Exporting vs. Outsourcing by MNC Subsidiaries: Which Determines FDI Spillovers?*

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Abstract

Export orientation of multinational corporations (MNCs) has seldom been incorporated in the analysis of spillovers from foreign direct investment (FDI). Also, until recently empirical research dealt mainly with intra-industry spillovers from FDI with restrictive treatment of inter-industry effects. Yet, to the extent that local producers are not in the competitive fringe of MNCs, both spillovers from export oriented subsidiaries and inter-industry spillovers may be more likely. First, when MNCs use the host country as export platform, domestic firms are by and large not competitors to subsidaries. Then, there would be no incentives to restrict technical information flows. Our results using panel data from Venezuelan manufacturing point to FDI spillovers, mainly between but also within industries, from export-oriented MNCs to large domestic firms. Second, MNCs that outsource have an incentive to transfer technical knowledge to local upstream suppliers. When we allow for spillovers to take place across sectors, we find evidence that backward linkages are a channel of technology diffusion from export-oriented MNCs to domestic manufacturers. Furthermore, small and medium plants do not experience productivity gains ensuing FDI while large domestic producers experience higher productivity growth, suggesting the importance of differences in absorptive capacity.

Keywords: Export platform; Local outsourcing; Absorptive capacity; Generic knowhow.

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1 Introduction

Evidence on foreign direct investment spillovers (FDI) based on the assumption that benefits should accrue to local firms with similar characteristics to multinational corporations' (MNCs) subsidiaries, e.g. same sector, has been inconclusive. However, it is crucial to incorporate into the analysis the extent to which potential recipients of technology transfer from MNCs are in competition with subsidiaries. In particular, MNCs may attempt to minimize propagation of technical knowledge to the competitive fringe among local firms. On the one hand, FDI location minimizes profit losses due to leakage of technical information to host-country firms competing with MNC subsidiaries within *both* the same sector and same domestic market. On the other hand, host-country producers in other sectors, and not in direct competition with the exporting MNCs, may benefit. In this paper, we incorporate both export orientation and inter-sectoral linkages to analyze the extent of spillovers in Venezuelan manufacturing. For large domestic plants, the evidence is consistent with MNC entry yielding diffusion of generic knowhow about exporting and vertical FDI spillovers upstream but not downstream.

Foreign direct investment (FDI) by multinational corporations (MNCs) has grown without precedent recently, especially penetrating middle-income countries. During the 1990's, the growth of FDI flows trebled the growth in international trade. Most FDI flows occur among industrialized nations, as do international trade transactions. Yet, presently, the main source of international finance to developing countries is FDI. This trend has revitalized the ongoing debate over the impact of FDI on productivity growth in less developed countries that host MNCs. If we take into account that MNCs would avoid spillovers that would induce profit loses, then within sector spillovers from FDI would seem less likely than across sectors. Hence, FDI may well substitute within-sector domestic investment by direct competitors but complement it across sectors.

In one of the most widely cited papers on FDI spillovers, Aitken and Harrison (1999) report plant-level evidence that, by and large, shows absence of intra-industry spillovers in Venezuelan manufacturing. This result is to be expected from the point of view of the MNCs optimal market penetration strategy. In particular, horizontal FDI spillovers are more likely to generate profit losses to MNCs than vertical FDI spillovers. Other things equal, FDI flows are more likely to locations in which horizontal spillovers do not occur. Yet, the authors of that paper conclude absence of positive FDI spillovers in Venezuela solely on the basis of intra-industry effects from MNC operations. The lack of horizontal spillovers is documented but there is no evidence as to whether the cause is either lack of technological opportunities brought about by FDI or lack of absorptive capacity by domestic producers to deploy new techniques.

Now, intra-industry FDI spillovers may indeed occur if they do not induce profit loses to MNCs. Specifically, if the MNC uses the host country as an export platform, horizontal FDI spillovers may be expected in case that the subsidiary lacks direct domestic competitors. Also, vertical FDI spillovers may be expected as the MNC may find it advantageous to share technical information with upstream suppliers and downstream clients. Hence, we complement Aitken and Harrison's findings by allowing for FDI to impact upon domestic productivity differently depending on whether it takes place in upstream sectors, whether the subsidiaries of the MNCs investing in the host country are export oriented, and the on size of the domestic firms that are potential recipients of FDI spillovers. This last dimension is meant to capture the fact that large producers are most likely to have the absorptive capacity to adopt new technologies. We find that *only* large plants in Venezuelan manufacturing are recipients of positive spillovers from FDI in upstream sectors and, to a lesser extent, in the same sector by export-oriented MNCs.

In this paper we investigate empirically whether FDI in a developing country generates positive externalities on local producers. Initial measurements of spillovers with panel data have yielded limited evidence of improvements in domestic productivity ensuing FDI partly because only intra-industry spillovers were considered, without allowance for inter-industry diffusion (e.g. Aitken and Harrison, 1999). Since MNC's locate their subsidiaries to avoid rent erosion due to local competition, other things equal, the MNC's deployment of subsidiaries via FDI is designed to minimize the risk of propagation of specific technical knowledge to potential competitors. In particular, for strategic reasons, intra-industry knowledge spillovers to host-country firms from MNCs' manufacturing activities, and from subsidiaries competing for local markets, are unlikely. Furthermore, evidence about spillovers from industrial R&D, as well as urban economic organization studies, reveals important technology diffusion between but not within industries.

Thus, the scarcity of empirical findings of intra-industry spillovers stemming from FDI is not surprising. If there is leakage of technical knowledge from the subsidiary to domestic producers, such spillovers are most likely to generate productivity improvements in non-competing and complementary sectors. The evidence of absence of intra-industry FDI spillovers in panel data studies is important because it suggests the excludability of technical knowledge. However, evidence in other contexts hints at the importance of considering inter-sectoral knowledge flows. Scherer (1982) finds R&D spillovers to diffuse across industries. In the context of knowledge diffusion in cities, Glaeser et al. (1992) found important spillovers between rather than within sectors suggesting returns to cross-fertilization of ideas in diverse instead of specialized environments.

While intra-industry FDI spillovers are not to be expected, inter-industry spillovers are likely. First, if the MNC has domestic vertical linkages in the host country, subsidiaries will benefit from knowledge sharing with both clients and suppliers. On the one hand, local market penetration generates forward linkages and information flows between the subsidiary and the users of its output are beneficial to the MNC. On the other hand, outsourcing yields backward linkages leading to knowledge transfer to upstream sectors. Hence, the vertical propagation of knowhow that creates new technological opportunities for host-country producers induces inter-industry spillovers but industry-specific knowledge flows are bound to be limited in scope. Second, cost-reducing opportunities to producers in sectors other than the subsidiary's own do not induce rent losses to the MNC. The incentive to use resources for trade secrecy to avoid diffusion of generic knowledge is small. Therefore, generic technology, which can be deployed in production across sectors, is more likely to propagate than sector-specific technology. Third, the techniques that can be adopted from generic knowledge in manufacturing activities generally require less absorptive capacity than specialized high-tech processes. At the same time, when MNCs primarily export, they do not compete with domestic plants and do not have incentives to prevent technology diffusion to domestic plants supplying local markets.

Beyond increasing domestic technological opportunities, entry by MNC subsidiaries can cause productivity gains for host-country producers though increased competition. First, the setting up of the MNC subsidiary raises managerial incentives in host-country enterprises to make efficiency-enhancing investments because of the increased risk of a loss of market share. And second, there is a selection effect that increases average productivity of operating plants since only the fittest survive the subsidiary's competition. The pro-competitive impact of MNC entry is primarily intra-industry. It will tend to be deleterious to inefficient domestic producers who cannot challenge the MNC and lose market share until eventually closing down. To avoid rent loses, the MNC will target FDI to locations in which domestic competitors are unlikely to cope in the short-run even if in the very long-run the domestic industry might become more efficient.

The paper is organized as follows. After this introduction, Section 2 reviews and discusses the related literature. The theoretical and empirical research on FDI spillovers is surveyed. With regard to the sectoral pattern of spillovers, a synthesis of the implications of the literature is provided. In Section 3, the estimation framework and the background facts are provided with data description. Then, Section 4 contains the evidence that characterizes the impact of FDI. The results obtained from measuring the technological diffusion and quantifying vertical spillovers from FDI in Venezuela suggest both the absence of horizontal spillovers from MNCs to direct competitors and positive upstream spillovers from MNCs to local suppliers. Finally, Section 5 offers concluding remarks.

2 Related Literature

This section starts with a review of the theoretical literature on MNC strategy and the implication for the impact of FDI on the host country. The general presumption about the sectoral pattern of spillovers to domestic manufacturing that emerges from these models is one of absence of intra-industry externalities but a likely positive impact at the inter-industry level. Then, a synthesis is provided of evidence from cross-section and panel data. The discussion of the econometric evidence documents that the higher expected propensity for inter-industry effects has not featured prominently in previous research on the impact of FDI on domestic manufacturing in the host country.

2.1 Theoretical Background

A survey of the theoretical literature about the impact of FDI on host-country industrial organization reveals that the modeled mechanisms are more likely to operate at the inter-industry rather than the intra-industry level. First, there is a body of literature on the choice by the MNC to use FDI as a mode of market penetration. The strategic considerations due to the risks of imitation and eventual replacement faced by the subsidiary are introduced (see e.g. Helpman, 1984; Ethier, 1986; Ethier and Markusen, 1996; Markusen and Venables, 1998). Second, there are models about the pecuniary externalities from FDI via the backward linkages to input markets that MNC entry can generate (see e.g. Rivera-Batiz and Rivera-Batiz, 1990; Rodriguez-Clare, 1996; Markusen and Venables, 1999). Finally, research has focused on the impact of entry by an enterprise with technological opportunities superior to local ones, such as a MNC, on incumbent domestic industry when different types of market structure prevail (see e.g. Bardhan, 1982; Varian, 1996).

First, the literature on the optimal market penetration strategy by the MNC emphasizes the minimization of the probability of imitation, especially under imperfect intellectual property rights in the host country. Organizational choices can be used to delay the emulation by domestic producers with absorptive capacity. In an incomplete contracts environment, resource and information transfer within the MNC minimize transaction costs (Ethier, 1986). Also, economies of scope stemming from product-specific R&D can explain the vertically integrated nature of MNCs (Helpman, 1984). Trade secrecy and efficiency wages are also used to mitigate technology leakage from FDI. Over time, the dissipation of technical knowledge rents if intra-industry spillovers materialized is mitigated as the MNC organizes production to maximize the imitation lag (Ethier and Markusen, 1996).

The location of the MNC subsidiary minimizes rent erosion due to copying by local firms. Proximity to potential competitors with absorptive capacity to reverse engineer proprietary technology would be detrimental to the MNC, and subsidiaries will be set up where potential rivals cannot erode its market share (Markusen and Venables, 1998). Since the MNC can benefit from knowledge diffusion when it reaches downstream clients and upstream suppliers, it will encourage vertical flows of generic knowledge leading to inter-industry spillovers. Linkages can be a propagation mechanism for technological externalities above and beyond the pecuniary externalities highlighted by Hirschman (1977).

Second, some of the literature on backward linkages emphasizes the static effect of the increased demand by the MNC for local intermediate inputs (Rivera-Batiz and Rivera-Batiz, 1990). More recent models emphasize the dynamic effect on host-country productivity ensuing expansion of both the demand and supply of intermediate inputs and services (Markusen and Venables, 1999). Not only do incumbent upstream sector producers benefit but also the MNC, may start providing goods or services that were previously unavailable in the host country. Thus, MNC operations can induce local availability of new intermediate services and inputs, and thereby a nexus between FDI penetration and growth in the productivity of downstream manufacturers (Romer, 1994; Rodriguez-Clare, 1996).

Hence, the impact of FDI goes beyond the change in utilization of the host-country factor endowment that improves allocative efficiency, the type of effect typically emphasized in trade theory, and may include improvements in technical efficiency. As the entry of the MNC induces the supply of new intermediate inputs, the productivity of downstream local firms can be enhanced due to a feasible increase in specialization. The direct demand effect on upstream sectors is primarily an inter-industry phenomenon. The indirect input-availability effect on downstream sectors is likely to be stronger at the inter-industry level than intra-industry. If outsourcing can benefit the competitive fringe in ways that cannot be avoided through exclusive contracts, in-house supply will be chosen.

Finally, whether the potential benefits of FDI materialize or not depends on the market structure in the host country. When demand in the host country is inelastic because of reduced availability of substitute goods, FDI yields higher rents for the MNC as local presence facilitates market penetration. Then, limited domestic competition relative to international competition means that FDI is more profitable to the MNC. Furthermore, competition from imports limits the attractiveness of imitation for domestic enterprises (Bardhan, 1982). Other things equal, the MNC will seek to set up subsidiaries in countries in which the market structure yields less direct competition within its industry but in which upstream sectors are competitive. Hence, FDI will be associated with situation in which there are few direct competitors and many input suppliers resulting in limited intra-industry spillovers but a positive impact at the inter-industry level.

The models in the literature imply that inter-industry positive externalities to host-country producers are much more likely than intra-industry gains in productivity ensuing FDI. For the MNC, technological spillovers from FDI represent a benefit when they diffuse downstream and upstream but a loss when they diffuse within the subsidiary's industry. Hence, the subsidiary will be deployed so as to minimize horizontal spillovers of industry specific knowhow to competitors while encouraging vertical flows of generic knowledge to complementary sectors. Yet, the higher expected propensity for inter-industry effects has not featured prominently in empirical research about the impact of FDI on domestic manufacturing in the host country. Furthermore, the large positive gap in terms of absorptive capacity required to adopt specific vis-a-vis generic technologies means that diffusion between rather than within sectors is more likely.

More recent literature has recognized that the production line of MNCs may be fragmented with manufacturing of various components and assembly taking in different countries (e.g. Venables, 1999). In the event that the MNC uses the host country as an export platform, the subsidiary may not have any domestic direct competitors. Then, horizontal and vertical spillovers may occur as neither would entail a loss of profits to MNC subsidiaries. Indeed, the evidence presented below in Section 4 indicates that the propagation of technology from MNCs to domestic firms is more likely when they are export oriented.

2.2 Empirical Evidence

Due to data limitations, until recently, empirical evidence on FDI spillovers was made up of case studies. The picture that emerged from the early literature has been important in guiding progress in the theory of FDI. The evidence has provided us with information about the mechanisms whereby MNC entry and presence can affect industrial organization in the host-country. This research emphasized linkages, labor turnover and demonstration effects. Recently database development has afforded the possibility of econometric testing on spillovers. And, only very recently, dynamic analysis has been conducted as panel data has replaced cross-section data.

2.2.1 Evidence from Cross-Section Data

Initial efforts to conduct econometric testing of FDI spillovers were limited in scope due to lack of data. In particular, only cross-section databases were available, or in the best of cases collections of cross-sections for a few years. Therefore, it was not possible to follow over time what the impact of MNC entry and permanence was on domestic enterprises. Since technological diffusion is essentially a dynamic phenomenon, the conclusions that can be drawn in these studies based solely on contemporaneous effects have serious limitations. In particular, these findings are subject to simultaneity and endogeneity biases. Therefore, it is not possible to establish causality with any confidence. Yet, this early econometric literature is important as a first approximation to quantify the mechanisms documented in case studies.

The econometric examination of spillover patterns started with the use of cross-section sectoral data. Pioneering studies searched for intra-industry spillovers in Australia and Canada respectively (Caves, 1974; and, Globerman, 1975). The approach was to estimate sectoral production functions, with the share of MNC affiliates as an explanatory variable. In both cases, there is a positive correlation between domestic enterprise productivity and subsidiary productivity. Although this pattern is consistent with FDI externalities, the aggregated results lack statistical power to discern the causal nature and magnitude of spillovers. Mexican data reveal the same pattern (Blomstrom and Persson, 1983).

Subsequent analyses conjectured that spillovers are more likely in some industries than others. In concentrated industries, where there is a wide technology gap between local producers and MNCs, externalities from MNC presence are unlikely to materialize. Indeed, it is found that in Mexican manufacturing, there is a positive correlation between foreign presence and local productivity only in sectors where the market share of MNC affiliates is low (Kokko, 1994). A similar pattern for Uruguayan manufacturing is found (Kokko, Tansini and Zejan, 1996).

Finally, there is evidence that the incentives for the MNC to transfer state-of-the-art technology are higher when the host-country competitive fringe faces lower barriers to entry. Blomstrom, Kokko and Zejan (1992) find that in consumer good industries, with relatively low intensity in complex technology and with low capital requirements, MNCs deploy more advanced technologies to overcome the disadvantages of alien status. The way for MNCs to outdo competitors is to keep one step ahead. In principle, as the authors conclude, a more competitive local market structure leads to an increase in the potential for spillovers due to the increase in technology flows. However, the authors do not test whether it is the case that there is local adoption of these more advanced techniques.

2.2.2 Evidence from Panel Data

By and large the few panel studies about FDI spillovers in less developed countries find the absence of a positive intra-industry productivity effect (Haddad and Harrison, 1993; Harrison, 1996; Hoekman and Djankov, 1998; Aitken and Harrison, 1999). The empirical findings are derived respectively from panel data of manufacturing plants in Morocco, Cote d'Ivoire, the Czech Republic and Venezuela. The empirical pattern uncovered where increases in MNC market share are detrimental to local producers in the subsidiary's industry is denoted "enclave formation." These results are not surprising in light of the above discussion of the theoretical literature, which predicts inter-industry rather than intra-industry spillovers. However, none of these studies considers the empirical possibility of inter-industry externalities in the econometric estimation. It is revealing that the one study that considers the diffusion of generic rather than industry-specific technology finds evidence consistent with FDI spillovers. The operation of export oriented MNC subsidiaries in Mexico is associated with a higher propensity for domestic enterprises to enter foreign markets (Aitken, Hanson and Harrison, 1997). The finding highlights the potential positive effect on host-country manufacturing of the diffusion of MNCs' generic knowhow about how to export, including information on standards, market access and distribution channels.

The reported evidence about FDI spillovers in Cote d'Ivoire, the Czech Republic, Morocco and Venezuela constitutes the first systematic effort to measure externalities from MNC activities using longitudinal data. The general finding of spillover absence contrasts with previous evidence of spillovers in cross-sectional data. However, the exclusively intra-industry character of possible externalities allowed in the specification of the empirical estimations is very limiting. While the positive contemporaneous correlation between sectoral productivity and sectoral FDI flows in cross-sectional data could reflect a causal relation in either direction, the nonpositive correlation in panel data confirms one of the implications from the theoretical literature.

The importance of inter-industry spillovers has been recognized and documented for a long time in studies about R&D and productivity (e.g., Romeo, 1974; Scherer, 1982). More recently Glaeser et al. (1992) have provided robust evidence showing that important knowledge spillovers occur between rather than within industries. The finding confirms Jacobs' (1969) conjecture that innovation is more likely to prosper in diverse rather than specialized environments. In the context of FDI spillovers, only recently, in Kugler (2000a and 2000b), was the need to allow for inter-industry effects in panel data studies recognized. Otherwise it is not possible to verify the sectoral pattern described above about the impact of FDI on host-country industrial organization. Since then, the finding of limited intra-sectoral spillovers but ample inter-sectoral effects from FDI has been documented also for Indonesia (Blalock, 2001), Lithuania (Smarzynska, 2002) and Mexico (Lopez-Cordova, 2002).

These studies use domestic input-output tables to construct a sectoral weighted average of FDI. The aim is to test whether backward linkages are a knowledge propagation mechanism from MNCs to domestic producers. The assumption is that the composition of input demand by MNCs' coincides with that of their domestic counterparts. While inter-industry spillovers are identified, backward linkages are but one potential propagation mechanism. In particular, it is possible that any weighted average of FDI across sectors would have a significant effect on domestic productivity.

In contrast to previous empirical research about FDI spillovers based on longitudinal data, in this paper, the estimation of the extent of new technological opportunities for domestic manufacturers stemming from MNC operations includes potential effects within the subsidiary's sector as well as across other sectors, but not limited to backward linkages. This occurs both directly through linkages to suppliers and indirectly through enhanced input availability. The structural estimation framework allows for not only for technological spillovers but also the pecuniary externalities. We also allow for heterogeneity of the impact of FDI on domestic producers depending on the export orientation of the MNC and the location of the subsidiary.

3 Data and Estimation

3.1 Basic Statistics and Database Description

Due to the dynamic nature of the diffusion process, FDI spillover estimation requires to follow sectors longitudinally. Consequently, the information needed to analyze FDI spillovers is used to construct a panel database with sufficient variables for productivity measurement, and also information on foreign ownership structure.

In Table 1, the mean, standard deviation, maximum and minimum of each variable is listed. There is evidence of substantial dispersion of variables measuring plant output and inputs. The foreign capital share variable also displays substantial variation with the mean participation at 13.6%. The variables measuring plant exposure to FDI flows generally display less dispersion. However, there is great variation across plants in terms of both intra-regional exposure to FDI and exposure to FDI by export oriented MNCs.

The paper uses a panel of manufacturing plants drawn from the annual Venezuelan Industrial Survey (Encuesta Industrial de Venezuela). The choice of period is 1995-2000. The annual survey includes all the plants with more than 50 employees. In addition, the Venezuelan Manufacturing Bureau includes every year a random sample of those plants with 50 or less employees. The number of plants varies greatly from year to year with a maximum of 3,759 plants in 1996 and a minimum of 1,788 in 1998. The construction of a balanced panel, however, and the exclusion of the outliers brings the final number of plants to 896 per year.

Data are recorded on each plant's geographic location, industry, age, capital structure, investment flows, expenditures on labor and materials, and value of output sold. The variables in the plant-level panel database yield a wide range of observable characteristics.

Data for each plant include gross production per worker, based on sale revenues, and capital per worker, based on book value reports. The labor force is classified by activity and the capital stock by type. Intermediate inputs and materials are reported as either imported or domestic. The fraction of foreign participation in the firm allows us to both construct measures of the impact of FDI in manufacturing and to control in estimation of the production function within each plant for the importance of links to MNCs. Three distinct measures of sectoral FDI in manufacturing, at the ISIC two-digit level, are used. A variable aggregating FDI within the plant's industry accounts for horizontal spillovers. Two variables aggregating FDI to downstream and upstream sectors use I/O matrix entries as weights and measure vertical spillovers propagated by forward and backward linkages respectively. Gross output was deflated using sectoral PPI, intermediate materials were deflated using wholesale sectoral PPI weighted with the I/O table.

The capital stock for each plant was constructed following the perpetual inventory method. All investment figures were transformed into 1995 prices using wholesale prices of various types of equipment. The depreciation rate was calculated using the reported amount of depreciated assets during one year and the value of the assets at the beginning of that year. Starting with the capital stock at the beginning of 1995, we updated the capital stock using the investment figures and the depreciation rates.

3.2 Estimation Framework

We estimate an augmented production function using plant-level data to explore the impact of FDI on the total factor productivity of producers operating in the host country. There are two sources of estimation bias when using ordinary least squares in this context. First, there is simultaneity problem generated by the endogeneity of inputs to productivity shocks observed by plant management but not by the econometrician. And, second, there is a selection bias induced by plant closings. To deal with these issues we use the estimation method proposed by Olley and Pakes (), and previously used in the context of assessing FDI spillovers by KY, S, B, LC .

3.2.1 Attrition with Plant Heterogeneity

We assume plants are heterogeneous with respect to their level of productivity. In every period, given factor prices and the market structure, the plant management selects to exit or to stay in business. The exit selection is irreversible. Management decisions are made after observing an idiosyncratic productivity shock that is a random draw from an exogenous Markov process. If the firm continues in operation, management deploys variable factors and decides how much to invest in capital. If exit is chosen, the plant's sell-off value Θ is realized. The exit choice is based on the maximization of expected discounted net profit cash flows.

The management's problem is

$$V_t(\omega_t, k_t) = \max\{\Theta, \sup_{i_t \geq o} \pi_t(\omega_t, k_t) - c(i_t) + \beta E_t V_{t+1}(\omega_{t+1}, k_{t+1})$$

where $V_t(\cdot)$ is the value function at period t and $\pi_t(\cdot)$ is the profit function of the plant, which both depend on the current value of the two state variables, namely capital k_t and productivity ω_t.Also, $c(i_t)$ represents the cost of investment, β is the discount factor, and E_t the expectation operator conditional on all information known at time t. Indexing of functions by time allows for shifting market structures and changing factor and output prices.

The law of motion for capital is given by

$$k_{t+1} = (1 - \delta)k_t + i_t$$

where i_t is the current period's gross investment.

In this set up, as shown by Ericson and Pakes (1995), conditional on the capital stock k_t, the optimal exit decision rule is to shut down operations if realized productivity is below a threshold level $\omega_t^*(k_t)$. If $\omega_t \geq \omega_t^*(k_t)$, the production continues, and otherwise the plant exits. The threshold function is decreasing (i.e. $\omega_t^{*\prime}(k_t) < 0$) if plants with more installed capital sustain bigger losses upon exit relative to plants endowed with less capital. This would mean that the difference between the discounted expected value of net profits and the sell-off value increases with the capital stock. Hence, other things equal, it is optimal for larger plants to stay in business even if current productivity is relatively low. Finally, if the plant continues, the investment demand is given by $i_t = i_t(\omega_t, k_t)$. This function is strictly increasing in ω_t, for any capital stock, if investment is strictly positive, as shown by Pakes (1994). The monotonicity of the productivity threshold function $\omega_t^*(k_t)$ and the investment demand function $i_t(\omega_t, k_t)$ are essential for the estimation algorithm outlined below. Then, observed capital and investment series can be used to infer the unobserved productivity shocks.

3.2.2 Olley and Pakes' (1996) Algorithm

Within the above theoretical framework, the estimation of production function is not straight forward because productivity, a state variable in the management's decision problem, is not unobserved. The two biases mentioned before plague the OLS production function estimation. Due to the simultaneity problem, as factor demands are positively correlated with the unobserved productivity term, OLS estimates of the corresponding coefficients are biased upwards. Moreover, the expectation of productivity decreases with the capital stock since firms with a larger capital stock can afford to survive with a relatively lower productivity level. Thus, as only continuing plants are observed, the estimated capital coefficient is biased downwards.[1]

We implement the Olley-Pakes algorithm in three steps. In the first step, we estimate consistently the coefficients corresponding to variable factors. Let the production function of firm i at time t be

$$\ln Y_{it} = \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \omega_{it} + \mu_{it}$$

where Y_{it} is output, K_{it} the plant's capital stock, L_{it} is the number of workers, M_{it} is real intermediate input expenditure, ω_{it} is plant-specific productivity, and μ_{it} is a term distributed around zero accounting for measurement error and for unexpected productivity shocks that do not affect the choice of inputs. To infer the unobserved productivity term ω_{it}, we invoke the monotonicity of the investment function $i_t(\omega_{it}, k_{it})$ to invert it and obtain an expression for the unobserved productivity term as a function of observables, i.e. $\omega_{it} = f(i_{it}, k_{it})$. Defining $\varphi(i_{it}, k_{it}) \equiv \beta_0 + \beta_1 \ln K_{it} + f(i_{it}, k_{it})$, the production function reduces to

$$\ln Y_{it} = \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \varphi(i_{it}, k_{it}) + \mu_{it}$$

Since the function $\varphi(\cdot)$ is unknown, it is approximated by a polynomial expansion in investment and capital. While we cannot disentangle the direct contribution of capital as an input from its indirect effect via investment, this quasi-linear regression can be estimated semiparametrically to obtain consistent estimates of β_2 and β_3, as we control both for the capital stock and unobserved productivity.

In the second step of the algorithm, we estimate the exit probability for each plant to address the selection problem. Let P_t be the probability that a plant will continuer. Then, $P_t = \Pr\{\omega_{t+1} \geq \omega^*_{t+1}(k_{t+1}) \mid i_t, k_t, \omega_t\}$ is the probability that next period's productivity will be larger than appropriate threshold conditional on the

[1]The simultaneity problem is only partially addressed in fixed effect estimation, given the assumption that the productivity term is constant over time.

information available at t. Note that from the law of motion of the capital stock we can write $\omega^*_{t+1}(k_{t+1}) = \omega^*_{t+1}(i_t + (1-\delta)\, k_t)$. Hence we can substitute for ω_t and ω^*_{t+1} to get $P_t = P_t\,(i_{it}, k_{it})$. Since the family of distribution functions from which ω_t is drawn is unknown, the survival probability is estimated non-parametrically. We use a probit model with a polynomial expansion on investment and capital as regressors.

In the third step we estimate the coefficient on the capital stock. We have to take account that capital is correlated with the unobserved productivity term, and that surviving plants have a level of productivity that exceeds a threshold, which in turn depends on the capital stock. We assume that next period's productivity depends on current period's productivity, which in turn can be written in terms of observable investment and capital.

Next define $g(\omega^*_{t+1}, \omega_t) = \beta_0 + E\left[\omega_{it+1} \mid \omega_t, \omega_{t+1} \geq \omega^*_{t+1}\right]$, i.e. the expectation of next period's productivity conditional on current productivity and on survival, plus the constant β_0. Now consider the expectation of $\ln Y_{it} - \beta_2 \ln L_{it} - \beta_3 \ln M_{it}$ conditional on k_{it+1} and survival,

$$E\left[\ln Y_{it} - \beta_2 \ln L_{it} - \beta_3 \ln M_{it} \mid k_{t+1}, \omega_{t+1} \geq \omega^*_{t+1}\right] = \beta_1 \ln K_{it} + g(\omega^*_{t+1}, \omega_t)$$

Let η_{it}be the innovation in productivity at t+1, which is assumed to be independent of the capital stock at the beginning of the period t+1. That is, $\eta_{it} = \omega_{it+1} - E\left[\omega_{it+1} \mid \omega_t, \omega_{t+1} \geq \omega^*_{t+1}\right]$. Then next period's production function can be written as

$$\ln Y_{it+1} - \beta_2 \ln L_{it+1} - \beta_3 \ln M_{it+1} = \beta_1 \ln K_{it+1} + g(\omega^*_{it+1}, \omega_{it}) + \eta_{it+1} + \mu_{it+1}$$

As the capital stock is not correlated with either error term, the coefficient on capital can be consistently estimated by controlling for ω^*_{t+1} and ω_t. While these variables are unobservable, we can be proxy by inverting the survival probability function and expressing ω^*_{t+1} as a function of P_t and ω_t. To complete the last step of the algorithm, we run the nonlinear least squares regression

$$\ln Y_{it+1} - \widehat{\beta}_2 \ln L_{it+1} - \widehat{\beta}_3 \ln M_{it+1} = \beta_1 \ln K_{it+1} + g(\widehat{P_t}, \widehat{\varphi}_{it} - \beta_1 \ln K_{it+1}) + \varepsilon_{it+1}$$

where terms with hats represent the estimates of the first and second steps substituted for the respective true values, and the unknown function is approximated by a polynomial expansion in its arguments.[2]

[2] As pointed out by Syverson (2001) the algorithm assumes that the only state variable that affects the firm's decisions, but that is unobserved by the econometrician, is the productivity shock. Without this assumption, the investment demand cannot be inverted in order to write productivity as a function of observables. If investment depends on other unobservables, the one-to-one correspondence between productivity and investment, holding fixed the capital stock, no longer holds and if the choice of inputs depends upon the (unobserved) expectation of variables such as the state of demand or input prices, the algorithm can yield biased estimates of the coefficients of the production function.

3.2.3 Estimation

To examine the correlation between firm productivity and foreign presence in the same industry or downstream sectors, we follow the approach taken by Aitken and Harrison (1999) augmented to have the impact of FDI on upstream sectors as in Blalock and Gertler (2001) and Smarzynska (2002), but we also to include the effect on downstream sectors. In common with the latter two papers and Keller and Yeaple (2003), we use the Olley-Pakes method. We estimate several variations of the following equation:

$$\begin{aligned}\ln Y_{it} = \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \\ \beta_4 FS_{it} + \beta_5 Horizontal_{jt} + \beta_6 Forward_{jt} + \beta_7\ Backward_{jt} + \\ \alpha_t + \alpha_r + \alpha_j + \varepsilon_{ijrt}\end{aligned}$$

where Y_{it} stands for firm i's real gross output at time t, which is calculated by adjusting the reported sales for changes in inventories of finished goods and deflating the resulting value by the Producer Price Index for the appropriate two-digit ISIC sector. K_{it}, capital, is defined as before and it includes machinery and equipment; office, accounting and computing machinery; electrical machinery and apparatus; motor vehicles, trailer and semi-trailers; and other transport equipment. L_{it}, employment, is measured by the number of workers. M_{it}, material inputs, are equal to the value of material inputs adjusted for changes in material inventories, deflated by material inputs deflator calculated for each sector based on the two-digit input-output matrix and deflators for the relevant two-digit ISIC sectors. FS_{it} measures the share of foreign capital in firm's total capital.

$Horizontal_{jt}$ captures the extent of foreign presence in the sector and is defined as foreign equity participation averaged over all firms in the sector, weighted by each firm's share in sectoral output. In other words,

$$Horizontal_{jt} = [\Sigma_{\text{i for all i}\epsilon\text{j}} FS_{ijt} Y_{ijt}] / \Sigma_{\text{i for all i}\epsilon\text{j}} Y_{ijt}$$

Thus the value of the variable increases with the output of foreign investment enterprises and the share of foreign capital in these firms. The variable Forward measures foreign presence in the industries that supply the sector to which the plant belongs and thus is intended to capture the extent of potential contacts between multinational suppliers and domestic customers.

It is defined in the following way:

$$Forward_{jt} = \Sigma_{\text{k if k}\neq\text{j}} \delta_{kj} Horizontal_{kt}$$

where $\delta_{kj}$is the proportion of sector k output supplied to sector j taken from the 1995 I/O matrix at the two-digit ISIC level.

The variable Backward is a proxy for the foreign presence in the industries that are being supplied by the sector to which the firm in question belongs and thus is intended to capture the extent of potential contacts between domestic suppliers and multinational customers.

It is defined in the following way:

$$Backward_{jt} = \Sigma_{\text{k if k}\neq\text{j}}\delta_{jk}Horizontal_{kt}$$

where δ_{jk} is the proportion of sector j output supplied to sector k taken from the 1995 I/O matrix at the two-digit ISIC level. The proportion is calculated excluding products supplied for final consumption but including imports of intermediate products. As the formula indicates, we do not include inputs supplied within the sector, since we want this effect to be captured by the Horizontal variable. Thus the greater the foreign presence in sectors supplied by industry j and the larger the share of intermediates supplied to industries with multinational presence, the higher the value of the variable. We use the basic specification to characterize the sectoral pattern of diffusion of FDI spillovers.

The main specification is estimated using time, industry and regional fixed effects to control for unknown factors that might affect the correlation between the firm productivity and the presence of foreign activity. The equation is also estimated in first differences to remove any fixed plant-specific unobservable variation. We report regressions with ordinary least squares and robust standard errors. In order to address for the possibility of an endogenous relationship between inputs and productivity, as suggested by Olley and Pakes (1996), we also report regressions with the Olley-Pakes correction. Finally, the combination of sectoral variables (like 'forward' or 'backward') with plant-level observations might lead to an underestimation of the standard errors which often results in spurious findings. Therefore, we use cluster standard errors for all observations for the same industry and year. Our application of the Olley-Pakes algorithm follows other recent work on FDI spillovers (e.g. Blalock (2001), Keller and Yeaple (2003) and Smarczynska (2002)) but we also use of cluster standard errors as pointed out above.

4 Results on the Impact of FDI in Venezuela

In our baseline specification, we replicate the results obtained by Aiken and Harrison (1999) who find that when spillovers across industries are ruled out, FDI has an intra-firm effect on productivity but there is no positive intra-industry effect. When we allow for inter-industry spillovers as in Kugler (2000b), the prediction is borne out that FDI is associated with absence of spillovers within sectors but with positive spillovers across sectors. As in other recent studies by Blalock (2001), Lopez-Cordova (2002) and Smarzynska (2002), backward linkages are a propagation mechanism of spillovers to upstream sectors while the horizontal effect is insignificant. Also, while we allow for forward linkages, they do not appear to operate as a diffusion channel of technology from MNCs to domestic plants. This is consistent with the fact that the bulk of inward FDI to Venezuela is concentrated in final good production rather than intermediate inputs.

4.1 Intra-industry Spillovers

Table 2 shows the results when only horizontal spillovers are considered. It can be seen that there are productivity gains associated with plant foreign participation. The result holds true for the two regressions in levels but not for the regressions in first differences. Accordingly, plants with foreign ownership are more productive than domestic plants but that their productivity does not grow faster. Hence, while plants with more foreign participation deploy more productive technologies, the rate at which these technologies are upgraded is not faster. Consistently with the results of Aitken and Harrison (1999) for Venezuela, where allowance is made for horizontal but not for vertical spillovers, there is no evidence of intra-industry spillovers in these regressions.

4.2 Inter-industry Spillovers

Table 3 includes the possibility of vertical spillovers both through backward and forward linkages. The results about the impact on plant efficiency of foreign participation are the same as before, namely higher productivity level but not higher growth. With regard to spillovers, when we account for neither the geographic location nor export orientation of FDI, we find absence of any evidence of either horizontal or vertical spillovers. Note that like horizontal spillovers, vertical spillovers can potentially benefit competitors if upstream suppliers to MNCs were to sell intermediate inputs to domestic plants serving the same market as subsidiaries. For this reason, failure to distinguish whether FDI is by MNCs using the host-country as an export platform or not leads to seeming absence of FDI spillovers, both horizontal and vertical. The reason is that while export-oriented MNCs have no incentives to block FDI spillovers, management of other subsidiaries will experience intensified competition if either horizontal or vertical spillovers materialize.

In the next step, before introducing export-orientation, we control for the geographic location of subsidiaries. Table 4 presents the results when FDI flows are disaggregated by regions, within sectors as well as across upstream and downstream sectors. Again, we found no evidence of vertical spillovers. In contrast, we found some evidence of a positive intra-industry effect of FDI in the same region both for domestic plants and those with foreign participation. This horizontal and geographically localized effect only impacts the level of productivity and not its growth. Such finding would seem inconsistent with the notion that multinationals affect the productivity of local firms in the same sector when they compete for the same market.

However, Aitken, Hanson and Harrison (1997) have found evidence in Mexican manufacturing that geographic proximity of domestic producers to plants with foreign participation enhances export opportunities. Hence, domestic plants are able to benefit from generic export knowhow diffused by nearby MNCs as long as they do not compete for the same market. The set of results on the analysis that follows provides empirical grounding to this explanation.

4.3 Exports by MNCs and FDI Spillovers

In Table 5, we take into consideration the orientation of MNC subsidiaries as to whether they are exporters or supplying the local market. Here we classify the MNC subsidiaries between those that exhibit an export market orientation (those that sell at least 50% of their output abroad) from those that exhibit a domestic market orientation (those that sell at least 50% of their output nationally). Three distinct results are robust. First, there is strong evidence that FDI in export-oriented MNC subsidiaries yields spillover diffusion to upstream sectors through backward linkages. The improvement on productivity, both on its level and its growth rate, spreads across domestic and foreign owned firms. Second, there is evidence of positive intra-industry spillovers, in the form of a higher level and growth rate of productivity, arising from FDI by export-oriented MNCs but restricted only to plants with foreign participation. There is no such effect on wholly domestic plants. This result arises because outward oriented MNCs are not necessarily competing with other foreign firms, which may be oriented to the domestic market or exporting to different markets. Hence, horizontal spillovers are possible as long as the beneficiaries from spillovers are not in direct competition with the MNCs financing new projects with FDI. Finally, there is evidence of a negative effect on the productivity growth of all plants from intra-industry FDI by MNCs with a domestic market orientation. This result arises because expansion by MNCs oriented to the domestic market yields loss of market share to other plants. This induces inventory accumulation and forces plants to cut production. As output is lower, production possibilities remain unchanged but plants move up the average cost curve. That is why we observe no change in the level of productivity accompanied by negative productivity growth.[3] Using this line argument, we can explain the positive effect of horizontal regional FDI on the level of productivity of all plants presented in Table 4.

4.4 Absorptive Capacity and Technology Adoption

Having found evidence of spillovers when classifying FDI by the market orientation of the MNCs which made it, we now want to expand the analysis by taking into

[3]It is important to note that this effect does not constitute a spillover, here understood as an informational externality. Rather, this negative effect on productivity growth is a pecuniary externality because it results from increased competition and it is mediated by the market.

consideration the size of the firms. The Venezuelan Statistical Bureau grouped firms according to the following criteria: Small, up to 20 employees; medium, from 21 to 100 employees; and large, more than 100 employees. In order to explore the possibility of having spillover effects related to plant size, the regressions in Table 5 are run again separating the whole sample in two groups: SMPs (i.e. small and medium sized plants) and large plans. The results reported in Table 6 are striking. The evidence of a negative effect on productivity growth from intra-industry spillovers arising from FDI by MNCs with a domestic market orientation is robust for SMPs both foreign owned and domestic.

However, evidence of positive spillovers arising from export oriented MNCs (horizontal and vertical via backward linkages) appears only in the sample of large firms.[4] The result seems to suggest that size is an important indicator of absorptive capacity to capture the potential positive spillovers due to technology diffusion from FDI by MNCs. In contrast, small and medium sized plants are unable to deploy new technologies, with unchanged production possibilities, and instead face the negative intra-industry effect from competition by MNCs oriented to the domestic market, resulting in gradually declining productivity. Indeed, small traps can be caught in a trap that prevents their growth. As they do not produce much output, it is not viable to incur sunk investments associated with the adoption of new technology. Hence, absorptive capacity is not built. Furthermore, as their relative productivity drops, small domestic plants move further up their average cost curve when MNC subsidiaries enter to compete in local markets. The result is that small plant experience the negative intra-industry effect documented. In contrast, large plants reap the benefits of scale, which provides incentives to build absorptive capacity and adopt new technologies.

5 Concluding Remarks

The evidence for Venezuela points to existence of propagation of FDI spillovers to upstream sectors along backward linkages. This evidence is consistent with the absence of intra-industry spillovers when FDI by local market oriented MNCs. As pointed out in Kugler (2000a), technology diffusion from MNC subsidiaries to other plants is unlikely when those plants are direct competitors. This is because propagation of technical knowledge to competitors might result in a loss of market share. However, technology diffusion that does not result in a loss market share will not be averted by the MNC. For that reason, FDI by export market oriented MNCs generates both

[4] Note that the diffusion of technology to upstream sectors emanating from MNC subsidiaries, like the horizontal diffusion, occurs only when FDI is by export oriented MNCs. This is because, as in the case of intra-industry spillovers, if the MNC is local market oriented, substantially enhancing technological opportunities for intermediate input suppliers could provide important benefits to direct competitors. In that case, the MNC might prefer to import its components therefor shutting down backward linkages as a potential channel for technology diffusion.

horizontal and vertical spillovers to foreign owned and domestic plants. In contrast, FDI by local market oriented MNCs generates a negative pecuniary externality on small and medium sized plants as subsidiary expansion displaces incumbents and induces higher average costs. Hence, FDI projects by MNCs that are likely to use the host-country as an export platform are most likely to yield spillovers. Tariff jumping FDI is likely to yield the least scope for spillovers.

The evidence for Venezuela on upstream spillovers coincides with results documented for Colombia, Indonesia, Mexico and Lithuania. The importance of the findings is due to the paper by Aiken and Harrison (1999) for Venezuelan manufacturing providing the most celebrated evidence purportedly showing the inexistence of FDI spillovers. The fact that FDI spillovers emanate from export-oriented MNCs to large domestic plants is consistent with the finding by Aitken, Hanson and Harrison (1997) that geographic proximity to subsidiaries by Mexican plants is associated with better export performance. In one of the most widely cited papers on FDI spillovers, Aitken and Harrison (1999) report plant-level evidence that, by and large, shows absence of horizontal spillovers in Venezuelan manufacturing. This result is to be expected from the point of view of the MNCs optimal market penetration strategy. If the MNC uses the country as an export platform, horizontal FDI spillovers may be expected due to the absence of direct domestic competitors. Also, vertical FDI spillovers may be expected as the MNC may find it advantageous to share technical information with upstream suppliers and downstream clients.

In contrast to our analysis, Aitken and Harrison (1999) conclude absence of positive FDI spillovers in Venezuela solely on the basis of intra-industry effects from MNC operations. We also find lack of horizontal spillovers in some specifications but complement their analysis as we further allow for vertical spillovers. Overall, our evidence is consistent with important spillovers originating from export oriented MNCs. Other recent papers have allowed for vertical spillovers (e.g., Kugler (2000b), Blalock (2001), Lopez-Cordova (2002) and Smarzynska (2002)) and found evidence indicating their presence but also absence of horizontal spillovers. We complement those findings by allowing for FDI to impact upon domestic productivity differently depending on whether it takes place in upstream sectors, whether the subsidiaries of the MNCs investing are export oriented and the size of the domestic firms. We find that large plants in Venezuelan manufacturing are recipients of positive spillovers both from FDI in upstream sectors, and, to a lesser extent, from FDI in the same sector by export-oriented MNCs. These findings corroborate the insight that FDI spillovers materialize only for host-country producers beyond the competitive fringe faced by MNC subsidiaries. Hence, as pointed out in Kugler (2000a), for strategic reasons MNCs have incentive to avoid and block propagation of technology to some domestic producers, namely those competing in the same industry and local market. Partial excludability of technical knowledge allows MNCs to reap benefits from superior technology and avoid market share losses. Yet, there is evidence of important FDI spillovers. The policies that are conducive to enhance technology transfer from

MNCs to host country producers should facilitate the establishment of export platforms by subsidiaries and remove barriers to the emergence of domestic intermediate input suppliers.

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Table 1

	No. of obs	Mean	Std. Dev.	Min.	Max.
Production	5376	335059	9917788	0	209000000
Intermediate inputs	5376	4110975	12800000	0	201000000
No. of employees	5376	209	288	0	3474
Capital stock	5376	543468	1984922	0	28100000
Foreign capital share	5376	13.6	31.9	0	100.0
Horizontal	5376	28.3	18.4	0	67.1
Backward	5376	26.7	10.6	12.5	59.4
Forward	5376	33.5	13.8	7.4	58.0
Horizontal (same region)	5376	2.6	7.9	0	52.4
Horizontal (other regions)	5376	23.9	17.3	0	64.0
Backward (same region)	5376	1.6	4.5	0	45.7
Backward (other regions)	5376	23.4	10.8	5.2	59.4
Forward (same region)	5376	2.6	6.9	0	41.9
Forward (other regions)	5376	29.5	14.3	4.1	58.0
Horizontal (local market oriented)	5376	25.1	17.0	0	63.0
Horizontal (export oriented)	5376	3.1	5.3	0	22.1
Backward (local market oriented)	5376	22.8	9.6	8.7	57.7
Backward (export oriented)	5376	3.8	3.3	0.3	18.5
Forward (local market oriented)	5376	28.9	14.3	4.6	55.6

Table 2

	Levels				1st Differences			
	All firms		Domestic firms		All firms		Domestic firms	
		O-P		O-P		O-P		O-P
M	**0.5237**		**0.5199**		**0.3163**		**0.3154**	
	(15.47)***		**(14.33)*****		**(6.70)*****		**(6.14)*****	
L	**0.4071**		**0.4119**		**0.3360**		**0.3047**	
	(9.25)***		**(8.15)*****		**(4.80)*****		**(3.59)*****	
K	**0.1279**		**0.1319**		0.0267		0.0345	
	(7.14)***		**(6.02)*****		(1.25)		(1.43)	
Foreign Share	**0.0021**	**0.0015**			-0.0005	-0.0003		
	(4.27)***	**(2.28)****			(1.48)	(0.85)		
Horizontal	0.0017	0.0023	0.0033	0.0035	0.0001	-0.0012	-0.0006	-0.0021
	(0.84)	(1.10)	(1.29)	(1.30)	(0.08)	(0.68)	(0.32)	(0.99)
No. of obs.	5376	5376	4188	4188	4480	4480	3490	3490
R^2	0.60	0.59	0.55	0.57	0.20	0.03	0.19	0.03

All regressions include time, industry and regional dummies
O-P: Olley & Pakes algorithm applied
t-statistics in parentheses. ***, **, * denote significance at the 1, 5 and 10% level

Table 3

	Levels				1st Differences			
	All firms		Domestic firms		All firms		Domestic firms	
		O-P		O-P		O-P		O-P
M	**0.5239**		**0.5202**		**0.3164**		**0.3155**	
	(15.45)*		**(14.32)***		**(6.70)***		**(6.14)***	
L	**0.4067**		**0.4113**		**0.3351**		**0.3042**	
	(9.22)*		**(8.12)***		**(4.80)***		**(3.60)***	
K	**0.1280**		**0.1319**		0.0267		0.0337	
	(7.14)*		**(6.02)***		(1.24)		(1.41)	
Foreign Share	**0.0021**	**0.0015**			-0.0005	-0.0003		
	(4.25)*	**(2.27)**			(1.51)	(0.86)		
Horizontal	0.0017	0.0023	0.0035	0.0034	0.0005	-0.0011	0.0000	-0.0019
	(0.87)	(1.02)	(1.34)	(1.23)	(0.31)	(0.64)	(0.05)	(0.89)
Backward	0.0026	0.0014	0.0036	0.0025	0.0031	0.0016	0.0027	0.0022
	(1.20)	(0.60)	(1.20)	(0.82)	(1.14)	(0.58)	(0.77)	(0.67)
Forward	-0.0015	-0.0017	-0.0018	-0.0026	-0.0012	-0.0012	0.0002	-0.0009
	(0.75)	(0.72)	(0.71)	(0.91)	(0.58)	(0.59)	(0.06)	(0.38)
No. of obs.	5376	5376	4188	4188	4480	4480	3490	3490
R^2	0.60	0.59	0.55	0.57	0.20	0.03	0.19	0.03

All regressions include time, industry and regional dummies
O-P: Olley & Pakes algorithm applied
t-statistics in parentheses. ***, **, * denote significance at the 1, 5 and 10% level

Table 4

	Levels				1st Differences			
	All firms		Domestic firms		All firms		Domestic firms	
		O-P		O-P		O-P		O-P
M	**0.5240**		**0.5205**		**0.3164**		**0.3157**	
	(18.36)* **		**(16.93)*** **		**(6.26)*** **		**(5.64)*** **	
L	**0.4047**		**0.4099**		**0.3351**		**0.3034**	
	(10.82)* **		**(9.22)*** **		**(5.84)*** **		**(4.42)*** **	
K	**0.1274**		**0.1314**		0.0269		0.0339	
	(6.32)* **		**(5.25)*** **		(1.33)		(1.50)	
Foreign Share	**0.0020**	**0.0014**			-0.0005	-0.0004		
	(5.02)* **	**(3.21)*** **			(1.37)	(0.77)		
Horizontal (same region)	**0.0079**	**0.0119**	**0.0122**	**0.0125**	0.0001	-0.0036	0.0037	0.0002
	(2.23) **	**(3.49)*** **	**(2.46)*** **	**(2.65)*** **	(0.05)	(1.00)	(1.24)	(0.07)
Horizontal (other regions)	-0.0017	-0.0005	0.0000	0.0012	-0.0006	-0.0018	-0.0016	-0.0027
	(0.50)	(0.14)	(0.01)	(0.28)	(0.41)	(1.14)	(0.83)	(1.40)
Backward (same region)	0.0059	0.0006	0.0099	0.0067	0.0006	-0.0069	-0.0047	-0.0113
	(1.02)	(0.10)	(1.38)	(0.95)	(0.12)	(1.21)	(0.77)	(1.63)
Backward (other regions)	0.0052	0.0038	0.0059	0.0043	0.0038	0.0036	0.0036	0.0045
	(1.09)	(0.81)	(1.03)	(0.77)	(1.43)	(1.27)	(1.17)	(1.41)
Forward (same region)	-0.0038	0.0004	-0.0074	-0.0080	0.0010	0.0040	0.0071	0.0084
	(0.59)	(0.06)	(0.81)	(0.93)	(0.22)	(0.72)	(1.23)	(1.13)
Forward (other regions)	-0.0027	-0.0029	-0.0044	-0.0054	-0.0022	-0.0023	-0.0010	-0.0174
	(0.59)	(0.64)	(0.75)	(0.95)	(0.98)	(0.92)	(0.38)	(0.60)
No. of obs.	5376	5376	4188	4188	4480	4480	3490	3490
R^2	0.60	0.59	0.55	0.57	0.20	0.03	0.19	0.03

All regressions include time, industry and regional dummies
O-P: Olley & Pakes algorithm applied
t-statistics in parentheses. ***, **, * denote significance at the 1, 5 and 10% level

Table 5

	Levels				1st Differences			
	All firms		Domestic firms		All firms		Domestic firms	
		O-P		O-P		O-P		O-P
M	**0.5238**		**0.5201**		**0.3166**		**0.3156**	
	(15.45)*		**(14.31)***		**(6.71)***		**(6.16)***	
L	**0.4070**		**0.4119**		**0.3363**		**0.3051**	
	(9.23)*		**(8.13)***		**(4.80)***		**(3.61)***	
K	**0.1280**		**0.1319**		0.0266		0.0337	
	(7.14)*		**(6.02)***		(1.24)		(1.40)	
Foreign Share	**0.0021**	**0.0014**			-0.0005	-0.0003		
	(4.28)*	**(2.27)**			(1.41)	(0.75)		
Horizontal (local market oriented)	0.0015	0.0013	0.0024	0.0019	-0.0006	**-0.0024**	-0.0015	**-0.0035**
	(0.59)	(0.52)	(0.72)	(0.59)	(0.40)	**(1.64)***	(0.76)	**(1.76)***
Horizontal (export oriented)	0.0039	**0.0085**	0.0027	0.0072	**0.0085**	**0.0074**	0.0065	0.0062
	(0.90)	**(1.76)***	(0.47)	(1.14)	**(2.69)***	**(2.07)**	(1.59)	(1.33)
Backward (local market oriented)	0.0015	0.0004	0.0020	0.0012	0.0011	0.0004	0.0004	0.0006
	(0.66)	(0.14)	(0.68)	(0.36)	(0.41)	(0.13)	(0.12)	(0.17)
Backward (export oriented)	**0.0130**	**0.0159**	**0.0132**	**0.0156**	**0.0138**	**0.0094**	**0.0144**	**0.0109**
	(2.28)	**(1.89)***	**(1.90)***	**(1.78)***	**(2.79)***	**(1.81)***	**(2.55)***	**(1.97)***
Forward (local market oriented)	-0.0009	-0.0021	-0.0011	-0.0029	-0.0007	-0.0015	0.0008	-0.0009
	(0.42)	(0.80)	(0.40)	(0.88)	(0.33)	(0.73)	(0.31)	(0.40)
No. of obs.	5376	5376	4188	4188	4480	4480	3490	3490
R^2	0.60	0.59	0.55	0.57	0.20	0.03	0.19	0.03

All regressions include time, industry and regional dummies
O-P: Olley & Pakes algorithm applied
t-statistics in parentheses. ***, **, * denote significance at the 1, 5 and 10% level

Table 6

Small and Medium Firms	Levels				1st Differences			
	All S&M		Domestic S&M		All S&M		Domestic S&M	
		O-P		O-P		O-P		O-P
M	**0.5136**		**0.5196**		**0.2482**		**0.2557**	
	(12.15)* **		**(11.54)*** **		**(4.90)*** **		**(4.80)*** **	
L	0.1018		0.0385		**0.2763**		**0.2574**	
	(1.02)		(0.36)		**(3.13)*** **		**(2.45)*** **	
K	**0.1765**		**0.1803**		0.0435		0.0443	
	(6.89)* **		**(6.11)*** **		(1.22)		(1.20)	
Foreign Share	**0.0018**	0.0017			-0.0002	-0.0011		
	**(1.73)* **	(1.52)			(0.38)	(1.25)		
Horizontal (local market oriented)	0.0064	0.0055	0.0073	0.0062	-0.0019	**-0.0052**	-0.0025	**-0.0056**
	(1.23)	(1.05)	(1.27)	(1.07)	(0.73)	**(1.97)* **	(0.88)	**(2.03)** **
Horizontal (export oriented)	-0.0029	0.0009	-0.0025	0.0009	0.0025	-0.0015	0.0008	-0.0033
	(0.37)	(0.10)	(0.28)	(0.09)	(0.45)	(0.24)	(0.13)	(0.52)
Backward (local market oriented)	0.0053	0.0020	0.0079	0.0046	-0.0012	-0.0025	-0.0009	-0.0009
	(1.17)	(0.41)	(1.59)	(0.84)	(0.28)	(0.53)	(0.19)	(0.19)
Backward (export oriented)	0.0031	0.0108	0.0046	0.0130	0.0018	-0.0018	0.0044	0.0046
	(0.22)	(0.61)	(0.32)	(0.78)	(0.20)	(0.18)	(0.49)	(0.57)
Forward (local market oriented)	-0.0048	-0.0056	-0.0073	-0.0078	-0.0021	-0.0047	-0.0017	-0.0045
	(0.90)	(1.06)	(1.26)	(1.37)	(0.54)	(1.17)	(0.38)	(1.07)
No. of obs.	2196	2196	1896	1896	1830	1830	1580	1580
R^2	0.44	0.49	0.42	0.48	0.13	0.03	0.13	0.03
Large Firms	Levels				1st Differences			
	All Large		Domestic Large		All Large		Domestic Large	
		O-P		O-P		O-P		O-P
M	**0.5216**		**0.5123**		**0.3603**		**0.3538**	
	(11.82)* **		**(10.59)*** **		**(5.23)*** **		**(4.56)*** **	
L	**0.5302**		**0.5707**		**0.3163**		**0.2706**	
	(11.02)* **		**(8.69)*** **		**(3.99)*** **		**(2.53)*** **	
K	**0.0749**		**0.0767**		0.0197		0.0299	
	(4.95)* **		**(3.62)*** **		(0.68)		(0.92)	
Foreign Share	**0.0020**	**0.0017**			-0.0004	0.0001		
	(4.02)* **	**(2.95)*** **			(0.94)	(0.26)		
Horizontal (local market oriented)	**-0.0027**	**-0.0025**	-0.0033	-0.0029	0.0002	-0.0006	-0.0008	-0.0018
	**(1.86)* **	**(1.76)* **	(1.39)	(1.23)	(0.16)	(0.39)	(0.38)	(0.81)
Horizontal (export oriented)	**0.0086**	**0.0139**	**0.0081**	**0.0129**	**0.0124**	**0.0134**	**0.0112**	**0.0144**
	(2.26) **	**(4.29)*** **	**(1.75)* **	**(2.73)*** **	**(4.72)*** **	**(5.06)*** **	**(2.96)*** **	**(3.18)*** **
Backward (local market oriented)	0.0000	0.0001	-0.0012	-0.0002	0.0024	0.0024	0.0008	0.0013
	(0.03)	(0.09)	(0.57)	(0.09)	(1.04)	(0.95)	(0.28)	(0.39)
Backward (export oriented)	**0.0182**	**0.0194**	**0.0178**	**0.0169**	**0.0195**	**0.0168**	**0.0176**	**0.0149**
	(3.60)* **	**(3.51)*** **	**(2.76)*** **	**(2.40)*** **	**(4.63)*** **	**(3.46)*** **	**(2.99)*** **	**(2.23)** **
Forward (local market oriented)	0.0000	-0.0007	0.0010	-0.0005	0.0003	0.0005	0.0025	0.0016
	(0.01)	(0.32)	(0.48)	(0.17)	(0.17)	(0.23)	(1.11)	(0.70)
No. of obs.	3180	3180	2292	2292	2650	2650	1910	1910
R^2	0.58	0.71	0.55	0.69	0.28	0.04	0.27	0.03

All regressions include time, industry and regional dummies
O-P: Olley & Pakes algorithm applied
t-statistics in parentheses. ***, **, * denote significance at the 1, 5 and 10% level