The Role of Human Capital In Productivity Spillovers from FDI: An Empirical Analysis on Turkish Manufacturing Firms*

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Abstract

The importance of human capital skills in allowing for productivity spillovers from foreign direct investment (FDI) to domestic firms at the country (macro) level is well established in the literature. In this paper, using firm-level data, we decompose this effect and investigate through which channel of linkages human capital endowments of local firms act as an absorptive capacity. An unbalanced panel data of Turkish manufacturing firms covering the period 1990-2001 is used. The firm-level total factor productivities (TFP) are calculated following Levinsohn-Petrin methodology. The role of human capital endowments of firms in allowing for horizontal and vertical linkages to enhance the local firms' total productivities is tested regressing this TFP measure on indicators of the skill composition of firms, linkage measures and interactions of these two terms. The results of suggest that there are positive productivity spillovers through backward linkages, while horizontal and forward linkages play no role in contributing to the productivities of local firms. A deeper investigation suggests that horizontal linkages matter positively only for local firms with more human capital/skilled labor.

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1 Introduction

The transfer of new technologies and techniques has a key role in economic growth and development of a country. This technology diffusion may take place through different channels, among which foreign direct investments (FDIs) are considered to be very important. Multinational companies (MNCs) operate with a higher level of technology to be able to compete with domestic firms which are familiar to the local market conditions, business practices and consumer preferences (Blomström and Sjöholm, 1999). This characteristic of MNCs enable domestic firms to gain access to new technologies through imitating the products and techniques of the foreign firms or gaining access to their managing and marketing skills. Therefore, policy makers have started to apply policies to attract FDI believing that the technology transfer from MNCs to domestic firms takes place and increases the productivity of domestic firms.

The empirical literature that analyzes the effects of technology transfers from MNCs to domestic firms has shifted focus to exploring the effects of FDI on domestic firm productivity by using micro-level data. These studies investigate two different channels that link domestic firms and foreign firms. The earlier literature examines the effect of an increase in foreign presence within the sector that domestic firm operates in. This intrasectoral channel is defined as horizontal linkage in the literature. However, the studies have found that horizontal linkage either has negative or no effect on domestic firm productivity. This investigated interest in evaluating intersectoral linkages between domestic and foreign firms. These channels are defined as backward and forward linkages, where the former is the relationship between domestic and foreign firm when the domestic firm is the input supplier of the foreign firm, and the latter is the relationship when foreign firm is the input supplier of the domestic firm. The studies that analyze the intersectoral effects of FDI mostly provide evidence on positive productivity spillovers through backward linkages.

Furthermore, the literature suggests that existence, direction or magnitude of spillovers from FDI through above defined channels may differ according to the characteristics of domestic firms. In other words, domestic firms may possess some characteristics that enable them to benefit more from foreign presence which are called "absorptive capacities" and not taking these capacities into consideration in spillover analysis may produce insignificant or biased results (Mervelede and Schoors, 2005). In the micro literature these absorptive capacities refer to the technology gap of the domestic firms with its foreign competitor, export status and size of the domestic firms.

In the literature focusing on macro data, Borensztein et al. (1998) and Xu (2000) suggest that in order to benefit from FDI inflows, countries should possess a minimum threshold level of human capital. They find that above this threshold level the countries with higher levels of human capital benefit more from FDI inflows. Taking cue from these macro level studies, the following analysis tests for the existence of a similar absorptive capacity story using firm level data. In other words, the question of whether the possible spillovers from FDI on domestic firm productivity differs across domestic firms that possess different levels of human capital is studied.

The plant-level data set used in this study is gathered from the Turkish Statistical Institute (Turk-Stat). It is a data set on Turkish manufacturing industry and it covers the period 1990-2001. The analysis does not cover the years after 2001 due to the change in the database of the survey. Details of the dataset are provided in section 3.

For the purpose of our study, first the total factor productivity (TFP) of firms are estimated. Then, by using the estimated TFP as the dependent variable, spillover effects of FDI on domestic firm productivity are examined through above defined linkages. This analysis is similar to a study on spillover effects by Yılmaz and Özler (2005) who utilize Turkish manufacturing firm-level data set for the years 1990-1996. Therefore, in the first part of the below study, the period of the analysis of Yılmaz and Özler (2005) is extended to cover years up to 2001 which include the time period aftermath of the Customs Union Agreement with European Union countries signed in 1996. As can be seen from Figure 1, the average FDI inflows to Turkey throughout the years 1990-1996 is $741 million while this average increases to \$878 million for the years 1997-2000[1]. Also, the extent of the data is quite long compared to other micro-level studies in the literature[2]. This is important in the sense that the data is long enough to record changes in foreign ownership of individual firms and overall macroeconomic conditions.

Finally, we investigate whether the possible impact of MNCs on domestic firm productivity differs across domestic firms that possess different levels of human capital. In other words, we ask whether the existence, direction or magnitude of spillovers on domestic firm productivity through horizontal, backward and forward linkages depends on human capital level of domestic firms[3].

Before the main findings are summarized, it is worth noting that two alternative set of regressions are reported. While in the first sets of regressions we report the effects of foreign firms' presence on the *level* of TFP, for comparison with Borensztein et al. (1998), in the second set of regressions we repeat the exercise using the *growth rate* of TFP as the dependent variable. The results of level regressions capture the jumps in the TFP level of firms due to a percentage-point change in linkage measures. On the other hand, growth regressions capture the effect of a percentage-point change in linkage measures on the growth rate of firm-level TFP. In other words, while the first one captures a jump with no change in trend the latter captures a trend change.

The results support the role of human capital as an absorptive capacity. Evidence suggests that there are positive *backward spillovers* on *firm-level* productivity if the skilled employee share of a domestic firm is *smaller* than 12 percent. Moreover, as the domestic firms possess lower levels of human capital, they benefit more from foreign presence in the downstream sector.

The economic intuition behind these results can be as follows. MNCs provide direct supervision to their input suppliers since they benefit from high-quality inputs. However, due to competition MNCs

[1] The year 2001 is not included in the average simply because of the fact that there is a large jump in FDI inflows due to the large amount of credit provided by the mobile phone arm of Telecom Italia, the foreign partner of the GSM Is-TIM Telekominikasyon Hizmetleri A.S. company. Furthermore, in 2002, FDI inflows fall back to \$1130 million which further strengthens the view that 2001 is an outlier.

[2] See, for example, the studies of Javorcik (2004) over the period 1996-2000, Yilmaz (2005) over the period 1990-1996 and Mervelede and Schoors (2005) over the period 1996-2001.

[3] The definition of human capital is discussed in section 3.

may prevent information leakages to their domestic suppliers that produce similar goods, yet in different sectors, with them. The domestic suppliers that have higher levels of human capital may also be the ones that produce similar products with MNCs. Therefore, MNCs may choose to work with firms that have low levels of human capital and carry their direct supervision to these firms.

Another reason for MNCs to choose to work with domestic suppliers with low human capital could be as follows. It is highly probable that high-tech domestic suppliers with higher levels of human capital supply inputs at high costs. Then, it may be less costly for MNCs to supervise the domestic suppliers with low levels of human capital and purchase their inputs from these suppliers than to purchase higher-quality yet more expensive inputs from high-tech domestic suppliers. Again, by this way the domestic firms with low levels of human capital may realize productivity increases through direct transfer of knowledge.

On the other hand, the results suggest that the spillover effects from FDI through horizontal and forward channels on the TFP *level* of domestic firms are not affected by the human capital level of these firms.

Furthermore, in analyzing the TFP *growth* of domestic firms, results suggest that a domestic firm may benefit from FDI inflows to the sector that it operates in, i.e. through horizontal linkages, only if it possesses a minimum threshold share of skilled employee (which is equal to 35 percent). Above this threshold level, as human capital level of domestic firms increases, the positive impact of horizontal linkage on domestic firm's TFP growth increases. This finding supports the results of Borensztein et al. (1998) and Xu (2000) at the firm level.

Finally, growth regressions suggest that the spillover effects of FDI on growth rate of firms' TFP through backward and forward linkages do not differ across domestic firms that possess different levels of human capital.

The rest of the study is structured as follows: section 2 reviews the literature on spillover channels, section 3 discusses the data and estimation strategy. The results of the study and some robustness checks are presented in section 4 and section 5 concludes.

2 Literature Review on Spillover Channels

This study analyzes the spillover channels of FDI. The spillovers may take place through three different channels; horizontal, backward and forward. The horizontal spillovers take place when domestic firms benefit from foreign affiliates which are operating within the domestic firm's sector. The backward linkage is defined as the relation between domestic and foreign firms when the domestic firm operates as the input supplier of the sector that multinational operates in. The spillover benefits may be realized through forward linkages when multinational operates at the upstream sector of the domestic firm; in other words, multinational operates as the input supplier of the domestic firm. In this section, we give a brief review of spillover channels and the review the relevant literature.

The horizontal spillovers may be realized through imitating the foreign technologies, techniques and managerial skills. Also, to gain access to more efficient techniques, local firms may hire workers trained by multinationals (namely, labor turnover). Furthermore, existence of a foreign affiliate in the sector may create a competition effect and domestic firms may try to catch up with multinationals through research and development activities and reallocation of resources (Blomström and Kokko, 1998). Finally, international trade brokers, accounting firms, consultant companies and other type of professional services which multinational corporations require may become available to domestic firms (Blalock and Gertler, 2003).

On the other hand, the competition effect created by multinational entrance may prevent horizontal spillovers from taking place. Multinationals competing with domestic firms may try to inhibit information leakages. They may impede domestic firms to gain access to their efficient technologies and techniques by using intellectual property rights and trade secrecy or paying higher wages than domestic firms are able to pay to prevent labor turnover (Javorcik, 2004). Also, as multinationals acquire market shares in the host economy, this may divert demand from domestic firms and increase their average costs. This may further decrease the domestic firm productivity (Aitken and Harrison, 1999). Furthermore, by hiring skilled workers, multinationals may cause "brain drain" in the local sector (Blalock and Gertler, 2003).

The recent literature has suggested that MNCs do not have such incentives of preventing information leakages to upstream or downstream sectors, and hence, the benefits of FDI may be instead realized through vertical (backward and forward) linkages.

Backward spillovers are possible if the transportation cost between host and home country is high enough, and hence, multinationals have an incentive to source locally. As multinationals demand higher-quality inputs, they will try to improve the efficiency of their intermediate input suppliers by direct knowledge transfer. Furthermore, just because multinationals demand higher-quality inputs, to be able to sell their products to foreign affiliates, local suppliers will have an incentive to improve their production techniques. Finally, entrance of a multinational into the final goods sector may create benefits of scale for domestic suppliers (Javorcik, 2004 and Blalock and Gertler, 2003).

In addition to backward spillovers, another type of intersectoral benefits may be realized through forward linkages. Domestic firms who gain access to higher-quality intermediate inputs and to the complementary services provided for these inputs may present higher levels of productivity (Javorcik, 2004).

On the contrary, local suppliers may not be able to meet the standards of MNCs and have difficulty in supplying higher-quality inputs that foreign firms demand. This may limit the spillovers through backward channels (Mervelede and Schoors, 2005). Similarly, forward spillovers may be limited if domestic firms are not able to utilize the high-quality and more expensive inputs that are produced by MNCs.

The literature that investigates the possible spillover effects of FDI mostly provide mixed results. The earlier studies focusing solely on the horizontal spillover channels starts with industry-level analysis. These studies mostly point to a positive correlation between FDI presence and average value added per worker[4]. However, the positive correlation in these studies may arise from the reverse causality problem. In other words, MNCs may have a tendency to operate in more productive industries. Also, exit or contraction of domestic firms due to the the competition effect created by multinational entry might be increasing the share of productive firms in the industry which can be another reason for this positive correlation (Aitken and Harrison, 1999).

To overcome the above defined problem, case-level studies regarding the spillovers from *a* specific MNC to firms in the sector MNC operates in were undertaken[5]. However, the problem with these case-level studies is their findings are specific to the multinational they focus on. Therefore, the results of these studies are limited in providing a general result on FDI spillovers.

Therefore, the literature has evolved to focus on firm-level panel data studies. These include the studies on developing economies (see Haddad and Harrison (1993) on Morocco, Aitken and Harrison (1999) on Venezuela, Blomström and Sjöholm (1999) on Indonesia, Djankov and Hoekman (2000) on the Czech Republic, Konnings (2001) on Bulgaria, Romania and Poland) and on developed economies (see Haskel et al. (2002) on U.K. and Keller and Yeaple (2003) on U.S). There are two main questions asked in these studies. First, they examine whether the firms acquired by multinationals are more productive than their domestic counterparts. This is called the *direct effect* of FDI and most of the studies in the literature find this direct effect to be positive. Second, they ask whether there are *spillover effects* from MNCs to the domestic firms through horizontal linkages. In other words, they examine the impact of an increase in foreign presence within the sector that domestic firm operates in on firm productivity.

The spillover effects are found to be insignificant or negative in studies that focus on developing

[4] See, for example, Caves (1974), Mansfield and Romeo (1980), Blomström and Persson (1983), Blomström and Wolff (1994) and Blomström (1999).

[5] See, for example, Larrain et al. (2001) and Moran (2001).

countries[6]. Haskel et al. (2002) and Keller and Yeaple (2003) find positive spillovers from FDI when investigating the possible benefits in a developed country context. The difference in results between two types of studies may arise from the fact that in developed countries domestic firms may have higher levels of absorptive capacities allowing them to benefit from MNCs.

Then, micro level studies that focus on vertical linkages besides horizontal linkages were conducted. The studies focusing on both horizontal and vertical linkages found that vertical spillovers are more likely to take place. Schoors and Tol (2001) on Hungary, Blalock and Gertler (2003) on Indonesia, Mucchielli and Jabbour (2003) on Spain, Sasidharan and Ramanathan (2007) on India have found positive backward spillovers from FDI.

There are two more studies analyzing the spillovers through both horizontal and vertical channels which are important for this study. Javorcik (2004) who analyzes the spillover effects of FDI, uses a firm-level data from Lithuanian manufacturing industry covering the period 1996-2000. Her results indicate that there are only backward spillovers from FDI. In other words, an increase in the foreign presence in the downstream sector of the local supplier leads to a statistically significant rise in productivity of this supplier. On the contrary, there is no evidence of spillovers from multinationals that operate at the same sector with domestic firms, i.e. no horizontal spillovers from FDI. Furthermore, the results suggest that there are negative effects of foreign suppliers to their domestic customers, i.e. negative forward spillovers.

Yılmaz and Ozler (2005) study the firms in the Turkish manufacturing industry over the period 1990-1996. They find that positive spillovers from foreign presence on firm-level productivity takes place only through horizontal and forward linkages, with no evidence for spillovers from multinationals through backward linkages they construct. Hence, they suggest that using these two linkages in the same regression may create multicollinearity. Therefore, they calculate product-based linkage measures

[6] This argument is not valid for Blomström and Sjöholm (1999) who found positive spillovers for Indonesia.

instead of industry-based linkage measures which produce low correlations among each other and allow simultaneous inclusion of these linkage measures in the analysis. The results of their analysis suggest that the product-based measures produce evidence for statistically significant but economically insignificant positive backward spillovers, while horizontal and forward channels lose their significance.

These mixed results for spillovers from FDI on firm productivity may lead one to think that the net effect of these linkages should be evaluated by taking firm-specific characteristics into consideration.

3 Literature Review on Absorptive Capacities

In this section, we will discuss the absorptive capacities of domestic firms that affect the existence, direction and magnitude of spillovers and review the literature on absorptive capacities. The absorptive capacities are defined as the technology gap between the domestic and foreign firm, export status and size of the domestic firms in firm-level studies.

The studies which consider technology gap between domestic and foreign firms as an absorptive capacity, propose that in the case of large technology gaps an increase in foreign presence may hurt domestic firms through the competition effect. On the other hand, small technology gaps may stimulate a productivity catch-up by domestic firms (Mervelede and Schoors, 2005).

Studies by Castellani and Zanfei (2001) on France, Italy and Spain and by Mervelede and Schoors (2005) on Romania, define absorptive capacity of the domestic firm as the technology gap between foreign and domestic firms. Castellani and Zanfei (2001), who focus solely on horizontal linkages, find that high technology gaps (low absorptive capacity) along with high levels of foreign productivity, have the highest positive productivity effects on domestic firms. On the other hand, Mervelede and Schoors (2005), who focus on both intersectoral and intrasectoral spillovers, propose that technology gap is not a source of heterogeneity in the case of horizontal spillovers. Backward spillovers are positive and high if the absorptive capacity of the domestic firm is high or low enough. The positive productivity effects through forward linkages increase as the absorptive capacity of domestic firm increases.

Lenger and Taymaz (2006), on the other hand, study spillovers analysis on two different type of firms in Turkish manufacturing industry; firms in low-tech industries and firms in medium- and high-tech industries. They also distinguish between spillovers in the form of facilitation of technological activity in the host economy (innovativeness) and technology transfer. Their results suggest no evidence for horizontal spillovers, both in terms of innovativeness and of technology transfer, to both type of firms. The forward spillovers hinder innovativeness of firms in medium- and high-tech industries. The backward spillovers, on the other hand, foster innovativeness of firms in medium- and high-tech industries. They further ask whether firms with different levels of skilled employee and size benefit more from spillovers and find that these characteristics of firms do not change their results.

On the other hand, the studies that investigate the role of export openness of domestic firms in spillovers from FDI suggest that domestic exporter firms, which are already competing with high-technology foreign firms, are more likely to benefit from FDI spillovers. In other words, if they possess characteristics that enable them compete with foreign firms in the export market, these characteristics may lead them to also benefit from FDI spillovers.

Girma et al. (2003) investigates whether the export status of the domestic firm is an absorptive capacity to allow for benefit from FDI. Using Irish manufacturing industry data, they find that exporter firms do not benefit more from FDI compared to their non-exporter counterparts. Mervelede and Schoors (2005), on the other hand, find that export status of domestic firms affects the impact of spillovers from FDI. However, the direction and magnitude of this effect are found to depend on other types of absorptive capacities in their study.

In this study we test for the role of human capital in allowing for firm-level spillover effects. The human capital level of domestic firms is important in the sense that it is a part of firm's technological capability. In other words, domestic firms that possess higher levels of human capital are more able to absorb technologies or managerial skills of foreign entrants. The effect of human capital on the direction of possible horizontal, backward and forward spillovers can be explained as follows.

In the case of horizontal spillovers, skill level of domestic firms are important since imitation of foreign technology, operational and management skills require some level of human capital. Therefore, one can expect that domestic firms that possess higher levels of human are more capable of imitating foreign technology. Hence, firms with higher human capital may realize higher productivity spillovers from FDI through horizontal linkages.

On the other hand, domestic firms with higher levels of human capital may be in more competition with MNCs than domestic firms with lower levels of human capital. Although there are no formal contracts between the domestic firm and MNC that operate in same sector, MNCs may prevent technology transfer to these high-tech firms with higher levels of human capital.

In order to benefit from backward spillovers, domestic firms have to be able to produce inputs that can meet the standards of MNCs. The firms that are more technologically advanced and possess high levels of human capital are more able to meet these standards. Therefore, these firms may have higher possibility to interact with MNCs as suppliers and the spillovers through backward linkages on domestic suppliers with high human capital may be higher. Furthermore, this may create higher competition for domestic suppliers with low levels of human capital and these firms may realize negative spillover through backward linkages (Mervelede and Schoors, 2005).

On the contrary, MNCs may not choose to work with these domestic firms endowed with higher levels of human capital for two reasons. First, these domestic suppliers may be the ones that are more technologically advanced, and hence, producing similar goods with MNCs, yet in different sectors. Therefore, to avoid competition, MNCs may choose to work with domestic suppliers which possess low levels of human capital.

Second, the domestic firms with higher levels of human capital may be producing high-tech inputs that are more costly. The MNCs that choose to operate in the host economy in order to purchase inputs at low costs may have an incentive to purchase from low-tech suppliers which are endowed with low levels of human capital. This may arise from the fact that, it may be less costly to give direct supervision to these firm than purchasing high-tech domestic suppliers' products. Therefore, the direct technology transfer from MNCs to domestic suppliers with low human capital may increase the productivity of these suppliers.

In the forward spillovers case, the high-tech and more expensive products of foreign firms can be used as an input by domestic suppliers with higher levels of human capital. These firms may realize productivity gains through increased quality of inputs, and hence, realize higher positive forward spillovers. Moreover, as these high-tech firms benefit from foreign presence in upstream sector, they may create a competition effect for low human capital firms. Thus, firms with low levels of human capital get hurt through forward linkages (Mervelede and Schoors, 2005).

On the other hand, as in the backward spillovers case, the domestic firms that possess higher levels of human capital may be producing similar, yet in different sectors, products with MNCs and in the downstream sector of MNCs. Therefore, to avoid competition, MNCs may prevent information leakages to these domestic firms.

Thus, one can say that the human capital level of domestic firms may affect the possible productivity spillovers from FDI and it should be taken into consideration in spillover analysis.

Human capital has been used as an absorptive capacity in macro-level studies. Borensztein et al. (1998) investigate the role of FDI in the economic growth of a country by utilizing data on FDI flow from OECD countries to 69 developing countries. In their base model, an increase in FDI flows to a country, by increasing the imitation possibilities, lowers the cost of production which in turn results in 'capital deepening', and hence, economic growth. The model suggests that since human capital is a complementary factor to physical capital, the effect of FDI on the growth rate depends on the human capital level in the host country. Their findings show that a country may benefit from FDI inflows only if it possesses a minimum threshold level of human capital. Furthermore, they suggest that as human capital of a country increases, a rise in FDI inflows increases the growth of GDP more. The aim of this study is to ask whether this country-level story is valid at firm-level.

4 Foreign Direct Investment in Turkey

In this section FDI trends in world and specifically in Turkey are discussed. Both developing and developed countries have started to adopt policies that facilitate the entry of FDIs into the economy, expecting that the possible spillover benefits take place and increase the productivity of domestic firms. Figure 2 presents the increasing trend of FDI inflows to both developed and developing countries.

The world FDI inflows in 2006 increased by 23 percent and reached $1,833 billion in 2007. In developed countries, the inflows increased by 25 percent and reached $1,247 billion while in developing countries they increased by 21 percent and reached $500 billion in 2007 from $412 billion in 2006.

However, Turkey's FDI inflows have been low until 2005. A comparison with similar economies in the region could provide a clear picture. Although, in 2001, Turkey was larger than Poland, the Czech Republic and Hungary in terms of population, GDP and investment, FDI inflows to these country's compared to Turkey was much higher (see Figure 3). Furthermore, the gap between FDI inflows to these countries and to Turkey increased after the 1997 EU negotiations of Poland, the Czech Republic and Hungary. Although the gap decreases in 2001, this arises from the fact that the foreign partner of the GSM Is-TIM Telekominikasyon Hizmetleri A.S. company, namely the Telecom Italia, gave credit which amount to $1.4 billion which is included into Turkey's FDI flows.

A clearer perspective about FDI inflows in Turkey is possible with the following numerical facts. As mentioned above, the average FDI inflows to Turkey throughout the years 1990-1996 was $741 million while this average slightly increases and reaches $878 million for the years 1997-2000 following the

Customs Union Agreement with EU countries[7]. FDI inflows to Turkey are mostly concentrated in the transport, storage and communication; finance; trade and repairs; motor vehicles and other transport equipment; petroleum, chemicals, rubber and plastic products industries where the first three industries belong to the services sector and the last two belongs to the manufacturing sector.

Due to data availability, this study focuses only on the manufacturing industry. Of the manufacturing sectors it includes above mentioned major manufacturing industries that receives high levels of FDI inflows. The details about the data set used in this study are given in the next section.

5 Data

5.1 Describing the Data Set

The data set used in this study is on the Turkish manufacturing industry collected by the Turkish Statistical Institute (TurkStat). This data set is available at TurkStat in a machine-readable form starting from 1980. Information on addresses of establishments are collected in two steps. First, TurkStat conducts Census of Industry and Business Establishments (CIBE) every 10 years for every industry except agricultural industry[8]. CIBE is collected from establishments that have 1 or more employees and possess information on addresses and employment of firms. For the entry and exit of establishments that have 10 or more employees, they gather information from the chamber of industry annually. After collecting addresses, TurkStat conducts Annual Survey of Manufacturing Industries (ASMI) at establishments with 10 or more employees[9]. However, in this study, only data on establishments with 25 or more employees is used simply because necessary variables are not available for the establishments that

[7] The average FDI inflows throughout the years 2002-2004 reached $1890 million and it increased to $1350 in the period 2005-2007. However, this analysis does not cover the period after 2001 due to the availability of the data.

[8] In the period of this analysis, CIBE is conducted only in 1992.

[9] TurkStat also gathers data on establishments with less than 10 employees. Until 1992 this data was collected as explained above. After 1992, the sampling method has been adopted for this type of establishments.

have 10-24 employees[10]. Finally, this study focuses only on private establishments[11].

Total number of firms and foreign affiliated firms included in this analysis are 5578 and 265, respectively. Table-1 presents the number of firms and foreign affiliated firms for each year in the analysis. Although, the number of firms and foreign firms have increased throughout the period of this study, the percentage share of foreign affiliated plants have only increased from 4.7 percent in 1992 to 5.7 in 2001.

The sectors with the highest foreign presence are industrial chemicals (351), other chemicals (352), electrical machinery (383) and transport equipment(384) as can be seen from Table-2. The sectors with the lowest foreign presence are leather products (323) and footwear (324).

Next, the variables used in the analysis are discussed. All data used in the analysis and detailed below are obtained from TurkStat.

5.2 Production-Side Variables

In this section, we detail the production-related data including output and input of the firms. Note that, all variables are measured in 1990 Turkish Liras.

Output is measured as the sum of the revenues from the annual sales of the firm's final products, the revenues from the contract manufacturing and the value of stock of final products at the end of the year minus the value of stock of final products at the beginning of the year. It is deflated by the relevant three-digit output price deflator.

Material inputs are measured as the sum of the value of purchases of intermediate inputs (except for the fuel) and the value of stock of material inputs at the beginning of the year minus the value of stock of material inputs at the end of the year. This variable is deflated by the relevant three-digit

[10] Although the time period of this analysis is 1990-2001, the capital stock series is constructed from 1983 in order to reduce problems arising from the initial capital stock calculation. However, detailed investment series needed for capital stock calculation is only available after 1991 for the firms that have 10-24 employees. Also, for these firms, the fuel consumption is included in material inputs and cannot be extracted. Therefore, the analysis excludes these firms.

[11] This data set is not on firms but is on establishments. However, Turkish manufacturing industry consists mostly of single plant establishments Yılmaz and Özler (2005).

input price deflator.

Energy variable is the sum of the values of fuel purchases and electricity used in production. Electricity used in the production is calculated as the sum of the value of electricity purchased and the value of electricity produced minus the value of electricity sold. Both electricity and fuel are deflated by their own price deflators.

Labor is measured as the number of employees of the firm in a given year. Also, skill disaggregation of labor is available from the data. The employees that work in production are classified as technical personnel, foremen and workers. Furthermore, technical personnel is disaggregated into middle- and high-level technical personnel. The employees that work in management are classified as management employees, office employees and other type of employees.

Firm level data on investment in machinery and equipment, building and structure, transportation equipment and computer and programming are available in the data. Except for computer and programming, all series are available since 1983. Computer and programming investment is reported since 1995. Since the disaggregated investment deflator is not available, the different investment series are deflated by the aggregate investment deflator[12].

Using these investment series, capital stock series for machinery and equipment, building and structure, transportation equipment and computer and programming are constructed applying the perpetual inventory method. The details about this method are of importance and are discussed in detail below.

Initial capital stock is calculated by assuming that the firms are at their balanced growth path. Therefore, denoting the initial year of the firm with “0”, initial capital stock is constructed as follows:

$$K_1 = (1 - \delta)K_0 + I_0 \tag{1}$$

[12] The aggregate investment deflator is gathered from Saygılı et al. (2005).

$$K_1/K_0 = (1-\delta) + I_0/K_0 \tag{2}$$

If the firms are at their balance growth path:

$$K_1/K_0 = Y_1/Y_0 = 1 + g_{0,1} \tag{3}$$

Therefore, substituting (3) into (2) and rearranging the equation we get[13]:

$$K_0 = I_0/(g_{0,1} + \delta) \tag{4}$$

Then, perpetual inventory method is applied to construct capital stock series:

$$K_t = (1-\delta)K_{t-1} + I_t \tag{5}$$

Following Yılmaz and Özler (2005), depreciation rates of 5%, 10%, 20% and 30% are used for building and structure, machinery and equipment, transportation equipment, computer and programming respectively, to construct initial capital stock and to apply the perpetual inventory method[14].

For the firms that report zero investment at their initial year, it is assumed that they can't be producing without capital. Therefore, initial capital stock is calculated at the year that they report positive investment and this amount is iterated back to the beginning year by dividing capital stock $(1-\delta)$ each year.

After calculating capital stock series for building and structure, machinery and equipment, transportation equipment, computer and programming, these series are aggregated to form the total capital stock series of the firm.

[13] The robustness checks for alternative initial capital stock calculation are presented in section 4.

[14] Robustness checks for different depreciation rates are provided in section 4.

Table-3 presents some summary statistics on the Turkish manufacturing industry. Foreign firms' average production is much higher than their domestic counterparts. Also, foreign firms are larger in terms of number of employees and are more capital intensive when one compares average employment and average capital/labor with their domestic counterparts. Finally, average total factor productivity of foreign-owned firms are much higher than domestic-owned firms. All of these differences between domestic and foreign firms are statistically significant.

Table-4 presents the sectoral summary statistics. Again the variables are statistically different among sectors. The sectors that have the highest production and employment are industrial chemicals (351), other chemicals (352), ceramics (361), glass (362), electrical machinery (383) and transport equipment (384). The most capital intensive sectors are beverages (313), textiles (321), industrial chemicals (351), other chemicals (352), ceramics (361), glass (362) and fabricated metals (381). Finally, the highest total factor productivity is at sectors food miscellaneous (312), wood products (331), other chemicals (352), fabricated metals (381) and electrical machinery (383).

These differences are important in TFP calculation. Since sectors have different tendencies in production-side variables, TFP calculation is conducted sector by sector rather than using the whole sample. Once TFP is calculated using above defined production-side variables, it will be regressed on linkage measures and control variables.

5.3 Linkage Variables

In this section, we discuss the calculation of the key variables, namely the horizontal, forward and backward linkages. This calculation requires the input-output matrix of three-digit industries. The input-output matrix is only available for the years 1990, 1996 and 1998. Therefore, we used 1990 matrix for the years 1990-1993, 1996 matrix for the years 1994-1997 and the 1998 matrix for the years 1998-2001.

Horizontal linkage that measures the relationship between domestic and foreign firm when they operate in the same sector is calculated as:

$$H_{jt} = \sum_{j\epsilon m}(f_{jt} * Q_{jt}) / \sum_{j\epsilon m} Q_{jt}$$

where f_{jt} is the foreign-ownership share of plant j at time t, Q_{jt} is the output of plant j at t. Therefore, H_{jt} can be defined as the share of foreign affiliated plants' output in sector j in total output of sector j. Note that, H_{jt} increases when there is an increase in foreign investment in sector j or an increase in output of foreign-affiliated plants in sector j.

The backward variable that measures the relationship between domestic and foreign firm, when domestic firm is the input supplier of the foreign firm, is calculated as:

$$B_{jt} = \sum_{j \neq m} \alpha_{jm} H_{mt}$$

where α_{jm} is the share of sector j's output supplied to sector m in total output of sector j.

The forward variable that measures the relationship between domestic and foreign firm, when domestic firm purchases inputs from foreign firm, is calculated as:

$$F_{jt} = \sum_{j \neq m} \sigma_{jm} H_{mt}$$

where σ_{jm} is the share material inputs purchased by sector j from sector m in total inputs purchased by sector j.

Hence, B_{jt} measures foreign presence in the industries that purchases inputs from sector j. On the other hand, F_{jt} measures the foreign presence in the industries that sell inputs to sector j. Note that inputs supplied in the same sector are not included in the formulas simply because of the fact that they are measured in H_{jt}.

In Table-5, the mean and standard deviation of linkage measures are presented. The average of horizontal linkage over the years 1990-2001 is 9.7 percent. This average is close to what Yılmaz and Özler (2005) find for the period 1990-1996, however, much lower than what Javorcik (2004) finds on Lithuania for the period 1996-2001. The average of backward is 3.7 percent in this study which is close to what Javorcik (2004) and Yılmaz and Özler (2005) find for their data sets. Finally, forward measure's average is 3.6 percent which is also close to the average that Yılmaz and Özler (2005) find, but lower than what Javorcik (2004)finds for Lithuania.

In Table-6, the averages of these linkage variables throughout the sample period are reported. Here, one can see that the averages of three linkages have increased throughout the period of this study but not significantly. Finally, in Table-7 the correlation coefficients of these linkage variables are shown to be quite low. Therefore, using all three linkage measures together in the regressions is not likely to create multicollinearity problem.

5.4 Control Variables

Following Javorcik (2004), we try to distinguish the technological spillovers from benefits of scale by controlling for a variable which is defined as the demand of other sectors for sector j's products and it is calculated as:

$$Demand_{jt} = \sum_{jm} a_{jm} Y_{mt}$$

where a_{jm} is the Input-Output matrix coefficient indicating that in order to produce one unit of good m a_{jm} units of sector j's goods are needed and Y_{mt} is the output of sector m at time t, deflated by three-digit sectoral price deflator. Furthermore, to be able to distinguish the competition effect from technological spillovers, again following Javorcik (2004), we use the herfindahl index in the regressions. The herfindahl index for sector j gives the industry concentration which takes smaller values if the industry is competitive.

5.5 Absorptive Capacity

It is expected that firms which posses higher levels of human capital realize higher productivity levels for a given level of input. Human capital of the firm is controlled by the share of skilled employees in total employees. Two alternative definitions are used for the extent of skilled employee. In the first definition, skill notion takes the education of workers into the account. In other words, employees such as high-level technical personnel and management staff are defined as skilled employees. Second definition includes on-the-job-training and includes middle technical personnel, foremen and office employees in the definition. The analysis is conducted using both definitions and results do not change significantly. Therefore, for the rest of the paper, the results of regressions using the first definition of skilled employee are reported in order to be consistent with the argument of Borensztein et al. (1998) who considers formal education level as the measure of human capital.

The average of skilled employee share over the whole period is 6.7 percent as shown in Table-5. The skilled employee share of firms on average seems to have been increasing from 1990 to 2001, although this increase is not statistically significant (see table-6).

6 Methodology

6.1 Methodology for TFP Calculation

To investigate the productivity effects of foreign direct investment, the earlier literature used Ordinary Least Squares (OLS) estimation of the Cobb-Douglas production function. However, OLS estimation of Cobb-Douglas production functions may create some methodological problems. The Cobb-Douglas production function can be represented as follows:

$$Y_{it} = A_{it}(K_{it})^{\beta k}(L_{it})^{\beta l}(M_{it})^{\beta m}(Eit)^{\beta e} \tag{6}$$

where Y_{it}, K_{it}, L_{it} M_{it} and E_{it} are output, capital, labor, material inputs and energy usage of firm i at period t, respectively. A_{it} is the efficiency level of the firm i at period t.

The logarithmic form of this function is as follows:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \beta_e e_{it} + \varepsilon_{it} \tag{7}$$

where small cases refer to natural logarithms of the variables. Due to possible measurement errors in TFP, $ln(A_{it})$ takes the form of $\beta_0 + \varepsilon_{it}$. Here, mean of efficiency level across producers and time is measured by β_0 and firm and time specific shocks to this mean are measured by ε_{it}.

However, as suggested by Griliches and Mairesse (1995), treating inputs of production as exogenous variables can create biases in the OLS estimation of equation (7). A firm's decision on how much freely variable inputs, namely the labor and material inputs, should be used in production at period t depends on the productivity of the firm at period t which is embodied in ε_{it} and this shock is observed by the firm prior to t, but not by the econometrician. If a firm observes an increase in productivity in period t, it will increase the amount of variable inputs used in production accordingly. This produces positive correlation between ε_{it} and β_l, β_e or β_m , which leads the econometrician to overestimate the relevant coefficients.

Another problem with OLS estimation of the production function is the selection bias. The selection bias can be explained as follows. Capital stock, as a state variable, responds to productivity shocks with a lag. If a firm possesses large amounts of capital stock, it will expect higher returns for a given level of productivity and, therefore, it will continue to operate in the market even if it observes low levels of productivity for the next period (Olley and Pakes, 1996). On the contrary, firms with lower levels of capital may not be able to remain in the market in similar conditions. Hence, for the firms that continue operating, this feature of capital stock will create a negative correlation between β_k and ε_{it} and the econometrician will underestimate the coefficient of capital.

There are several methodologies which try to overcome these problems. Olley and Pakes (1996) suggest to proxy productivity shocks with investment decision of the firms and therefore eliminate the relationship between productivity shocks and variable inputs. Moreover, they incorporate an exit-entry rule into the estimation procedure to overcome the selection bias.

Another methodology for TFP calculation is suggested by Levinsohn and Petrin (2003). They suggest that in data sets that include large number of zero observations in investment series, the investment cannot be monotonically increasing in productivity. Therefore, productivity shocks cannot be proxied by investment decisions. On the other hand, firms generally report material inputs positively. Moreover, it is less costly to adjust material inputs than to adjust investment. Therefore, material inputs respond to the productivity shocks better than investment and using investment as a proxy for productivity shocks may lead to some correlation between productivity shocks and variable inputs to remain (Petrin, Poi and Levinsohn, 2004). Hence, Levinsohn and Petrin (2003) introduce material inputs as a proxy into the estimation procedure.

The estimation procedure of Levinsohn and Petrin (2003) can be explained as follows: Disaggregating the error term in (7), ε_{it}, into productivity shocks known to the producer, ω_{it}, and unobservable shocks to the efficiency, υ_{it}, the following function is estimated:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \beta_e e_{it} + \omega_{it} + \upsilon_{it} \tag{8}$$

The demand for material inputs is assumed to be dependent on the firm's state variables:

$$m_{it} = h_i(k_{it}, \omega_{it}) \tag{9}$$

To understand the two-step estimation method, one needs to clarify the assumptions that are utilized in the procedure. First, they assume that intermediate inputs are monotonically increasing in productivity (invertibility condition). Therefore the inversion of the intermediate input demand function provides:

$$\omega_{it} = h_i(k_{it}, m_{it}) \tag{10}$$

They further assume that productivity shocks follow a first-order Markov process:

$$\omega_{it+1} = E(\omega_{it+1}|\omega_{it}) + \xi_{it+1} \tag{11}$$

From now on, we discuss the estimation procedure when the dependent variable is value added rather than output. The reason for this is when output is used as the dependent variable usually Levinsohn-Petrin is not able to identify the coefficients for material inputs, energy, labor and capital due to the lack of variation in data (Arnold, 2005). We find that this is also the case for the Turkish manufacturing industry. Therefore, we use value added, which is gross output net of intermediate inputs, as the dependent variable.

Value added is calculated as follows:

$$\nu_{it} = y_{it} - \beta_m m_{it} - \beta_e e_{it} \tag{12}$$

Therefore, the production function (8) can be written as:

$$\nu_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \upsilon_{it} \tag{13}$$

By substituting (10) into (13), the following production function is obtained:

$$\nu_{it} = \beta_l l_{it} + \phi_{it}(k_{it}, m_{it}) + \upsilon_{it} \tag{14}$$

where

$$\phi_{it}(k_{it}, m_{it}) = \beta_0 + \beta_k k_{it} + h_i(k_{it}, m_{it}) \tag{15}$$

Equation (14) is estimated by substituting a higher order polynomial in k_{it} and m_{it} for $h_i(k_{it}, m_{it})$. This first step of Levinsohn-Petrin (LP) gives a consistent estimate of β_l.

At the second stage, the coefficient β_k is identified. Since the coefficient of labor and predicted values of value added are known, one can write the estimated $\phi_{it}(k_{it}, m_{it})$ as follows:

$$\hat{\phi_{it}} = \hat{\nu_{it}} - \hat{\beta_l} l_{it} \tag{16}$$

From (15), it is known that

$$\omega_{it} = \hat{\phi_{it}} - \beta_k k_{it} \tag{17}$$

Also, the assumption that productivity shocks follow a first-order Markov process enables to predict ω_{it}:

$$\hat{\omega_{it}} = E[\hat{\omega_{it}} | \omega_{it-1}] = \gamma_0 + \gamma_1 \omega_{it-1} + \gamma_2 \omega_{it-1}^2 + \gamma_3 \omega_{it-1}^3 + \epsilon_t \tag{18}$$

Therefore, the sample residual can be written as:

$$\upsilon_{it} + \xi_{it} = \nu_{it} - \hat{\beta}_l l_{it} - \beta_k k_{it} - E[\hat{\omega_{it}}|\omega_{it-1}] \tag{19}$$

Finally, the coefficient of capital that minimizes (18) gives the consistent estimate of capital, β_k.

In this study, the Levinsohn-Petrin estimation procedure is used due to large number of zero observations in investment series in Turkish manufacturing industry[15]. We could have used Olley-Pakes by using only positive investment observations in order to avoid monotonicity problem. However, this causes loss of observations, and hence, efficiency. Also, since industries show statistical differences in output, employment and capital to labor ratios (see Table-4). Levinsohn-Petrin is applied to sectors individually rather than on the whole of the manufacturing industry.

Table-8 and Table-9 show the estimation results of the production function using OLS and Levinsohn-Petrin, respectively. As expected, the coefficient of labor decreases and that of capital increases when we use Levinsohn-Petrin instead of OLS.

6.2 Methodology for Spillover Analysis

Ultimately, in this paper the relationship between FDI and TFP is to be tested. For this purpose the calculated firm-level total factor productivity is regressed on industry-based linkage measures. To test for the spillover effects in line with Javorcik (2004) and Yılmaz and Özler (2005), we estimate the following regression[16]:

$$lnTFP_{ijrt} = \beta_0 + \beta_1 horizontal_{jt} + \beta_2 backward_{jt} + \beta 3 forward_{jt} \tag{20}$$

[15] 41 percent of the data on investment is composed of zero observations.

[16] Yılmaz and Özler (2005) suggest that two firms may be linked through both horizontal and backward linkages since they find the correlation between these two linkage measures to be 0.8. Therefore, due to multicollinearity problem, they calculate product-based measures for linkage variables. On the other hand, in our study, the correlations between the three measures are found to be quite low as can be seen from Table-7. Therefore, we continue to use these industry-based linkage measures in our analysis.

$$+control\ variables + \alpha_i + \alpha_r + \alpha_t + \varepsilon_{ijrt}$$

where $lnTFP_{ijrt}$ is natural logarithm of total factor productivity of firm i, operating in sector j, in region r, at time t. $Horizontal_{jt}$, $backward_{jt}$ and $forward_{jt}$ are linkage measures for industry j where firm i operates in.

Second, to be able to ask the absorptive capacity question, the below model is estimated:

$$lnTFP_{ijrt} = \beta_0 + \beta_1 horizontal_{jt} + \beta_2 backward_{jt} + \beta_4 forward_{jt} \tag{21}$$

$$+\beta_5 horizontal_{jt} \times skilled\ employee_{ijrt} + \beta_6 backward_{jt} \times skilled\ employee_{ijrt}$$

$$+\beta_7 forward_{jt} \times skilled\ employee_{ijrt} + \beta_8 skilled\ employee_{ijrt}$$

$$+control\ variables + \alpha_i + \alpha_r + \alpha_t + \varepsilon_{ijrt}$$

where interaction variables are added to equation (20). These interaction variables reflect the effect of the linkage measure on productivity when firms possess different levels of skilled employees.

The above regression may be ridden with endogeneity problems, where the skill composition of the firm's labor force may be dependent on the firm's productivity. In order to alleviate this problem we re-run the above regressions with a lagged structure of the skill composition of the firm taken into account. Hence, we complete the analysis by estimating the following equation:

$$lnTFP_{ijrt} = \beta_0 + \beta_1 horizontal_{jt} + \beta_2 backward_{jt} + \beta_4 forward_{jt} \tag{22}$$

$$+\beta_5 horizontal_{jt} \times skilled\ employee_{ijr,t-1} + \beta_6 backward_{jt} \times skilled\ employee_{ijr,t-1}$$

$$+\beta_7 forward_{jt} \times skilled\ employee_{ijr,t-1} + \beta_8 skilled\ employee_{ijr,t-1}$$

$$+control\ variables + \alpha_i + \alpha_r + \alpha_t + \varepsilon_{ijrt}$$

7 EMPIRICAL RESULTS

In this section, the effects of FDI on firm-level TFP are examined and results are presented in Table 10 through Table 12.

Table 10 provides the aggregate effects of each linkage channel on the productivity of local firms. Results suggest that the Turkish firms have no significant productivity spillovers from foreign firms through their horizontal linkages. On the contrary the vertical linkages seem to play a significant role in generating productivity spillovers, both negative and positive. Turkish local firms are found to be positively and somewhat significantly from the backward linkages with multinational firms. In other words, the positive sign of the coefficient reflects the view that MNCs increase the TFP level of their suppliers, though not statistically significant at all times. The forward linkages are found to robustly matter in generating negative productivity spillovers to the local firms from MNCs. The coefficient of the forward linkage measure appears to be negative and significant at 1% and 5% significance level. This finding may result from the fact that only high technology firms are capable of utilizing higher-quality and more expensive inputs produced by MNCs. Therefore, the forward linkage may hurt low-technology firms through increased competition. If the population of local firms are dominated by such low-tech firms who might be hurt from the high-tech local firms that are capable in capitalizing on t the higher-quality inputs provided by MNCs then forward linkages might hurt the overall local economy rather than benefit it.

The demand variable is statistically significant in all specifications indicating that there are indeed benefits of scale effects in this sample. The negative and statistically significant coefficient of the herfindahl index on the other hand is suggestive of positive productivity effects of a competitive market environment. The negative sign of the variable suggests that the firm level TFP decreases as the industry it operates in gets less competitive.

7.0.1 Absorptive Capacity Results

The results of spillover analysis which do not take absorptive capacities of domestic firms into account suggest no evidence for horizontal spillovers yet suggest evidence of vertical spillovers, i.e. positive spillovers from backward linkages and negative spillovers from forward linkages. However, as mentioned above, the firm-specific characteristics may determine the existence, direction or magnitude of spillovers and not taking them into consideration may produce insignificant results. Therefore, in this section, the results of the regressions that analyze spillover effects from FDI when human capital is considered to be an absorptive capacity among domestic firms are presented. The regressions are run on domestic firms and the results are presented in Table 11 and Table 12.

Table 11 reports results where the possible endogeneity between productivity and the skill composition of the firm's labor force is ignored, whereas Table 12 tries to deal with this problem by including the skill composition terms with one-period lag. Due to this here we only discuss the results reported in Table 12.

Here, one can see that the horizontal linkage remains to be insignificant where its interaction terms with skill share of the firm is positive and significant. The positive sign reflects the view that domestic firms that have higher levels of human capital realize increases in TFP from a rise in foreign presence in their sector. These results suggest that only loacl firms that have the skill composition to allow them to imitate or compete with the MNCs are able to positively and significantly benefit from the horizontal linkages with the MNCs.

The coefficient of the backward linkage is still positive and mostly statistically significant. Here, the positive sign of the backward variable indicates that an increase in foreign presence in the downstream sector of the domestic firm increases the productivity of domestic firms. The effect of backward linkage is found to be positive and independent of the skill composition of the local firms. Similarly, human capital of the local firms do not seem to play any significant role in allowing for the forward linkages to generate productivity spillovers.

8 CONCLUSION

This study analyzes the effect of human capital on the existence, direction and magnitude of possible productivity spillovers from FDI. The earlier literature used human capital as an absorptive capacity in macro-level studies. The aim of this study is to test whether the macro-level effect of human capital is valid at the firm level.

To investigate this, a firm-level unbalanced panel data from Turkish manufacturing industry over the period 1990-2001 is used. First, by using Levinsohn-Petrin semiparametric estimation procedure, the firm-level TFP is calculated. Then, the estimated TFP is regressed on three linkage measures in order to analyze the spillover effects of FDI. Finally, a deeper investigation of whether domestic firms with higher human capital benefit more from these spillovers is presented.

The results suggest that the human capital endowment of local firms , i.e. the skill composition of the local firms, are of significance only in allowing for the horizontal linkages to matter. Evidence suggests that as the general findings in the literature backward linkages are of importance in generating positive productivity spillovers, while the horizonral linkages are also of importance but only for the local firms that have the skill composition that allows them to either imitate or compete with the MNCs.

Therefore, this study proposes that firm characteristics are important determinants of spillovers from FDI and they should be taken into consideration in the spillover analysis. However, further investigation of these characteristics should be conducted in order to analyze the net effect of linkage measures on productivity. In other words, besides human capital, other firm characteristics such as the technology level, export openness, import openness, size and financial status of the firms could be used as absorptive capacities in the regressions. This remains as an issue for future research.

Table-1: Descriptive Statistics by Year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total number of plants	2944	2921	3178	3632	3764	4141	4305	4587	4867	4771	4771	4560
Number of FA plants	140	142	158	181	186	204	213	222	245	268	261	262
Percent of FA plants	4.7	4.8	4.9	4.9	4.9	4.9	4.9	4.8	5.0	5.6	5.4	5.7

Source: TurkStat.
Notes: Plants with 10 percent or more foreign ownership shares are defined as foreign affiliated (FA) plants.

APPENDIX

FIGURES AND TABLES

Table-2: Descriptive Statistics by Sector

Sector	All Plants-Years	FA Plants-Years	% of FA Plants
311	4592	311	6.7
312	1255	154	12.3
313	408	41	10
321	9239	235	2.5
322	6465	257	4
323	568	2	0.3
324	583	5	0.8
331	800	16	2
332	663	11	1.7
341	902	80	8.9
351	479	94	20
352	1525	354	23.2
355	800	67	8.3
356	2150	138	6.4
361	288	9	3.1
362	428	29	6.8
369	3689	124	3.3
372	703	28	4
381	4120	216	5.2
382	3169	220	7
383	2465	361	14.6
384	2510	368	14.6
390	640	42	6.6

Source: TurkStat.
Notes: Plants with 10 percent or more foreign ownership shares are defined as foreign affiliated (FA) plants.

Table-3: Summary Statistics by Year

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
All Plants												
Avg. Emp.	179	165	154	141	134	133	142	148	149	142	146	144
Avg. Output	29.1	32.5	35.9	37.8	33.2	35.9	35.7	40.7	38.7	39.2	43.7	44.1
Avg. K/L	91.7	94.5	109.9	123.2	127.6	146.3	124.7	137.7	139	155.5	142.8	150.5
Avg. TFP	4.7	4.8	4.9	5	4.8	4.9	4.9	5	5	5.1	5.1	5
FA Plants												
Avg. Emp.	525	534	506	466	420	391	380	386	400	371	399	400
Avg. Output	131.6	168.3	195.4	224.1	177	193.3	182.8	224.3	206.7	199.9	242.7	238.9
Avg. K/L	115.8	128.6	122.8	128.3	142.1	161.3	172.4	197.2	181.5	217.8	224.1	246.1
Avg. TFP	5.3	5.5	5.7	5.9	5.7	5.8	5.7	5.8	5.8	5.8	5.8	5.8
Local Plants												
Avg. Emp.	162	146	135	123	119	120	130	136	135	129	131	129
Avg. Output	24.1	25.6	27.5	28.1	25.8	27.8	28.1	31.3	29.7	29.7	32.2	32.3
Avg. K/L	90.5	92.7	109.2	122.9	119.2	145.5	122.2	134.7	136.8	151.8	138.1	144.6
Avg. TFP	4.6	4.7	4.9	5	4.8	4.9	4.9	5	5	5.1	5.1	5

Source: TurkStat.
Notes: Plants with 10 percent or more foreign ownership shares are defined as foreign affiliated (FA) plants. Output and capital/labor is in billion 1990 TL. Total factor productivity (TFP) is calculated by Levinsohn-Petrin production function estimation procedure.

Table-4: Summary Statistics by Sector

Sector	Avg. Output	Average Emp.	Avg. K/L	Avg. TFP
311	30.6	133	118.5	4.3
312	26.1	92	132.3	5.9
313	48.9	142	209	3.4
321	35.6	215	155.6	5.1
322	15	118	42	5.5
323	19.1	68	70.6	6.1
324	9.7	79	42.8	4.2
331	24.3	85	92.2	6.1
332	15.6	121	47.8	3.6
341	37.1	118	126.5	4.9
351	121.5	252	273.6	4.3
352	73.2	178	168.1	5.6
355	36.6	149	78.5	4.7
356	29.3	90	125.2	5.4
361	92.1	370	154.5	3.8
362	81.3	283	154.5	5.3
369	20.7	91	136.4	3.2
372	46.5	99	138.4	3.4
381	24.6	93	210.8	6.2
382	34.3	120	96.4	4.7
383	104.2	184	133.5	6.3
384	90.5	257	95.9	4.3
390	10	88	66	3.5

Source: TurkStat.
Notes: Plants with 10 percent or more foreign ownership shares are defined as foreign affiliated (FA) plants. Output and capital/labor is in billion 1990 TL. Total factor productivity (TFP) is calculated by Levinsohn-Petrin production function estimation procedure.

Table-5: Summary Statistics for Linkage Measures

Linkage Measure	Number of Observations	Mean	Standard Deviation
Horizontal	48441	0.097	0.109
Backward	48441	0.037	0.033
Forward	48441	0.036	0.023
Skilled Employee	48441	0.067	0.073

Source: Own calculations.
Notes: Horizontal, backward and forward are linkage measures that takes values from 0 to 1. Skilled employee is the share of skilled labor in total labor.

Table-6: Annual Linkage Measures

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Horizontal	0.067	0.080	0.084	0.088	0.094	0.096	0.093	0.093	0.098	0.105	0.110	0.126
Backward	0.023	0.027	0.030	0.033	0.037	0.039	0.039	0.039	0.038	0.039	0.040	0.046
Forward	0.026	0.029	0.030	0.030	0.036	0.037	0.031	0.031	0.033	0.038	0.049	0.052
Skilled employee	0.060	0.062	0.065	0.067	0.068	0.070	0.067	0.065	0.064	0.066	0.067	0.073

Source: Own calculations.
Notes: Horizontal, backward and forward are linkage measures that takes values from 0 to 1. Skilled employee is the share of skilled labor in total labor.

Table-7: Correlation Coefficients for Linkage Measures

	Horizontal	Backward	Forward
Horizontal	1.00		
Backward	-0.03	1.00	
Forward	0.21	0.01	1.00

Source: Own calculations.
Notes: Horizontal, backward and forward are linkage measures that takes values from 0 to 1. Skilled employee is the share of skilled labor in total labor.

Table-8: OLS Estimates of Production Function (1990-2001), Dependent Variable: Value Added

Sector	Labor***	S.E.	Capital	S.E.	No of Obs.
311 Food	1.01	0.03	0.22***	0.02	476
312 Food Miscellaneous	1.23	0.05	0.09***	0.03	1293
313 Beverages	1.35	0.14	0.19***	0.07	429
321 Textiles	0.99	0.02	0.17***	0.01	9492
322 Wearing Appeal	0.94	0.03	0.15***	0.01	6649
323 Leather Products	1.08	0.09	0.12	0.04	582
324 Footwear	1.26	0.08	0.11***	0.03	599
331 Wood Products	1.29	0.09	0.17***	0.03	828
332 Furniture	1.25	0.08	0.12***	0.04	675
341 Paper	1.22	0.12	0.25***	0.05	926
351 Industrial Chemicals	0.95	0.11	0.28***	0.06	502
352 Other Chemicals	0.98	0.06	0.30***	0.04	1600
355 Rubber Products	1.06	0.08	0.30***	0.03	827
356 Plastics	1.02	0.06	0.25***	0.03	2210
361 Ceramics	1.22	0.12	0.22***	0.05	296
362 Glass	1.13	0.09	0.25***	0.05	447
369 Nonmetal Minerals	1.28	0.05	0.31***	0.02	3806
372 Nonferrous Metals	1.15	0.09	0.18***	0.04	741
381 Fabricated Metals	1.02	0.04	0.26***	0.02	4246
382 Non-electrical Mach.	1.17	0.04	0.15***	0.02	3255
383 Electrical Machinery	1.04	0.05	0.25***	0.03	2569
384 Transport Equipment	1.11	0.03	0.19***	0.02	2579
390 Other Manufacturing Products	1.02	0.09	0.17***	0.03	666

Notes: S. E. denotes standard errors. ***, ** and * indicates the statistical significance at the 1, 5 and 10 % levels, respectively. Statistical significance indicators apply to all sectors if it is next to the variable name.

Table-9: Levinsohn-Petrin Estimates of Production Function (1990-2001), Dependent Variable: Value Added

Sector	Labor***	S.E.	Capital	S.E.	No of Obs.
311 Food	0.74	0.03	0.27***	0.05	4764
312 Food Miscellaneous	0.90	0.06	0.05	0.09	1293
313 Beverages	0.67	0.12	0.40***	0.12	429
321 Textiles	0.66	0.02	0.22***	0.03	9481
322 Wearing Appeal	0.67	0.03	0.16***	0.03	6612
323 Leather Products	0.71	0.07	0.13	0.14	582
324 Footwear	0.88	0.09	0.18**	0.08	599
331 Wood Products	0.71	0.11	0.10	0.10	828
332 Furniture	0.96	0.07	0.22**	0.09	674
341 Paper	0.90	0.14	0.17	0.10	925
351 Industrial Chemicals	0.91	0.16	0.25	0.20	502
352 Other Chemicals	0.63	0.08	0.27***	0.07	1599
355 Rubber Products	0.69	0.08	0.22*	0.13	827
356 Plastics	0.65	0.06	0.23***	0.05	2210
361 Ceramics	0.79	0.13	0.32	0.20	290
362 Glass	0.99	0.09	0.10	0.13	447
369 Nonmetal Minerals	0.89	0.04	0.29***	0.09	3722
372 Nonferrous Metals	0.87	0.10	0.34***	0.09	741
381 Fabricated Metals	0.67	0.04	0.14***	0.04	4242
382 Non-electrical Mach.	0.82	0.06	0.21***	0.06	3254
383 Electrical Machinery	0.66	0.06	0.18**	0.09	2569
384 Transport Equipment	0.79	0.05	0.27***	0.06	2579
390 Other Manufacturing Products	0.74	0.08	0.34**	0.15	666

Notes: S. E. denotes standard errors. ***, ** and * indicates the statistical significance at the 1, 5 and 10 % levels, respectively. Statistical significance indicators apply to all sectors if it is next to the variable name.

Table-10: Spillovers from FDI

Variable	1	2	3	4	5	6
horizontal	0.15	0.12			0.08	0.04
	(0.20)	(0.20)			(0.20)	(0.20)
backward			0.46	0.68**	0.44	0.66**
			(0.35)	(0.35)	(0.35)	(0.35)
forward			-1.04***	-0.83***	-1.04***	-0.83***
			(0.30)	(0.30)	(0.30)	(0.30)
demand		0.03***			0.03***	0.03***
		(0.01)			(0.01)	(0.01)
herfindahl		-1.56***			-1.73***	-1.74***
		(0.59)			(0.59)	(0.59)
No of observations	45948	45948	45948	45948	45948	45948
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The numbers in parenthesis denote standard errors. ***, ** and * indicates the statistical significance at the 1, 5 and 10 % levels, respectively. Sample includes data from 1990-2001. The dependent variable is ln(TFP). Foreign share is the foreign ownership share of the firm. Horizontal, backward and forward are sectoral linkage measures that takes values from 0 to 1. Skilled employee is the share of skilled labor in total labor. Demand is the amount of output of the sector that is used by other sectors. Herfindahl is the usual herfindahl index.

Table-11: Human Capital as an Absorptive Capacity: Level of Skilled Employee

Variable	1	2	3	4
horizontal	0.11	0.08	0.07	0.07
	(0.21)	(0.21)	(0.20)	(0.21)
backward	0.61	0.85**	0.84**	0.86**
	(0.37)	(0.37)	(0.38)	(0.37)
forward	-0.76**	-0.53	-0.52	-0.83***
	(0.35)	(0.35)	(0.34)	(0.30)
horizontal*skilled employee	-0.07	-0.08	-0.27	-0.15
	(0.83)	(0.82)	(0.81)	(0.83)
backward*skilled employee	-2.07	-2.96	-2.75	-2.88
	(1.95)	(1.95)	(1.98)	(1.97)
forward*skilled employee	-4.21	-4.40	-4.36	
	(2.99)	(2.99)	(2.94)	
skilled employee	0.46***	0.48***	0.71***	0.33***
	(0.16)	(0.16)	(0.19)	(0.12)
skilled employee square			-0.44**	
			(0.18)	
demand		0.03***	0.03***	0.03***
		(0.01)	(0.01)	(0.01)
herfindahl		-1.71***	-1.70***	-1.70***
		(0.59)	(0.59)	(0.59)
No of observations	45948	45948	45948	45948
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes

Notes: The number in parenthesis denote standard errors. ***, ** and * indicates the statistical significance at the 1, 5 and 10 % levels, respectively. Sample includes data from 1990-2001. The dependent variable is ln(TFP). Horizontal, backward and forward are sectoral linkage measures that takes values from 0 to 1. Skilled employee is the share of skilled labor in total labor. Skilled employee square is the square of skilled employee share. Demand is the amount of output of the sector that is used by other sectors. Herfindahl is the usual herfindahl index.

Table-12: Human Capital as an Absorptive Capacity: Lag of Skilled Employee

Variable	1	2	3	4
horizontal	-0.02	-0.04	-0.03	-0.04
	(0.23)	(0.23)	(0.23)	(0.23)
backward	0.36	0.64*	0.64*	0.65*
	(0.38)	(0.38)	(0.38)	(0.38)
forward	-0.33	-0.14	-0.13	-0.50
	(0.33)	(0.34)	(0.34)	(0.31)
horizontal*skilled employee	2.06***	2.03***	2.01***	1.81***
	(0.73)	(0.72)	(0.72)	(0.71)
backward*skilled employee	-0.44	-0.61	-0.62	-0.50
	(1.93)	(1.93)	(1.93)	(1.93)
forward*skilled employee	-5.67	-5.20	-5.27	
	(3.17)	(3.18)	(3.20)	
skilled employee	0.06	0.07	1.11	-0.10
	(0.17)	(0.17)	(0.19)	(0.14)
skilled employee square			-0.06	
			(0.17)	
demand		0.03***	0.03***	0.03***
		(0.01)	(0.01)	(0.01)
herfindahl		-1.85***	-1.85***	-1.85***
		(0.64)	(0.64)	(0.64)
No of observations	45948	45948	45948	45948
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes

Notes: The number in parenthesis denote standard errors. ***, ** and * indicates the statistical significance at the 1, 5 and 10 % levels, respectively. Sample includes data from 1990-2001. The dependent variable is ln(TFP). Horizontal, backward and forward are sectoral linkage measures that takes values from 0 to 1. Skilled employee is the share of skilled labor in total labor. Skilled employee square is the square of skilled employee share. Demand is the amount of output of the sector that is used by other sectors. Herfindahl is the usual herfindahl index.