“Impact of FDI on innovation in Tunisia’s high-tech industries”

AUTHORS	Sonia Seghir

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Sonia Seghir (Tunisia)

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Abstract

Foreign direct investment (FDI) has been traditionally considered as important channel in the diffusion of advanced technology. Whether it can promote technology progress for the host country is the focused problem. This paper analyzes the influences of FDI on the innovation activity of 17 high-tech firms in Tunisia via spillover channels with the panel data model.

The results indicate that the spillover effects of FDI are not as significant as it usually thought. The author finds that domestic firms gain technology spillovers through vertical linkages with foreign firms, but the effect of the horizontal presence of foreign firms on the productivity of domestic firms is negative. This suggests that potential technology transfer between foreign firms and their local competitors is more than offset by the competition induced by the entry of foreign firms. The existence and strength of horizontal and vertical spillovers depend on industry and firm characteristics and on the types of FDI.

Keywords: FDI, spillover, innovation, spatial effect.
JEL Classification: C59, F10, F49, F22.

Introduction

Foreign direct investment (FDI) is a driving force of growth for every developing economy. An important motivation for this interest is the possible existence of FDI spillovers, a concept that embodies the fact that multinational enterprises own technology which can be transmitted to domestic firms and then base on this to establish domestic innovation capability. It brings new capital, technology and know-how. This investment comes either in the form of a greenfield project, where a new plant is built and, therefore, a new company formed, or in the form of foreign capital inflow to an existing domestic company. In both cases, this company is typically characterized by higher productivity and competitiveness (Javorcik and Arnold, 2005).

Recently, there has been an effort to increase the knowledge about the factors that determine the existence, sign and magnitude of FDI spillovers. Perhaps the most important lesson to be learned from the existing studies is that we need to complement the "global evaluation" of whether FDI spillovers exist or not with a detailed analysis of "the different circumstances and policies of countries, industries and firms that promote or obstruct spillovers" (Lipsey, 2002, p. 32).

In addition to the existing determinants of FDI spillovers, this article argues that local environmental (macro-economic) factors such as the economic development of the host province/region within a country, is also an important precondition for determining the nature and extent of technological spillovers from foreign to domestic firms. However, there is ambiguity as to the expected influence of the economic development of the host province/region on the FDI spillovers.

To answer these questions by analyzing the effects of FDI on the performance of domestic companies in Tunisia with respect to different types of foreign investment – acquisitions and greenfields. We study these effects within the same sector as well as through vertical linkages. We employ up-to-date data that cover the period of 1995-2009. We also focus on the time structure of these effects.

In fact, Tunisia has been the main beneficiary of FDI among European countries in the 1990s. Are there significant spillover effects from inward FDI on innovation activity by the domestic firms? Or is it that Tunisia has been simply importing technologies without developing the ability to innovate on its own?

The paper is organized as follows. Section 1 presents the technology spillovers from FDI. The empirical framework is described in section 2 and the data are discussed in section 3. The empirical results are in section 4, which report the baseline findings on horizontal and vertical spillovers, the relationships between industry and firm characteristics and technology spillovers, and the impacts of the different types of FDI. The final section presents conclusions.

1. Technology spillovers from FDI

1.1. Horizontal spillovers. Horizontal spillovers refer to knowledge spillovers within an industry due to the presence of multinational enterprises (MNEs). The entry of MNEs may provide technology externalities to local firms through a number of mechanisms. First, local firms may be able to learn simply by observing and imitating product innovations or novel forms of organization adapted to local conditions. It may be very costly for local firms to collect information on new technology or

processes in the absence of MNEs. In addition, domestic firms may have little information on the costs and benefits of innovations and new technology, and they may thus regard them to be highly risky. As they make direct contacts with MNE affiliates, information is diffused, uncertainty is reduced, and the possibility of adoption increases (Blomstrom and Kokko, 1996).

Secondly, a more observable mechanism of technology spillovers within the same industry is the movement of employees. Labor turnover may disseminate technology from MNEs to other firms as workers trained or employed by MNEs move to domestic firms or start their own businesses. This spillover is especially important for sectors which are strongly competitive or in which human capital formation is very costly. This is also crucial for firms that lack the technological capability and managerial skills to compete in world markets.

Thirdly, technology spillovers may come from competition generated by the presence of MNEs. If MNEs have advantages over domestic firms in technology, then greater competitive pressure may induce domestic firms to introduce new products or new technology to defend their market share, and to adopt new management method to increase productivity. However, MNEs may have negative effects on domestic firms because they may attract demand away from domestic firms, thus forcing the domestic firms to reduce their output and productivity (Aitken and Harrison, 1999).

Many empirical studies have used different types of datasets to assess the incidence of horizontal spillovers to domestic firms. Most studies that use industry level data find positive spillovers to local firms. Early studies that employ industry level data, e.g., Caves (1974) for Australian manufacturing industries and Globerman (1979) for Canadian manufacturing, find that foreign presence has a positive impact on the productivity of domestic firms. Other studies which also find positive spillovers are Blomstrom and Persson (1983) for Mexican manufacturing industry, Blomstrom and Sjoholm (1999) for Indonesian manufacturing sectors, and Liu (2002) for Chinese manufacturing industries. However, aggregate data at the industry level have been unable to control for productivity differences across industries. The positive correlation between the foreign presence and the productivity of domestic firms might be partially due to the fact that foreign firms invest in more productive industries. Thus, using industry data may lead to an endogeneity problem and an upward bias.

With firm-level data, most studies find no or negative evidence of horizontal spillovers to domestic firms. Haddad and Harrison (1993) employ data on Morocco and show that there is no evidence of spillovers and competition seems to push local firms towards the best practice frontier in industries with low level of technology.

For Venezuela, Aitken and Harrison (1999) find that increases in foreign ownership in an industry negatively affect the productivity of domestic plants in that industry. They describe this negative spillover as a market stealing effect as foreign firms force domestic firms to cut production.

The authors report similar findings for Indonesia, except that negative effects are smaller in Indonesia than in Venezuela. Using panel data of UK manufacturing industries, Girma et al. (2001) find no significant effect of foreign presence on the labor productivity or total factor productivity of the UK firms from 1991 to 1996. In contrast, Griffith (1999), Liu et al. (2000), Haskel et al. (2002), and Harris and Robinson (2003) use the UK micro data for manufacturing firms and present a significantly positive correlation between a domestic firm's total factor productivity and the foreign affiliate share of activity in that industry. More interestingly, Haskel et al. (2002) show that positive spillovers are found to come from the US and French presence, but Japanese presence produces negative spillovers.

Studies on transition economies also show negative or insignificant spillover impacts. Konings (2001) finds that FDI is important for transferring technology to an affiliate, but provides evidence of negative spillovers to local firms in Bulgaria and Romania from 1993 to 1997 and no evidence of spillovers in Poland. Using firm level data for the Czech Republic for the period of 1992-1996, Djankov and Hoeckman (1998) also find negative effects of spillovers on domestic firms. Damijan et al. (2003) find that spillovers are rare in 10 transition economies in Eastern Europe, but there is no evidence of negative spillovers.

The mixed evidence on horizontal spillovers may be explained by differences in local firm characteristics and the host country condition. The negative effect is usually attributed to the absorptive capacity of local firms together with the technology gap between foreign and domestic firms. Some studies find evidence of spillovers from foreign presence in domestic firms that engaged in R&D activity (Kinoshita (2000) for the Czech Republic; Kathuria (2000) for India). Other studies show that the skill level of the industry and of domestic firms is positively correlated to the productivity spillovers (Girma et al. (2001) for the UK; Schoors and Van der Toll (2002) for Hungary).

With respect to the technology gap, Kokko (1994) shows that spillovers are smaller in Mexican industries with a larger labor productivity gap between local and foreign firms. Kokko et al. (1996) find a similar result in Uruguayan manufacturing sectors; if the productivity gap is small, foreign technology appears to be more useful for domestic firms because they have skills needed to learn the foreign technology. In contrast, using Indonesian manufacturing data, Sjohlom (1999) finds evidence of spillovers to domestic firms only in a sub-sample with a large technology gap.

The occurrence of horizontal spillovers is related to competition in the domestic market. Using industry data on Mexican manufacturing, Blomstrom et al. (1992) find that local competition is positively related to imports of technology by affiliates of multinationals. Sjoholm (1999) presents evidence supporting the idea that higher technology spillovers are found in industries with higher domestic competition. Girma et al. (2001) also point out the importance of competition in determining the extent of spillovers in the UK manufacturing. They find that the greater the degree of foreign competition in the industry, the larger the spillover.

Another factor that may influence technology spillovers is the export orientation of domestic firms. Blomstrom and Sjoholm (1999), who study Indonesian manufacturing, show that while non-exporting domestic firms experience significantly positive spillovers, exporting domestic firms do not gain significant spillovers.

Sinani and Meyer (2004) show a similar result in Estonia; since export oriented firms already face competitive pressure from the world market, their productivity is not significantly affected by the presence of foreign enterprises in the domestic market.

1.2. Vertical spillovers. Vertical spillovers occur between MNEs and local enterprises across industries. Vertical technology spillovers may occur through both backward linkages (from buyer to supplier) and forward linkages (from supplier to buyer).

Backward linkages create technology spillovers through several mechanisms. First, MNEs may transfer technology directly to their local suppliers by training or technical assistance in order to increase the quality of supplier products. Secondly, close linkages between MNEs and local suppliers may induce workers in MNEs to turn to local suppliers, thereby disseminating technology from MNEs. Thirdly, higher requirements for product quality and on-time delivery set by MNEs may provide incentives to local suppliers to improve their production process or technology (Smarzynska, 2004).

Forward linkages may induce technology spillovers through various channels. First, domestic firms may benefit from supplies of intermediate goods and machinery from MNEs that provide better quality products and lower costs. Secondly, as marketing outlets for MNEs, domestic firms may receive support in the form of training in sales techniques and supply of sales equipment, therefore generating more technology externalities. Thirdly, FDI in infrastructure and business services directly improves the productivity of its customers if these services are introduced or improved (Meyer, 2003).

While there are numerous empirical studies on horizontal spillovers, there are relatively few studies on vertical spillovers. Kugler (2001), using Colombian manufacturing data shows that spillovers from FDI are primarily inter-industry and not intra-industry. With firm level data from Indonesia Blalock and Gertler (2002) provide evidence of positive FDI spillovers through backward linkages; Indonesian firms in industries with growing downstream FDI experience greater productivity growth than other firms. Schoors and Van der Tol (2002), in a study on Hungary, find that while there are positive and significant effects of backward linkages, forward linkages generate negative effects. Based on firm level panel data from Lithuania, Smarzynska (2004) finds a similar result; technology spillovers from FDI take place through contacts between foreign firms and their local suppliers in upstream sectors.

Thus, the empirical literature has provided strong evidence in support of vertical spillovers. However, the existing empirical literature has mainly focused on the basic questions of whether or not vertical spillovers exist and with little evidence on which circumstance would determine the strength of such spillovers. In fact, the second question merits most attention because the major policy debates are no longer on whether or not to allow FDI, but how maximize the benefits of FDI spillovers for local firms. This paper fills the gap by considering the role of specific actors involved, foreign enterprises and local firms, and the relationships between them in the existence and strength of vertical spillovers.

2. The empirical framework

The production function of domestic firm is assumed to be Cobb-Douglas and homogeneous of degree one:

$$Y_{ijt} = (K_{ijt})^{\alpha} \times (L_{ijt})^{1-\alpha} e^{Zijt}, \quad (1)$$

where Y_{ijt}, K_{ijt} and L_{ijt} are output, capital and labor of domestic firm i in industry j at time t, respectively.

Z_{ijt} represents exogenous shocks to production and is explained in detail below. Dividing both sides of equation (1) by L_{ijt} gives the following function for labor productivity of domestic firm *i*.

$$\frac{Y_{ijt}}{L_{ijt}} = \left(\frac{K_{ijt}}{L_{ijt}}\right)^{\alpha} e^{Zijt}, \quad (2)$$

$$\frac{Y_{ijt}}{L_{ijt}} = \begin{pmatrix} \frac{K_{ijt}}{L_{ijt}}, Labor\ Quality_{ijt}, Scale_{ijt}, Concentration_{jt}, Technology\ Gap_{ijt,} \\ Technology\ Spillovers_{jt} \end{pmatrix} \quad (3)$$

where $\frac{Y_{ijt}}{L_{ijt}}$ is average labor productivity of domestic firm *i* in industry *j* and is measured as the ratio of gross out to total employees; $\frac{K_{ijt}}{L_{ijt}}$ is domestic firm *i*'s capital intensity, which is measured as the ratio of fixed assets to total employees in firm *i*. Foreign firms may be more capital-intensive and larger than domestic firms, and these characteristics may account for some of productivity differentials between foreign firms and domestic firms. Thus, we use this variable to control for the impact of capital intensity on productivity (Quoc Hoi Le, Richard Pomfret, 2008).

Labor Quality$_{ijt}$ represents the skills of workers that affect the productivity of firm *i*. Since firm-specific data on the number of skilled workers are not available, labor costs (including wages and training costs) per employee are used as a proxy for the human capital stock of the firm. This is based on an assumption that firms with higher average labor costs per worker employ higher skilled labor.

To account for the impact of scale on productivity, we measure the scale effect ($Scale_{ijt}$) as the ratio of sales in firm *i* to total industry sales.

To examine the effect of technology gap on technology spillovers, we define the technology gap for each domestic firm as the percentage difference between its labor productivity and that of the average foreign firm in the same industry:

$$Technology\ Gap_{ijt} = \\ = (Average\ LP_{jt} - LP_{ijt}) / LP_{ijt}, \quad (4)$$

where *Average* LP_{jt} is the mean of the labor productivity of foreign firms in industry *j* at time *t* and LP_{ijt} is the labor productivity of domestic firm *i* in industry *j* at time *t*. A negative value of the variable indicates that domestic firm *i* is more productive than the average foreign firm in the same industry and a positive value indicates that firm *i* is less productive than the average foreign firm in the same industry. A positive value shows that a technology gap exists between the domestic firm and the average foreign firm in the same industry.

Felipe (1999, p. 6) in a survey of the literature on total factor productivity describes *Z* as "a measure of elements such as managerial capabilities and organizational competence, R&D, inter-sector transfer of resources, increasing return to scale, embodied technical progress, and diffusion of technology". Hence, labor productivity of domestic firm *i* can be expressed as follows:

Technology spillovers from FDI (*Technology Spillovers*$_{jt}$) are considered under two categories: horizontal spillovers (between domestic firms and foreign firms within the same industry) and backward spillovers (from foreign firms to their domestic suppliers). Because most foreign firms in Tunisia are export-oriented and generally do not supply Tunisian's customers, we do not consider technology spillovers through forward linkages (from foreign firms to domestic customers).

Horizontal spillover (HS_{jt}) is measured as the share of employment accounted by all foreign firms in industry *j* at time *t*:

$$HS_{it} = \frac{\sum_{k=1}^{m} FL_{kjt}}{\sum_{k,i=1}^{m,n} (FL_{kjt} + DL_{ijt})}, \quad (5)$$

where FL_{kjt} (k=1,…,m) is employment of foreign firms *k* in industry *j* and year *t*, and DL_{ijt}; (i = 1,…, n) is employment of domestic firms *i* in industry *j* and year *t*. This measure reflects mainly the competitive pressures that encourage domestic firms to introduce new products to defend their market share and adopt new management methods to increase productivity. Imitation, reverse engineering, personal contact and industrial espionage are also captured by this measure.

Backward Spillover (BS_{jt}) is derived from the extent of foreign presence in industry *j* that is being supplied by other industries. It captures the extent of potential contacts between domestic suppliers and foreign firms in industry *j* and is defined as follows:

$$BS_{jt} = \sum_{r=1}^{p} \alpha_{jrt} \times HS_{it} (r = 1,..., p), \quad (6)$$

where α_{jrt} ($0 \leq \alpha_{jrt} \leq 1$) is the proportion of industry *r*'s output that is supplied to industry *j*. Inputs supplied within the industry are not included, since they are already captured by the *HS* variable.

We use OLS with the correction for heteroskedasticity. We restrict our attention to domestic firms in order to avoid a potential bias if foreign investors tend to acquire stakes in the largest and most successful domestic firms. We control for the potential endogeneity of foreign presence and region or industry characteristics by adding fixed effects for industry, region and time. Foreign firms may choose to locate in a given region where there is better infrastructure, which also improves the efficiency of domestic firms. If foreign investors are attracted to industries with higher labor productivity, then the observed correlation between foreign presence and domestic productivity may overestimate the positive impact of the foreign sector. The industry, region, and time dummies control for unobserved variables that may be driving changes in, for example, the attractiveness of a given industry or region. We also use lagged values of relevant variables as instruments to account for endogeneity.

3. Data

The company-level annual data used here are obtained from FIPA (Foreign investment promotion agency). Financial data cover the period of 2000-2009, include almost 54 Tunisian firms (17 firms are high-tech established in "*The parc technologique El-Ghazala*).

For studying vertical spillover effects, we employ inter-industry data (input-output matrices) that come from the Industry Promotion Agency (API) and are available for every year during 2000-2009. There is an often used assumption in previous studies that these matrices do not change much over time.

The data set contains information on the property structure of the enterprise, sales, output, labor, total costs, capital stock, investment, location, ownership, research and development (R&D) activity, international trade, and other specialized questions.

4. Horizontal and vertical spillovers from FDI

This section reports results on the effect of FDI through both horizontal and vertical linkages on the productivity of domestic firms. The results in Table 1 show that the effect of backward spillovers on productivity is positive and significant. This implies that greater amounts of backward linkages from foreign firms increase the labor productivity of domestic firms in the Tunisian industry. The spillover estimates suggest that an increase of backward linkages by 1% points would increase the labor productivity of domestic firms by 1.09%. Several reasons can explain why backward linkage is an important channel of technology diffusion from foreign firms to domestic ones in Tunisia. Foreign firms are more likely to share their know-how and technology with domestic firms because the intermediate goods supplied are specific to their production processes. Moreover, domestic firms may benefit from technology spillovers through the training and turnover of workers provided by foreign firms, and through visits to domestic firms by technical staff of foreign firms.

The effect of foreign presence on domestic firms within the same industry (horizontal spillover) is negative and significant. This result is consistent with the existing literature that finds evidence of negative intra-industry effect in developing countries. The reason for negative horizontal spillovers in Tunisia may come from the fact that the presence of foreign firms reduces the productivity of domestic firms through competition effects. Foreign firms have advantages, which allow them to attract demand away from domestic firms and force domestic firms to increase their average costs and to reduce their productivity. The negative competition effects may outweigh the positive effects of demonstration and imitation generated by the presence of foreign firms.

Since technology spillovers from foreign firms to domestic firms may take time to manifest, we re-estimate the model with lagged horizontal and backward spillover variables. The results in column 2 of Table 1 (see Appendix) confirm those with contemporaneous spillover variables that there are positive technology spillovers from backward linkages, but negative effects from the presence of foreign firms in the same industry.

Among the other control variables, labor productivity is positively related to capital intensity. The results suggest that a 1% increase in the ratio of capital to labor in a domestic firm will lead to a 7.2% increase in its labor productivity. The coefficient of labor quality is positive and significant at the 1% level in all regressions and similar in magnitude, suggesting that a larger share of skilled workers increases the labor productivity of domestic firms. The effect of competition on productivity captured by the concentration variable is negative and significant. A reduction of industry concentration (an increase in the level of competition) by 10% increases the productivity of domestic firms in that industry by 6.1%. This suggests that competition from a domestic firm appears to induce other domestic firms to use their resources better in order to maintain their market share, which in turn en-

hances their productivity. The production scale of a domestic firm has a positive and significant effect on its productivity. This implies that a firm that is smaller than the most efficient firm in the industry can take advantage of scale economies. The technology gap between domestic and foreign firms negatively affects the productivity of domestic firms, suggesting that domestic firms lagging behind foreign technology seem to have lower productivity.

The absorptive capacity of domestic firms may facilitate technology spillovers. To account for the absorptive capacity of domestic firms in determining the extent of spillovers, we interact labor quality and technology gap with the spillover variables. The results in column 4 of Table 1 show that the interactions between labor quality and the spillover variables are positive and significant. This means that the technology spillovers from FDI to domestic firms are bigger in firms with higher level of labor quality. The technology gap is related to the extent of technology transfer through horizontal linkages, as the coefficient on the interaction between the technology gap and horizontal is negative and significant.

This suggests that domestic firms with a narrow technology gap may have a certain level of technological capacity to compete with foreign firms, reducing the negative effects of competition generated by foreign firms. However, the technology gap does not affect the extent of backward spillovers. This may be due to the fact that foreign firms may provide technical assistance to local suppliers to help them raise the quality of intermediate products.

Conclusions

This paper examines technology spillovers from FDI to domestic firms in Tunisia. Using firm level data for the period of 2000-2009, the paper investigates technology spillovers taking place through horizontal and backward linkages. Moreover, the paper considers the impact of the characteristics of industries, domestic and foreign firms on the existence and magnitude of such spillovers.

The empirical results provide evidence that backward linkage is the most important mechanism of technology transfer from foreign to domestic firms. Domestic firms in industries with backward linkages from industries with a large foreign presence have higher productivity, ceteris paribus, than other firms. This backward spillover is affected by the size of the domestic firm, the quality of its labor force, and the technology gap.

The effect of the horizontal presence of foreign firms on the productivity of domestic firms is negative. This implies that the competition effect induced by the entry of foreign firms is stronger than the potential technology transfer between foreign firms and their domestic competitors. The existence of this competition effect depends on the firm and industry characteristics. While state firms, collective firms, trade-oriented firms, R&D performing firms and firms in industries of medium and high technology are not significantly affected by the competition generated by foreign firms, the presence of foreign firms affects negatively the productivity of private firms, domestic-oriented firms, non R&D performing firms, and firms in low technology industries.

The characteristics of foreign firms also influence the existence and strength of negative horizontal spillovers. The productivity of domestic firms is negatively associated with the presence of fully owned foreign firms, but not with the entry of partially owned foreign firms. While domestic-oriented foreign firms have negative effects on domestic firms' productivity, export-oriented foreign firms do not have significant impact. In sum, although technology spillovers from FDI to domestic producers are widespread in Tunisia and can be both horizontal and vertical, their incidence is related to industry and firm characteristics.

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Appendix

Table 1. Horizontal and vertical spillovers from FDI (dependent variable: labor productivity of domestic firms)

Independent variables	1	2	3	4	5
Horizontal	-1.19 (0.58)**		-1.02 (0.58)*	-2.08 (0.01)***	-0.92 (0.58)
Backward	1.09 (0.29)***		1.10 (0.29)***	0.35 (3.40)	1.02 (0.29)***
Capital intensity Labor quality	0.50 (0.009)***	-1.64 (1.01)*	0.50 (0.009)***	0.51 (0.009)**	0.50 (0.009)***
Scale	7.49 (0.26)***	8.19 (0.29)***	7.49 (0.26)***	2.67 (0.40***	7.40 (0.26)***
Concentration	3.18 (0.32)***	3.52 (0.42)***	3.15 (0.32)***	3.54 (0.32)***	3.36 (0.32)***
Technology gap	-0.61 (0.08)***	-0.88 (0.14)***	-0.60 (0.08)***	-0.66 (0.08)***	-0.63 (0.08)***
Labor quality* Horizontal	-0.61 (0.35)***	-0.64 (0.01)***	3.15 (0.35)***	3.54 (0.35)***	3.36 (0.35)***
Labor quality* Backward	-0.87 (0.05)***	3.52 (0.42)***	-0.87 (0.05)***	-0.88 (0.05)***	-0.26 (0.08)**
Technology gap* Horizontal		-0.88 (0.14)***		0.07 (0.01)***	-0.05 (0.005)*
Technology gap* Backward		-0.90 (0.07)***		0,59 (0.04)***	0.006 (0.01)***
Time dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes	Yes
Number of firms	54	54	54	54	54
Number of observation	3453	3453	3453	3453	3453
R-squared	0.22	0.25	0.22	0.23	0.23

Notes: *, ** and *** indicate statisticaly significance at the 10%, 5% and 1% respectively. Standard errors are in parentheses.