for the domestic firms to make a more efficient use of existing resources and technology or even to adopt new technologies, on the other hand, it may restrict the market power of domestic firms.

The efficiency of domestic firms may also be negatively affected through this channel, if foreign firms with advanced technologies produce at a lower marginal cost. By taking market share from domestic firms and forcing them to operate on a less efficient scale, with a consequent increase of their average costs, TNCs may lower the productivity of domestic firms as indicated in Aitken and Harrison (1999). However, domestic firms may also react to foreign competition by using the existing technology more efficiently or by investing in new technology in order to maintain their market shares[16].

3. Data, model and econometric estimation

3a) Data

Enterprise-level data used in this study come from the Structural Business Statistics Survey (SBSS) conducted by the Turkish Statistical Institute (Turkstat) on an annual basis[17]. In our dataset, the number of observations for each year varies from 77,000 (2003) to 85,000 (2006). The statistical unit or the unit of analysis used in the SBSS is the "enterprise" defined as "... *an organizational form that produces goods and services using decision autonomy at first degree. An enterprise carries out one or more activities at one or more locations*" and all data are collected at the enterprise level[18]. The classification of the enterprises' main activities is done in accordance with the Statistical Classification of Economic Activities in the European Community NACE Rev.1.1. All the enterprises with 20 or more employees are surveyed while those with less than 20 employees are selected on a sampling basis.

[16] Blomström and Kokko (1998).
[17] More information about the dataset is available on TurkStat web page at www.tuik.gov.tr.We were able to use this database thanks to the official authorization granted by and through a protocol signed with the TurkStat.
[18] We will use the terms 'firm" and "enterprise" interchangeably in the sequel.

The dataset contains firm-specific information on variables such as the number of employees, commercial revenue, turnover, capital ownership structure (local, foreign, public), values of material and energy inputs, gross fixed investment, changes in stocks, export and import values of the firm. The data is available over the period 2003-2006. In this study, the focus is on manufacturing firms defined as those units that are part of the NACE 1.1 sectors ranging from 15 to 37 at the two-digit level, and taking into account only manufacturing firms reduces naturally the number of observations. In addition, we use only private establishments with 20 or more employees, and the number of observations is further reduced by data cleaning and transformation procedures[19]. The final dataset is an unbalanced firm-level panel data with 192 four-digit level manufacturing industries over the period 2003-2006. The total number of observations is 30,178 for the whole sample. Foreign firms are defined as those firms where the share of foreign agents in equity equals at least 10%[20]. According to this definition, there are 1,489 observations for foreign-owned firms, i.e. about 5% of all observations, and 28,689 observations for domestic firms in our dataset over the period 2003-2006. Distribution of the number of firms at the two-digit NACE level is presented for 2006 in Table 1. Indicators on the presence of foreign firms in the Turkish manufacturing sector are presented in Figure 4 for a number of two-digit NACE sectors. These indicators are the share of foreign firms in the number of firms, in total employment, in total gross output and in total value added at the two-digit NACE level[21]. Note that data presented in Figure 4 refer to average values of each variable over the period 2003-2006.

First, Figure 4 indicates that in spite of the low number of foreign firms operating in the Turkish manufacturing sector (on average 6% for the whole manufacturing sector over the period 2003-2006), these firms control almost 25% of the Turkish manufacturing sector's gross output and value added, and 15% of its labor force. For instance, foreign firms in the motor vehicles sector employ 55% of the labor, and produce nearly 80% of the gross output and 73% of the value added. In the chemical products sector the foreign share in sector-level employment attains 39%

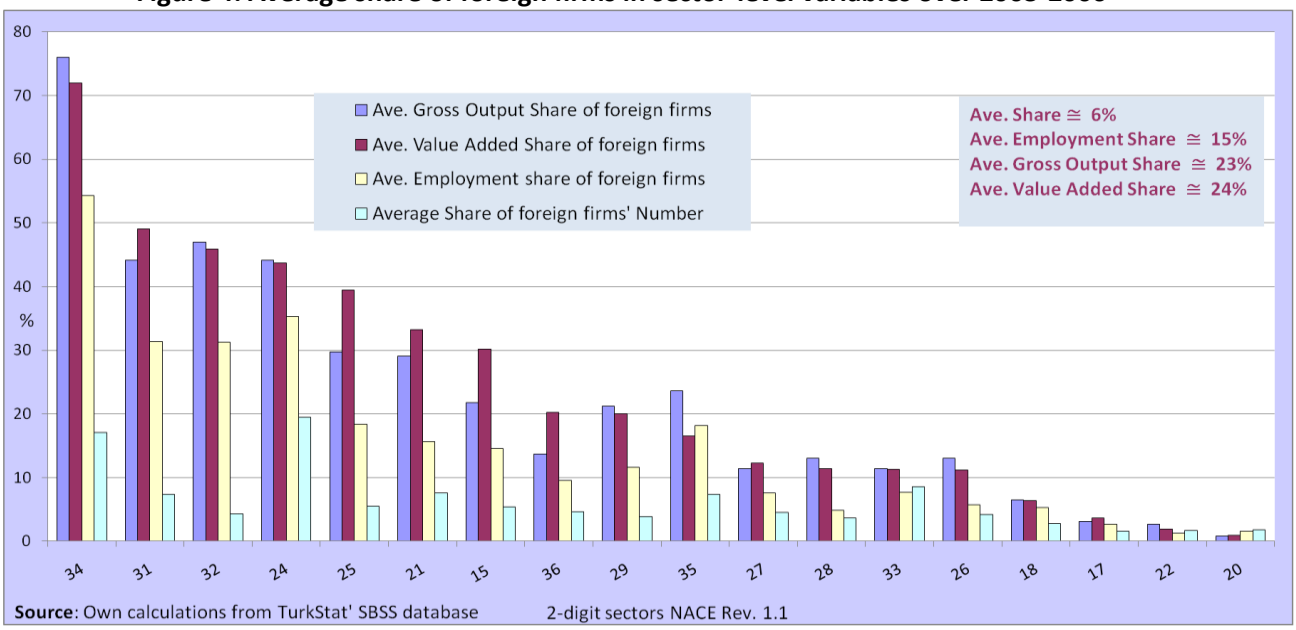
[19] More details on the cleaning procedure used are available from the authors upon request.
[20] We take 10% foreign share in accordance with the OECD and the IMF's definitions. See also Javorcik (2004).
[21] Data on tobacco, leather products, petroleum products and office machinery and computers are not included in Figure 4 since the total number of the firms in these sectors is less than ten.

Table 1: Sector-level distribution of the number of firms according to ownership structure (2006)

NACE	Sector	Local Firms	Foreign Firms	All Firms	Share of Firms with Foreign Capital (%)
15	Food products	758	46	804	5.72
16	Tobacco	4	5	9	55.56
17	Textiles	1155	16	1171	1.37
18	Wearing apparel	992	26	1018	2.55
19	Leather products	169	0	169	0
20	Wood products	105	2	107	1.87
21	Paper products	152	15	167	8.98
22	Publishing and printing	146	3	149	2.01
23	Petroleum products	8	1	9	11.11
24	Chemicals products	218	58	276	21.01
25	Rubber and plastic products	406	24	430	5.58
26	Other non-metallic mineral prc	474	20	494	4.05
27	Basic metals	277	13	290	4.48
28	Fabricated metal products	473	20	493	4.06
29	Machinery and equipment	583	25	608	4.11
30	Office machinery and computer	5	0	5	0
31	Electrical machinery	212	17	229	7.42
32	Radio, television and comm.	41	2	43	4.65
33	Medical instruments	59	6	65	9.23
34	Motor vehicles	234	48	282	17.02
35	Other transport equipment	75	6	81	7.41
36	Furniture	347	18	365	4.93
	Total	**6893**	**371**	**7264**	**5.11**

Source: Authors' calculations from TurkStat's SBSS database.

Figure 4: Average share of foreign firms in sector-level variables over 2003-2006*



* for NACE codes used on the horizontal axis, see Table 1.

and in gross output and valued added amounts nearly to 48% and 50%, respectively. Also foreign firms in the radio, television and communication sector employ 35% of the labor, and produce nearly 51% of the gross output and 53% of the value added. The difference between the share of foreign firms in gross output or value added and their share in employment at the sector level point to the fact that foreign firms use more capital-intensive production methods than their domestic counterparts.

Secondly, although we have not presented data on this issue, productivity level of foreign firms is larger than that of domestic firms in most of the two-digit NACE sectors[22]. Hence, these firms produce more efficiently than local firms and this is explained mostly by the capital- and technology-intensive production methods of the foreign firms, which reflect in turn their possession and control of intangible proprietary assets. The productivity gap between foreign and domestic firms points to the possibility of knowledge spillovers toward the second category of firms.

Finally, data presented above point to the important role foreign firms play role in the evolution of economic activity in the Turkish manufacturing sector and therefore justify the aim of the present paper.

3b) Model

In order to examine the impact of FDI-related horizontal technology spillovers on the productivity of local firms, we adopt a production function framework similar to the one in Javorcik (2004). In equation (1), *Y* stands for real gross output and factors of production included are physical capital stock (*K*), number of employees (*L*), intermediate materials (*M*) and energy inputs including fuel and electricity (*E*). *A* is a scale factor measuring the contribution of total factor productivity to gross output.

[22] On this issue over the period 1983-2001, see Pamukçu & Taymaz (2009) and Taymaz et al. (2010).

$$Y = A\ f(K, L, M, E) \qquad (1)$$

Adopting a Cobb-Douglas production function and taking the natural logarithm of both sides, we obtain:

$$\begin{aligned} \ln Y_{ijt} &= \alpha + \beta_1 \ln K_{ijt} + \beta_2 \ln L_{ijt} + \beta_3 \ln M_{ijt} + \beta_4 \ln E_{ijt} \\ &+ \beta_5 FS_{ijt} + \beta_6\ Scale_{ijt} + \beta_7\ HHI_{jt} + \beta_8\ Spillover_{jt} \\ &+ \alpha_t + \alpha_j + \varepsilon_{ijt} \end{aligned} \qquad (2)$$

where the indices i, j and t denote firm i operating in sector j at time t, respectively.

The non-input variables included in equation (2) will be defined and discussed below. Here it suffices to say that they capture the contribution of these variables to total factor productivity (measured by the term *ln A* after the logarithms are taken). Note that all monetary variables are measured in real 2003 Turkish Liras.

Gross output and input variables

Real output (Y_{ijt}) has been calculated as production value deflated by the producer price indexes (PPI) at the four-digit NACE level. *Capital stock* (K_{ijt}) is measured by the value of depreciation and depletion allowances of firms since no data on the book value of capital stock is available in our data set. This indicator is deflated by the fixed-capital investment deflator at the two digit level for the private manufacturing sector. *Labor* (L_{ijt}) is measured by the number of employees of the firm. *Material input* variable (M_{ijt}) is constructed as the sum of purchases of intermediate inputs except electricity and fuel. It is deflated by a composite input price index constructed for each two-digit NACE sector on the basis of the input-output matrix of the year 2002. In the calculation of the sector indexes, we take the six most important input coefficients for each sector. The PPI for the relevant two-digit NACE sectors is used for deflation. *Energy input* variable (E_{ijt}) is the sum of electricity and fuel expenses (LPG, natural gas, coal, gasoline, diesel

oil, heat, steam, hot water etc.). Both electricity and fuel expenses are deflated by an appropriate two-digit sector PPI.

Indicator of horizontal FDI-related technology spillovers

The indicator of FDI-related horizontal spillovers is constructed as the ratio of foreign equity share-weighted output[23] at the four-digit NACE sector level (j) to total output of the same sector (j):

$$Horizontal_{jt} = \frac{\left(\sum_{i:i \in j} FS_{it} Y_{it} \right)}{\sum_{i:i \in j} Y_{it}} \qquad (3)$$

This variable captures the extent of foreign presence in sector j at time t and is introduced in equation (2) to measure the extent of horizontal FDI-related technology spillovers[24]. The value of this variable increases proportionally with the output of the foreign firm and the share of foreign capital in these firms. A positive or negative and statistically significant coefficient on this variable points to the existence of horizontal knowledge and technology spillovers from foreign to domestic firms (through demonstration effects, competition effects and labor turnover) This proxy is also time-varying and sector specific variable[25].

Descriptive statistics for the FDI-related horizontal technology spillovers variable are presented in Table 2. Its average value is comprised between 11.78 % in 2005 and 12.44 % in 2004. However, its maximum value attains 75.69 % in 2006.

Table 2: Summary statistics for the horizontal technology spillovers indicator (%)

Year	Obs.	Mean	Std.Dev.	Min	Max
2003	7514	12.20	11.73	0	74.83
2004	7700	12.44	11.99	0	52.01
2005	7700	11.78	11.27	0	53.88
2006	7264	12.41	12.17	0	75.69

Source: Authors' calculations from the SBSS database

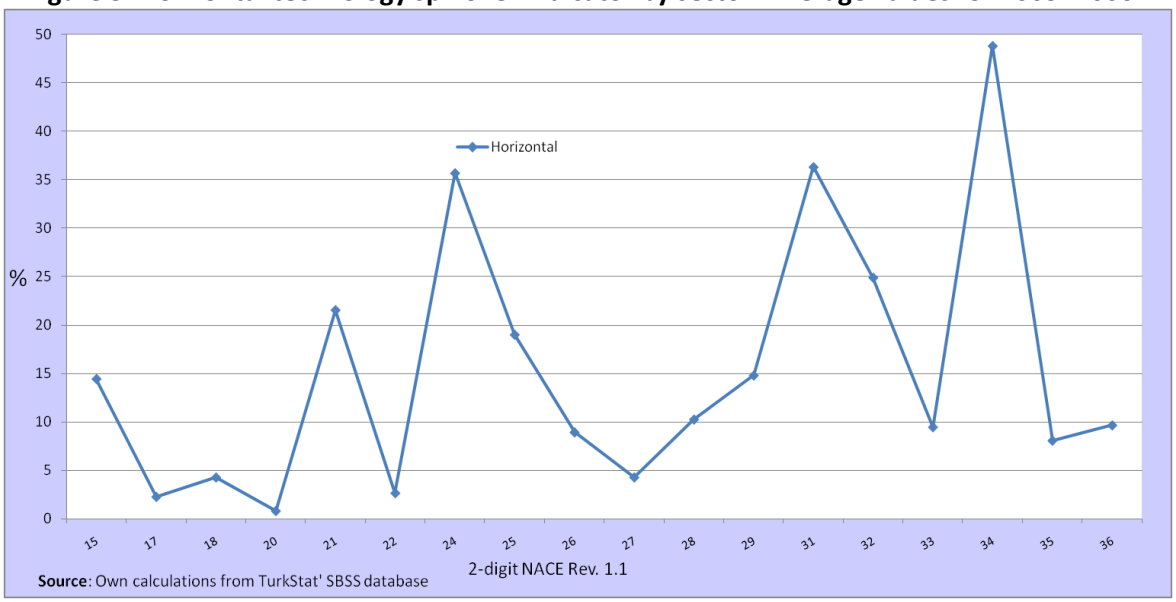
[23] A similar definition is used by Javorcik (2004), Blalock (2001) and Schoors and van der Tol (2001).

[24] In equation (2), FS equals zero as long as its value is less than 10%

25 We used alternatively employment as weights in equation as in Aitken and Harrison (1999) but the results do not change fundamentally.

In Figure 5 we present the average values of the horizontal technology spillover variable at the two-digit NACE level for the period 2003-2006. Significant variation across sectors is observed. The maximum value of the variable is 50% for the motor vehicles (NACE 34) sector, and nearly 35% for both electrical machinery (NACE 31) and chemicals products (NACE 24) sectors but it is below 5% for other five sectors (NACE 17-18-20-22-27). Its value ranges from 50% in motor vehicles to 1% in wood products.

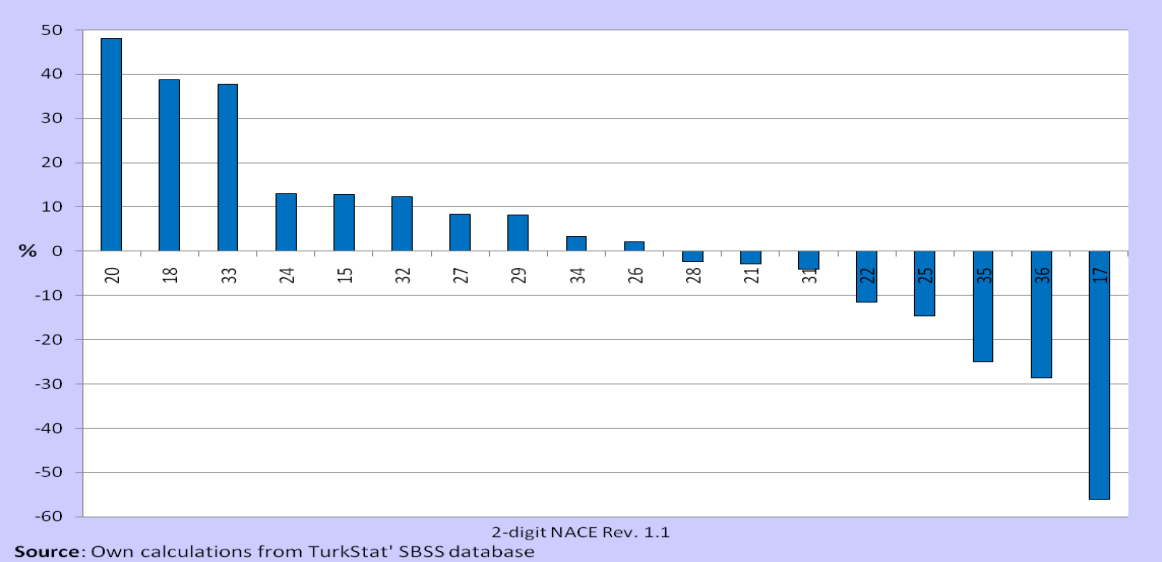
Figure 5: Horizontal technology spillover indicator by sector: Average values for 2003 -2006*



* for NACE codes used on the horizontal axis, see Table 1.

Figure 6 presents changes in the value of horizontal spillover variable in each sector between 2003 and 2006.

Figure 6: Change in Horizontal measure 2003-2006*



Source: Own calculations from TurkStat' SBSS database

* for NACE codes used on the horizontal axis, see Table 1.

Ten sectors registered a rise in the horizontal spillover measure, with three of them experiencing a change of more than 38 percentage points and the rest recording a change comprises between 10 and 3 percentage points. The largest change was observed in wood products (20 points), wearing apparel (18 points) and medical instruments (33 points).

Control variables

To isolate the factors other than FDI-related technology spillovers that might affect firm-level productivity we use three control variables.

Foreign share (FS_{ijt}) is the share of foreign capital in a firm's total equity. It is used to test for the existence of a foreign ownership effect on productivity.

The first one is *the Herfindahl-Hirschman Index of concentration of sales (Herfindahl)*, which measures the degree of concentration of sales in a sector. If a sector has a low concentration ratio this may indicate more intense competition between firms and exert a positive effect on their productivity level (Javorcik 2004). But a low market share might also impact negatively on R&D expenditures, hence on productivity level. To separate the concentration effects from horizontal

spillovers we added to the model the Herfindahl index at the four-digit sector level[26]. It is calculated in the following way.

$$\text{Herfindahl}_{jt} = \sum_{i} (\text{Share}_{ijt})^2, \text{ where } \text{Share}_{ijt} = \frac{Y_{ijt}}{\sum_{i} Y_{ijt}}$$

The second control variable is related to the scale of the firm. Those firms that produce more than the 'average' firm in the sector, in general, might benefit from scale economies, which might lead to higher productivity levels. To account for this factor, an indicator of firm scale defined as a firm's production divided by the average production volume in its four-digit NACE sector, is included in the model. A positive coefficient is expected for this variable. If we denote by N the number of firms in the four-digit level NACE rev.1.1 sector *j*, it is calculated as follows:

$$\text{Scale}_{ijt} = \frac{Y_{ijt}}{\sum_{i=1}^{N} Y_{ijt} \Big/ N}$$

Summary statistics of the variables used are presented in Table 3.

Table 3: Summary Statistics

	All Firms					Local Firms				
	Obs.	Mean	Std. Dev.	Min.	Max.	Obs.	Mean	Std. Dev.	Min.	Max.
lny	30178	15.47	1.43	8.16	22.34	28689	15.38	1.37	8.16	22.34
lnk	30178	11.76	2.09	0.12	19.34	28689	11.67	2.04	0.12	19.34
lnl	30178	4.27	0.96	3.00	9.19	28689	4.22	0.93	3.00	9.19
lnm	29761	14.79	1.67	0.04	21.91	28292	14.70	1.62	0.04	21.89
lne	29773	11.80	1.76	0.01	18.98	28292	11.73	1.73	0.01	18.98
Foreign Share	30178	0.04	0.17	0.00	1.00	-	-	-	-	-
Scale	30178	1.00	3.35	0.00	183.62	28689	0.87	3.04	0.00	183.62
Herfindahl	30178	0.03	0.04	0.00	0.36	28689	0.03	0.04	0.00	0.36
Horizontal	30178	0.12	0.12	0.00	0.76	28689	0.12	0.11	0.00	0.76
Horizontal_No Res	30178	0.12	0.12	0.00	0.76	28689	0.12	0.11	0.00	0.76
Horizontal_10% ≤ FS ≤ 49%	30178	0.02	0.02	0.00	0.13	28689	0.01	0.02	0.00	0.13
Horizontal_50% ≤ FS ≤ 99%	30178	0.06	0.05	0.00	0.53	28689	0.06	0.05	0.00	0.53
Horizontal_10% ≤ FS ≤ 39%	30178	0.01	0.01	0.00	0.06	28689	0.01	0.01	0.00	0.06
Horizontal_40% ≤ FS ≤ 69%	30178	0.03	0.04	0.00	0.27	28689	0.03	0.04	0.00	0.27
Horizontal_70% ≤ FS ≤ 99%	30178	0.04	0.04	0.00	0.53	28689	0.04	0.04	0.00	0.53
Horizontal_FS = 100%	30178	0.05	0.06	0.00	0.30	28689	0.05	0.06	0.00	0.30

Source: Authors' calculations from TurkStat's SBSS database.

26 This index is defined as the sum of the squared market shares of the enterprises in a given sector, and its value may range from 0 to 1. Higher values indicate a decrease in competition, whereas lower values indicate the opposite.

Distinction between export-oriented *versus* domestic market-oriented firms

As noted in Javorcik (2004), firms that produce for the export market may be benefit less from the FDI-related technology spillovers since in general they have few or no relationships with the foreign firms operating on the domestic market. To test this hypothesis we estimate our model separately on a sample of export-orientated firms where export-orientation is defined as an export intensity, i.e. firm exports divided by its gross output, of 50% or more. Domestic market orientation is defined symmetrically as an export intensity of less than 50%. Of course, such an assumption does not preclude that exporting firms might enjoy important technological capabilities to meet the high standards of their *foreign* customers and that technology and knowledge transfers might occur from these customers to them.

4) Estimation method and analysis of findings

4a) Econometric Estimation

We have a firm-level unbalanced panel dataset comprised of 37,008 observations over the period 2003-2006. We have the choice between the fixed effect (FE) and the random effect (RE) methods in the estimation of equation (2) in order to overcome a possible bias due to an unobservable time-invariant firm-specific effect which is included among explanatory variables. Indeed, in equation (2) the error term ϵ_{ijt} can be decomposed into two elements $\epsilon_{ijt}=u_i + v_{ijt}$: Here, u_i accounts for any unobservable time-invariant firm-specific effect (high quality management, for instance) not included in the regression but correlated with firm productivity. As to v_{ijt} , it varies over firms, sectors and time and is assumed to be normally distributed with mean zero and variance σ_v^2. This last term is assumed not to be correlated across firms, sectors, or time. If the OLS method is used for estimation, this might preclude us from taking into account a possible unobservable heterogeneity problem, which will lead to a heterogeneity bias. The FE model will produce consistent estimates in the presence of other variables not included in the model but affecting firm's productivity and correlated with the independent variables. On the other hand using the RE model will produce biased estimates since it is assumed that error term is uncorrelated with the regressors (Verbeek, 2008). Also to discriminate between fixed and random

effects models, we carried out the Haussmann test, which opted always in favor of the FE model. We also included a full set of year and sector dummies at the four-digit sector level (192) in equation (2) to account for the effect of common macroeconomic shocks and sector-level peculiarities on output growth.

We estimate our model alternatively on two samples: the first one with all the firms and the second one with only local firms so as to isolate a possible spillover effect on domestic firms. We also corrected standard errors for clustering within firms, as Moulton (1990) shows that regressions performed on micro units with aggregated sector variables lead to serious downward bias in the errors. Finally, we ran two models alternatively for export-oriented firms and domestic market-oriented firms for the reasons mentioned above.

4b) Analysis of findings

Estimation results are presented Table 4. The dependent variable is measured as the natural logarithm of the firm-level real gross output. First two columns report the results for the full sample and the sample of local firms, respectively. Fourth column pertains to export-orientated firms and the fifth one to domestic market-orientated firms.

Table 4: Determinants of firm-level output growth (Fixed effect estimation over 2003-2006)

	All Firms	Local Firms	Export Oriented Firms	Domestic Oriented Firms
lnk	0.017***	0.017***	0.011*	0.017***
	(0.002)	(0.002)	(0.006)	(0.002)
lnl	0.316***	0.314***	0.254***	0.316***
	(0.014)	(0.015)	(0.036)	(0.016)
lnm	0.277***	0.276***	0.312***	0.263***
	(0.014)	(0.014)	(0.033)	(0.015)
lne	0.054***	0.054***	0.047***	0.053***
	(0.005)	(0.005)	(0.011)	(0.006)
Foreign Share	0.034		-0.053	0.069
	(0.041)		(0.090)	(0.047)
Scale	0.164***	0.173***	0.123***	0.175***
	(0.018)	(0.021)	(0.028)	(0.025)
Herfindahl	-0.277*	-0.288*	0.039	-0.299*
	(0.121)	(0.131)	(0.386)	(0.136)
Horizontal	0.357***	0.374***	0.430*	0.366***
	(0.058)	(0.062)	(0.212)	(0.063)
Constant	9.749***	9.633***	8.820***	9.868***
	(0.282)	(0.275)	(0.474)	(0.315)
Observations	29388	27927	4652	24736
Number of Firms	7690	7390	1911	7147
Prob > F	467.16	413.32	40.37	143.67
R2	0.58	0.58	0.57	0.58

All regressions include year and sector dummies
Robust standard errors in parentheses corrected for clustering for each firm
*p<0.05, **p<0.01, ***p<0.001

First, we will examine estimation results for the first two models (columns 1 and 2 in Table 4). As expected, coefficients associated with the inputs are all positive and significant at the 0.1% significance level. The coefficients associated with two control variables are statistically significant. A unit increase in our firm scale indicator increases firm gross output by 0.16 %, an effect which is significant at 0.01 % level. Ceteris paribus, the degree of concentration of sales at the four digit-industry level tends to influence negatively firm output through its impact on frms' total factor productivity[27] but this impact is significant only at the 5% level. On the other hand, coefficient on the foreign ownership variable is not significant in the model including domestic as well as foreign firms. Contrarily to many existing studies which find a positive and significant effect for this variable, this finding may be explained by the fact that once other characteristics of foreign firms correlated with their ownership structure have been already taken into account – as this is the case of our paper – this ownership effect disappears[28].

As to the variable of interest, the indicator of FDI-related horizontal technology spillovers, it exerts a positive and statistically significant -at the 0.01 % level- effect output growth. The estimate of the associated coefficient is larger with the sample of local firms (0.37) than with the sample comprising all firms (0.36) but the difference is negligible. The first coefficient implies that a 1 percentage point increase in the horizontal spillover indicator – which is roughly the share of sector-level gross output achieved by foreign firms – is associated with a 0.37 percent increase in the gross output of local firms. Hence, our findings point to the existence of positive horizontal technology spillovers accruing from foreign to domestic firms in the Turkish manufacturing industry over the period 2003-2006. The econometric findings do not, however, enable us to disentangle the relative importance of different phenomena at the origin of the this positive and significant impact – it might be due to demonstration effects, competition effects, or to mobility of labor from foreign to domestic firms – or to any combination of them.

When estimation is performed on the sample of export- and domestic market-orientated firms (column 3 and 4 in Table 4), regression results do not change very much. Two significant changes occur with respect to results reported in the first column of Table 4. First, the indicator of

[27] The term *ln A* in equation (2).

[28] Taymaz and Ozler (2007) confirm this assertion in their study of the Turkish manufacturing sector over 1983-2001.

concentration is no more significant at the 5 % level for export-oriented firms while it remains significant for domestic market-oriented firms –this is an expected result since this indicator measures the degree of sales concentration on the *domestic* market. More important for the purpose of this study is the coefficient of the horizontal spillover variable, which is positive in both cases but now the level of significance differs: this impact is significant at the 0.01 % level for the domestic orientated firms while its level of significance is 5 % for export-oriented firms Therefore, these results tend to show that firms producing for the domestic market have benefited more intensively from the foreign presence in their sector compared to export-oriented firms through channels such as demonstration, competition or labor turnover effects.

Estimation results in Table 4 point to the existence and positive effects of FDI-based horizontal spillovers on output growth of domestic firms. Next, we use a number of alternative indicators for FDI-related horizontal technology spillovers and verify whether regressions results are robust to the indicator adopted. Indeed, a number of studies confirm that the degree of foreign ownership may be an important factor for the generation of horizontal spillovers[29]. For instance, the more modern and complex the technology, the more TNCs prefer to transfer it to an affiliate rather than to a third party by fear of losing its control. The risk of leakages of its intangible assets to a domestic partner will increase with the degree of involvement of the domestic partner in the partnership[30].

Since the degree of involvement of the foreign partner in the firm can be measured by its share in total equity, four different measures of foreign participation are used here[31]. The first one does not impose any restriction on foreign share (FS>0) while the second one is the indicator previously used in our study, i.e. with the share of foreign partner in total equity being equal to at least 10% (FS>10). Next, to analyze the impact of minority- and majority-owned joint ventures on spillovers, firms are categorized according to whether foreign share in equity is between 10% and 50% (10<FS<50), higher than 50% but less than 100% (50<FS<100) and finally whether full foreign ownership is observed (FS=100). Lastly, we divide foreign firms into four groups; foreign share between 10% and 39.9%, between 40% and 69.9%, between 70% and 99.9%, and

[29] For instance, see Blomstrom and Sjoholm (1999).
[30] Of course, other factors such as the absorptive capacity of local agents and the type of market aimed at by MNCs will influence the quantity and quality of technology transferred to the host country. See Kumar (1998).
[31]See Taymaz and Yilmaz (2008).

Table 5: Determinants of firm-level output growth with different spillover variables (1)
(Fixed effect estimation over 2003-2006)

	All Firms				Local Firms			
lnk	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnl	0.316***	0.316***	0.317***	0.317***	0.314***	0.314***	0.314***	0.314***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)
lnm	0.277***	0.277***	0.277***	0.277***	0.276***	0.276***	0.276***	0.276***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
lne	0.054***	0.054***	0.054***	0.054***	0.054***	0.054***	0.054***	0.054***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Scale	0.164***	0.164***	0.164***	0.164***	0.173***	0.173***	0.173***	0.173***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.021)	(0.021)	(0.021)	(0.021)
Herfindahl	-0.278*	-0.278*	-0.299*	-0.301*	-0.287*	-0.288*	-0.306*	-0.308*
	(0.121)	(0.121)	(0.121)	(0.122)	(0.131)	(0.131)	(0.132)	(0.132)
Horizontal (FS > 0%)	0.363***				0.375***			
	(0.058)				(0.062)			
Horizontal_ FS ≥ 10%		0.362***				0.374***		
		(0.058)				(0.062)		
Horizontal_ 10% ≤ FS ≤ 49%			-0.092				-0.216	
			(0.245)				(0.288)	
Horizontal_ 50% ≤ FS ≤ 99%			0.338***				0.355***	
			(0.063)				(0.067)	
Horizontal_ 10% ≤ FS ≤39%				0.374				0.365
				(0.296)				(0.315)
Horizontal_ 40% ≤ FS ≤ 69%				0.135				0.137
				(0.136)				(0.147)
Horizontal_ 70% ≤ FS ≤ 99%				0.360***				0.380***
				(0.067)				(0.071)
Horizontal_ FS=100%			0.403***	0.422***			0.410***	0.432***
			(0.062)	(0.064)			(0.066)	(0.068)
Constant	9.745***	9.748***	8.406***	8.415***	9.630***	9.633***	9.664***	9.643***
	(0.282)	(0.282)	(0.200)	(0.200)	(0.275)	(0.275)	(0.275)	(0.275)
Observations	29388	29388	29388	29388	27927	27927	27927	27927
Number of Firms	7690	7690	7690	7690	7390	7390	7390	7390
Prob > F	470.64	469.48	319.66	1023	619.45	413.32	333.03	744
R2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58

All regressions include year and sector dummies.
Robust standard errors in parentheses corrected for clustering for each firm
*p<0.05, **p<0.01, ***p<0.001

FS equal to 100%. We constructed different sector-level horizontal spillover indicators for each firm-specific foreign share variable and added them to equation (2). Different specifications of the original model are estimated using fixed effect methods for the entire sample of all firms, for local firms, for export- and domestic market- oriented firms. Estimation results are presented in Table 5 separately for all firms and for domestic firms only.

For all the models reported in Table 5, coefficient estimates obtained for the scale variable, the indicator of concentration and for input variables are qualitatively similar to those presented is Table 4[32]. Of more interest here are the estimates obtained for the different horizontal spillover indicators introduced in equation (2). The results for the first two spillover indicators point to a positive and significant impact on output growth, as could be expected from the findings in Table 4. The most striking result concerns, however, the respective impacts of minority- *versus* majority-owned joint ventures by foreign capital. We were unable to find any statistically significant impact of horizontal spillovers associated with minority joint ventures, however defined (foreign share less than %50 or 40%). On the other hand we found positive and significant estimates for spillover indicators associated with majority joint ventures (foreign share higher than 49% or 69%) and with full foreign ownership control (foreign share equals 100%). In addition, the size of coefficients associated with these spillover indicators is larger the larger the foreign share in firm equity and it is maximal in the case of full foreign ownership. In other terms, there is a positive relationship between the extent of foreign ownership at the firm level and the horizontal spillovers to which it leads. These findings do not change among the two samples on which regressions are run – i.e. all firms and only domestic firms.

Therefore, although foreign firms may try to minimize the leakage of their proprietary intangible assets toward their domestic partners in the host country by participation to capital in joint ventures, this leakage or involuntary diffusion of their assets occurs all the same. And our findings show that the recipients of these spillovers are domestic firms operating in the same sector activity as foreign firms – i.e. their competitors. An unexpected policy implication of this finding is that governments should not always intervene in order to increase the capital share of a

[32] We derived different firm-level FS variables for each spillover category and added them to the models in Table 5. We could not find, however, any significant correlation between the FS variables and output growth, so we did not include these firm-specific FS variables in the models.

Table 6: Determinants of firm-level output growth with different spillover variables (2)
(Fixed effect estimation over 2003-2006)

	Export Orientated Firms				Domestic Orientated Firms			
lnk	0.011*	0.011*	0.011*	0.011*	0.017***	0.017***	0.017***	0.017***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)
lnl	0.254***	0.254***	0.255***	0.255***	0.316***	0.316***	0.317***	0.316***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.016)	(0.016)	(0.016)	(0.016)
lnm	0.311***	0.311***	0.311***	0.310***	0.263***	0.263***	0.263***	0.263***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.015)	(0.015)	(0.015)	(0.015)
lne	0.047***	0.047***	0.047***	0.046***	0.053***	0.053***	0.053***	0.053***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.006)	(0.006)	(0.006)	(0.006)
Scale	0.124***	0.124***	0.124***	0.125***	0.175***	0.175***	0.175***	0.175***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.025)	(0.025)	(0.025)	(0.025)
Herfindahl	0.043	0.040	0.037	0.040	-0.300*	-0.301*	-0.328*	-0.331*
	(0.386)	(0.386)	(0.387)	(0.387)	(0.136)	(0.136)	(0.137)	(0.137)
Horizontal (FS > 0%)	0.429*				0.376***			
	(0.216)				(0.063)			
Horizontal_ FS ≥ 10%		0.415				0.375***		
		(0.216)				(0.063)		
Horizontal_ 10% ≤ FS ≤ 49%			0.182				-0.215	
			(0.710)				(0.271)	
Horizontal_ 50% ≤ FS ≤ 99%			0.340				0.361***	
			(0.241)				(0.067)	
Horizontal_ 10% ≤ FS ≤39%				-1.935				0.459
				(1.193)				(0.313)
Horizontal_ 40% ≤ FS ≤ 69%				0.465				0.100
				(0.317)				(0.149)
Horizontal_ 70% ≤ FS ≤ 99%				0.398				0.389***
				(0.275)				(0.070)
Horizontal_ FS=100%			0.568*	0.598*			0.406***	0.430***
			(0.256)	(0.267)			(0.067)	(0.068)
Constant	8.881***	8.825***	8.894***	8.920***	9.865***	9.591***	9.334***	9.884***
	(0.473)	(0.474)	(0.473)	(0.474)	(0.315)	(0.239)	(0.241)	(0.315)
Observations	4652	4652	4652	4652	24736	24736	24736	24736
Number of Firms	1911	1911	1911	1911	7147	7147	7147	7147
Prob > F	42.12	42.11	38.85	37.67	123.76	122.68	196.90	98.90
R2	0.57	0.57	0.57	0.57	0.58	0.58	0.58	0.58

All regressions include year and sector dummies
Robust standard errors in parentheses corrected for clustering for each firm
*p<0.05, **p<0.01, ***p<0.001

local partner in a joint venture. This might be accompanied by a less important – quantitatively or qualitatively – transfer of technology to the host country by foreign firms which could reduce the positive spillover or simply suppress it. The fact that the magnitude of the spillover effect is the most important in the case of full foreign ownership supports this view.

Table 6 shows regression results when estimation is performed alternatively on the sample of export- and domestic-orientated firms. Estimation results pertaining to the scale variable, the indicator of sales concentration and to input variables are qualitatively similar to those obtained previously in Table 4.

As for the impact of different spillover indicators on the output growth of export orientated firms, a positive and significant coefficient is obtained – albeit at a 5% significance level – only for the one based on full foreign ownership. In other terms, firms operating in the Turkish manufacturing sector but oriented toward export markets *do* benefit from FDI-related spillovers stemming from their sector of activity only when the foreign share in capital attains 100 %. In the case of domestic-orientated firms, regression results confirm our previous findings: we could not find any significant effect of horizontal spillovers on output growth for minority-owned joint ventures (less than %50 or 69) but we found positive and significant coefficients on horizontal spillovers for majority joint venture (higher than 50% or 70%) and for full foreign ownership control (100%).

4. Conclusion and suggestions for further research

In this chapter we carried out an econometric analysis to test for the presence of FDI-related intra-industry technology spillovers in the Turkish manufacturing industry over 2003-2006. We used a firm-level unbalanced panel dataset involving about 30 000 observations and a production function was estimated to this end. To the best of our knowledge this is the first econometric study on FDI-related spillovers in the Turkish manufacturing sector using firm-level data for the post 2001 period.

Our findings suggest that there are horizontal technology spillovers accruing from foreign to local manufacturing firms that operate in the same four-digit industry over 2003-2006. These spillovers

impact positively on firm-level output growth through their positive effect on the evolution of total factor productivity. This finding is in contrast to those of earlier studies on Turkish manufacturing industry on the same issue which found either a negative significant or a non-significant effect of FDI-related spillovers on firm performance. On the other hand compared to firms oriented toward the domestic market, linkages of export-orientated manufacturing firms with foreign firms operating in Turkey seem to be rather weak, resulting in a statistically insignificant impact of FDI-related spillovers on their productivity and growth rates.

The aforementioned finding as to the existence of a positive impact of FDI spillovers on firm output – through its impact on productivity – was obtained by adopting a very broad definition of foreign ownership, i.e. by considering as 'foreign' all those firms with at least 10 % of their capital owned by foreign agents. Next, we estimated our model by adopting different definitions of ownership mainly to distinguish between minority- and majority-owned firms by foreigners. The most striking result of our study is that we could not find any significant coefficient for the horizontal spillover indicators associated with minority joint ventures. However, we uncovered a positive and significant effect for horizontal spillovers related with majority joint ventures and with firms under full foreign ownership control. In other terms, firms with majority or full foreign ownership seem to be at the origin of intra-industry technology spillovers while minority-owned foreign firms do not.

Although a domestic share in firm capital higher than that of the foreign partner may reduce the volume and the quality of technology transfer which benefits to the domestic partner in a joint venture, this negative effect in our case is more than compensated by unintended technology transfers occurring to domestic firms operating in the same industry. The immediate policy implication of this finding is that governments should abstain from intervening in order to increase the share of domestic partners in joint ventures. When we distinguish between different degrees of foreign ownership and spillovers associated with them, there is evidence that export-oriented firms under full foreign control do benefit from FDI-based technology spillovers.

The findings of this study point to a number of problems when it comes to identify the effects of FDI spillovers but also suggest a number of directions into which research can be extended.

Firstly, the econometric investigation conducted in this chapter should be repeated once more recent firm data become available. This is all the more necessary since it may take a long time for FDI-spillovers to produce their final impact and since the findings of previous studies on FDI-spillovers pertaining to the pre-2001 period in Turkey are different from the ones obtained here.

Secondly, one can and should go one step further and investigate the existence of *vertical* FDI-related spillovers and their impact on the performance of domestic suppliers and customers of foreign firms[33]. The horizontal *vs.* vertical FDI-spillovers issue is an important one since some researchers maintain that searching for horizontal spillovers is equivalent to looking into wrong direction and that it is likely that only vertical FDI spillovers do exist[34]. This affirmation might have a solid base because of the unintended nature of technology transfers in the case of horizontal spillovers while transfers involving vertical spillovers –also called linkages– might be in the interest of both parties.

Finally, although findings of econometric studies have the benefit of generalization they act very often as a black box, not enabling to uncover the mechanisms behind the results obtained. For instance, in our case it is difficult to establish whether demonstration or competition effects, or labor mobility are behind the positive spillover effect obtained. The same remark would be pertain to a study testing the existence of vertical FDI spillovers Case studies pertaining to particular firms or field research oriented at several firms through questionnaires should be carried out to uncover what causes such effects or lack of it[35].

In any case the increase observed in FDI flows towards emerging economies, the major role of MNCs in the transfer of technologies, in general and the few studies conducted for the Turkish economy where the ratio of FDI inflows to GDP has increased since the early 2000s – none for the post-2001 period to our knowledge – in particular, point to the importance of conducting other studies such as this one for the Turkish economy.

[33] Lenger &Taymaz (2006) use sector-level data while Taymaz &Yilmaz (2008) use firm-level data to implement such a study for the pre-2001 period in the Turkish manufacturing sector.
[34] For instance, see Javorcik (2004).
[35] For instance, see Pamukçu &Sönmez (2011) for such a field study in the case of the Turkish automobile industry.

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