

# Foreign and Domestic Ownership: Evidence of Productivity Spillovers from New Zealand Firm Level Longitudinal Data

Kris Iyer<sup>1+</sup>, Philip Stevens<sup>+</sup> and Kam Ki Tang<sup>^</sup>

<sup>+</sup>Ministry of Economic Development, New Zealand

<sup>^</sup>School of Economics, the University of Queensland, Australia

## Abstract:

This paper examines whether foreign and domestic ownership induced productivity spillovers exist in New Zealand (NZ) manufacturing. The following types of productivity spillovers are evaluated: horizontal (i.e. intra-industry) spillovers and, backward and forward (i.e. inter-industry) spillovers. For each type of spillovers, four directions are modelled: a) foreign to domestic, b) foreign to foreign, c) domestic to foreign and d) domestic to domestic. In effect, 12 distinct spillovers are considered. Productivity spillovers accruing to exporters and non-exporters are distinguished. The analysis is carried out using a panel dataset of 11,175 manufacturing firms spanning the years 2000-2007, which is extracted from the prototype Longitudinal Business Database.<sup>2</sup> The following findings emerge. Foreign owned firms are more productive as are exporters. Domestic firms that export are able to appropriate backward and forward spillovers from foreign firms, but not horizontal ones. Non-exporting domestic players do not receive any productivity benefit from foreign firms, regardless of spillovers type. Foreign firms do not appropriate any spillovers from the domestic sector or from each other. The result of spillovers between domestic firms is ambiguous. Among the control variables incorporated in the study, the effects of scale on productivity are positive but those of competition are ambiguous – exporters benefit from increased competition and non-exporters are adversely affected.

**JEL Classifications:** F21; F23; D24

**Keywords:** foreign direct investment; multinationals; spillovers; horizontal linkages; vertical linkages; productivity.

---

<sup>1</sup> Corresponding author: Ministry of Economic Development, 33 Bowen Street, PO Box 1473, Wellington 6011, New Zealand, E-mail: kris.iyer@med.govt.nz

<sup>2</sup> Disclaimer: The opinions, findings, recommendations and conclusions expressed in this report are those of the authors. Statistics New Zealand (NZ) and the Ministry of Economic Development, NZ take no responsibility for any omissions or errors in the information contained here. Access to the data used in this study was provided by Statistics NZ in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular, business or organisation. The results in this paper have been confidentialised to protect individual businesses from identification. Statistics NZ protocols were applied to the data sourced from the New Zealand Customs Service; the Foundation for Research, Science and Technology; New Zealand Trade and Enterprise; and Te Puni Kokiri. Any discussion of data limitations is not related to the data's ability to support these government agencies' core operational requirements. Any table or other material in this report may be reproduced and published without further licence, provided that it does not purport to be published under government authority and that acknowledgement is made of this source.

## 1. Introduction

In countries that have perennially depended on foreign savings to fund domestic investment, the importance of welcoming all types of foreign investment is deeply entrenched in the minds of policy makers.<sup>3</sup> With foreign direct investment (FDI), in particular, political enthusiasm has been more pronounced. This largely owes to the view that in addition to complementing the domestic savings and employment, FDI is a source of productivity spillovers. Local, state and national governments have extended fiscal and non-fiscal incentives to attract FDI to their jurisdictions with a view to appropriate these spillovers. For their part, foreign firms (i.e., FDI firms) have often played governments against each other and secured significant benefits.<sup>4</sup> Managers of foreign firms concede that incentives are an important determinant of their location decisions (Easson 2001). Whether or not to incentivise FDI is a cost-benefit trade-off, one element of which is whether productivity spillovers do occur, and, if yes, where they do and in what order of magnitude. It is also important to determine the underlying mechanism through which the spillover process takes place so that other aspects of policy can be aligned to maximise the economy-wide benefits from FDI.

The process of spillovers is easy to comprehend, at least in theory. For a foreign firm to enter and succeed in the domestic market, it should have some compensating firm-specific advantages (FSAs) that enable it to compete with the existing local players, who would have better access to, and knowledge of, the domestic market (Graham and Krugman 1991).<sup>5</sup> Where the foreign firm is not able to fully internalize its FSAs, the possibility of spillovers arises. Spillovers may be appropriated by competing firms (both domestic and foreign) in the same industry. These are known as horizontal spillovers emanating from foreign firms. In some other cases, the foreign firm may intentionally transmit knowhow to associated firms in its supply chain, and these spillovers may be either backward (spillovers to firms that supply to the foreign firm) or forward (spillovers to firms that purchase from the foreign firm).

Recently, a parallel literature has emerged to argue that foreign firms locate in a domestic economy with a view to tap domestic technology rather than to exploit their own FSAs (e.g. Driffield and Love 2003; van Pottelsberghe de la Potterie and Lichtenberg 2001). Since this theory reverses the direction of spillovers from foreign-to-domestic to domestic-to-foreign, spillovers of this type have been termed ‘reverse spillovers’. Incentivising such FDI would be hard to justify.

Taking an even broader view, conventional and reverse spillovers are only half the story. Not all domestic firms or foreign firms are homogenous in terms of technology and business practice. As such, there is always the possibility of spillovers amongst domestic firms themselves, and likewise in the case of foreign firms. Thus, each of the horizontal and vertical spillovers may accrue in four directions: a) foreign-to-domestic, b) foreign-to-foreign, c) domestic-to-foreign, and d) domestic-to-domestic. Knowledge on each type of spillovers will contribute to better policy advice. For example, if there is evidence of spillovers amongst domestic firms themselves, then any incentive to FDI could be justified only if the foreign-to-domestic spillovers are at least as large as domestic-to-domestic spillovers. Further, where there is evidence of domestic-to-foreign and/or foreign-to-foreign spillover, then the appropriateness of the size of the FDI incentive should be judged by how large the foreign-to-domestic spillovers are compared to that of domestic-to-domestic spillovers plus domestic-to-foreign and/or foreign-to-foreign spillovers.

---

<sup>3</sup> Foreign investments are classified into three types – foreign direct investment (FDI), foreign portfolio investment (FPI) and other foreign investment (OFI). Statistics NZ defines inward FDI as the purchase, by non-residents, of 10 percent or more of the total equity of a NZ enterprise. Loans from overseas investors to NZ firms where those investors hold a significant equity stake are also counted as FDI. The idea underlying the 10 percent threshold is to capture foreign investment in domestic enterprises, where the purpose of the investment is to obtain or sustain a lasting interest in the enterprise and exercise a significant degree of influence on its management. Foreign investments in equity and debt securities that fall below the 10 percent threshold are categorised as FPI, while international bank lending and other private credits are classified as OFI.

<sup>4</sup> Among OECD countries, FDI subsidies range from USD 14,000 per job to USD 250,000 per job (UNCTAD, 1995).

<sup>5</sup> A non-exhaustive list of these compensating advantages includes technological superiority, better managerial and organizational skills and access to international markets.

There is emerging evidence that the ability of a firm to appropriate FDI spillovers is dependent on its market orientation (Javorcik 2004). Domestic firms that export appear to be better placed to gain from foreign presence in their own sector as well as from supply chain linkages (e.g. Lin et al. 2009). Evaluating this hypothesis requires modelling the multi-directional spillovers for exporters and non-exporters separately.

The regression models in this paper distinguish between horizontal, backward and forward spillovers (HS, BS and FS) and evaluate the spillover transmission process comprehensively by accommodating all the four directions in which each type of spillovers may be transmitted. Thereby, in total 12-way spillovers are evaluated. The 12-way spillovers are listed in Table 1 and Figure 1 shows the schematic displacements. To the best of our knowledge, this is the first paper that considers comprehensively all possible directions of spillovers between foreign and domestic firms.

**Insert Table 1 about here**

**Insert Figure 1 about here**

In general, empirical analyses of FDI spillovers have been plagued with econometric issues. These include the predominant use of cross-sectional data, selection bias associated with foreign firms ‘cherry-picking’ the more productive domestic firms for acquisition, self-selection of foreign firms into more productive industries, unresolved endogeneity in the production function and spurious significance of spillovers owing to the downward bias of the standard errors. Görg and Greenaway (2004) and Hale and Long (2007) provide a comprehensive account of these issues. In their pioneering works, Javorcik (2004) and Haskel et al. (2002) resolve several of the econometric shortcomings of past research. The methodological improvements suggested in Javorcik (2004) and Haskel et al. (2002) are built into the empirical modelling in this study. This paper also makes several contributions towards furthering methodological refinements. First, panel data is applied. This allows for addressing the issue of ‘cherry-picking’ without resorting to instruments, which are often not available due to data constraints. Second, it is recognised that using panel data models, even with fixed effects, does not completely resolve the upward bias in estimated spillovers resulting from foreign firms self-selecting into more productive industries. This is because spillovers are supposed to be correlated with the productivity of other firms, not the firm itself. The 12-way spillover model in this paper, while not eliminating the bias *per se* (if it does exist), provides us tools to test for its empirical significance. Third, it is now well established that productivity derived as a residual of a production function regression may be correlated with the factor inputs. This paper corrects for the endogeneity in the production function by using the Levinsohn and Petrin (2003) procedure. Last, as pointed out in Javorcik (2004), when regressing micro units, i.e., firm level productivity against spillover variables which are aggregated at the industry level, the estimated standard errors are biased downwards. This gives rise to the possibility of spurious significance of the spillover variables. The analysis in this paper corrects for such spurious results using corrected standard errors.

This paper focuses on productivity spillovers in New Zealand (NZ) manufacturing.<sup>6</sup> Notably, this is the first firm level study of FDI led productivity spillovers for the NZ economy. Investigating the productivity effects of foreign ownership is topical and important for NZ because of both the volume of FDI in NZ (relative to GDP) and the extent of integration of FDI in the economy. In terms of volume, NZ has relied more heavily on FDI as a source of fixed capital formation than any other developed country (UNCTAD 1999). Foreign firms are also well integrated into the domestic economy. In fact, foreign interests dominate the business landscape in NZ. Foreign firms in NZ generate 23% of sales, own 38% of productive assets, control 47% of the share market and provide 37% of all employment (Attewell and van Lijf 2005; Scott-Kennel 2006). Notwithstanding, owing to the lack of evidence, the process of FDI spillovers and the effects of FDI on the wider NZ economy is less

---

<sup>6</sup> The manufacturing sector focus owes to four reasons. First, with the exception of the finance and insurance sector, which is dominated by a few foreign banks, the manufacturing sector has been the largest recipient of FDI in NZ. Second, it is recognised that the linkages between foreign and domestic firms are more significant in the manufacturing sector as opposed to other sectors such as agriculture (UNCTAD 1999). Third, restricting the analysis to manufacturing permits a more detailed analysis than would have otherwise been possible in a single paper. Last, focusing exclusively on the manufacturing sector allows the reader to compare results of this paper with the international evidence, which has tended to be based upon manufacturing firms (e.g., Aitken and Harrison 1999, Javorcik 2004, Haskel et al. 2002).

understood. Davis (2003) suggests that improved understanding of FDI in NZ is necessary to help target policy initiatives that might induce beneficial foreign investment.

Thus far, FDI policy in NZ has been developed based on experience in other countries. Idiosyncratic factors at work mean that evidence generated in the context of one country may not be appropriate for policy design in another. This observation is particularly true for NZ given that the country is unique in several respects. It is small, distant and not so open to trade (relative to similar sized developed economies). It also presents an intriguing paradox where despite having world class institutions, the country's performance in the growth metric is just average (OECD 2003). In the past, the lack of good quality, comprehensive firm level dataset had been a serious impediment to appropriately researching productivity spillovers from FDI in NZ and to developing FDI policies that suit its own circumstances. The prototype Longitudinal Business Database (LBD), administered by Statistics NZ, removes the data impediments.<sup>7</sup>

Generally speaking, the LBD has been built primarily around government administered data collections and stands out for both its comprehensive coverage of firms and the variety of variables captured. The breadth of data in the LBD enables significant advances to be made in many areas of microeconomic analysis, including FDI (Fabling et al., 2008). For the present analysis, an unbalanced panel dataset of 11,175<sup>8</sup> manufacturing firms spanning the years 2000-07 is extracted from the LBD. The sample firms accounted for between 89 and 98% of the manufacturing value added (depending on the year), giving confidence that the coverage is comprehensive. The manufacturing economy is classified into 16 industry groups. This is the highest level of disaggregation that is possible given the Input-Output tables being used.<sup>9</sup>

The remainder of the paper is organised as follows. The next section reviews the international literature on FDI led productivity spillovers. Section 3 discusses the econometric methodology and presents the model specification. Section 4 describes the data and offers summary statistics. The results of the econometric analyses are reported in Section 5. The last section concludes.

## 2. Literature Review

### 2.1 Horizontal Spillovers from FDI

Horizontal spillovers from foreign ownership occur through one or more of the following conduits: a) movement of labour, b) imitation and observational learning and, c) competition.

#### *Movement of Labour:*

The relocation of the foreign firm trained workers to the domestic sector, either by changing jobs or starting new ventures, can potentially enhance productivity in two ways. First, the foreign firm trained workers may carry with them knowledge of new technology or management techniques and consequently become direct agents of technology transfer (Görg and Greenaway 2004). Second, the foreign firm trained workers may raise the productivity of co-workers in the domestic firms, simply by association. While there is much evidence to suggest that foreign firms pay higher wages to plug this 'leak' (e.g. Aitken et al. 1997, Feenstra and Hanson 1997), domestic firms also have been observed to respond by increasing compensation (e.g. Aitken et al. 1997).

#### *Imitation and observational learning:*

The advanced technologies and new products unleashed by a foreign firm in the domestic market force the local players to respond by innovating. Often, innovation takes the form of imitation, e.g. reverse engineering (Wang and Blomström 1992). The scope for imitation is restricted by the complexity of the product and process; the more complex they are, the more difficult it is to replicate them (Görg and Greenaway 2004). Where the foreign firm's products and technologies are vastly different from those of local firms, spillovers may not accrue

---

<sup>7</sup> The LBD is discussed in more detail in Fabling et al. (2008) and Statistics NZ (2007).

<sup>8</sup> All firm counts in this paper are random rounded.

<sup>9</sup> The Input-Output table derived by Stroombergen (2008) is used. The official input output tables (1995-96), while providing for higher levels of disaggregation are outdated and, in our opinion, not reflective of the current NZ manufacturing economy.

(Kokko 1994). The presence of foreign firms in the industry also provides non-technological benefits for the domestic competitors such as improved knowledge of management practices and export opportunities, and enhanced country of origin reputation (Meyer and Sinani 2005; Altenburg 2000).

*Competition*<sup>10</sup>:

On the one hand, foreign entrants might intensify domestic market competition leading to higher productivity, lower prices and more efficient resource allocation within the economy (e.g., Blomström, 1986). On the other hand, a foreign entrant may establish a position of market power, effectively crowding out the domestic players (Harrison 1994, Aitken and Harrison 1999). In the short run, this translates into excess production capacity and thus, low productivity. Higher wage paying foreign firms tend to raise wage costs for all firms impacting negatively on the profitability of domestic firms in the short run (Aitken et al. 1997). OECD (2002) observes that the risk of crowding out is exacerbated if the host country constitutes a geographically isolated market and the host-country market is small – cases we observe to be particularly applicable in the NZ context.

## ***2.2 Backward and Forward Spillovers from FDI***

These spillovers accrue through the formal association of the foreign firm with local suppliers or customers. Foreign firms gain from the improved performance of their associates, which suggests that such spillovers are more likely than horizontal ones (Javorcik 2004).

*Backward Spillovers (Spillovers accruing to domestic suppliers of intermediate inputs):*

Backward spillovers might take effect in several ways. A foreign firm might directly transfer technology or provide technical assistance to raise the quality and facilitate innovations (Moran 2001; UNCTAD 2001). The foreign firm may be able to assist in non-technical aspects of business such as through training the management (UNCTAD 2001), opening up export markets for the supplier (Lall 1980) and facilitating scale economies by expanding and guaranteeing a market for intermediate inputs (Lim and Fong 1982). Lastly, the foreign buyer might be instrumental in increasing the efficiency of domestic firms by bringing about competition among potential suppliers (Crespo and Fontoura 2007).

International empirical evidence on backward spillovers is reasonably robust and accumulating. Blalock (2002) and Blalock and Gertler (2002) report positive backward spillovers for Indonesian firms, while Javorcik (2004), Schoors and van der Tol (2001) and Wang and Gu (2006) find evidence of positive spillovers for Lithuanian, Hungarian and Canadian firms respectively. Gorodnichenko et al. (2007), analysing the data from 17 emerging economies, also find consistent evidence of backward FDI spillovers. Evidence of technology transfer via backward linkages is extensively documented in case studies (e.g. MacDuffe and Helper 1997; Moran 1998).<sup>11</sup>

Backward spillovers may be constrained by several factors. The foreign firm may choose to import the intermediate goods instead of sourcing them locally (Rodriguez-Clare 1996).<sup>12</sup> Even where a foreign firm sources locally, the suppliers may fail to learn and absorb the transferred technology if they lag far behind their foreign partners in productivity (Javorcik 2004). Also, the entry of foreign firms can lower the degree of linkages between industries if the foreign firm requires exclusivity arrangements as a pre-condition for technology transfer (Lin and Saggi 2007).

*Forward Spillovers (Spillovers accruing to domestic business consumers):*

---

<sup>10</sup> Although effects of foreign firm induced competition might be regarded as spillovers, the welfare consequences of competition are different from the technology spillovers which tend to be the focus of the FDI literature. Specifically, technology spillovers are Pareto-improving positive externalities, whereas increased effort by the local competitors represents a welfare transfer away from the harder-working employees to shareholders and/or customers (Haskel et al. 2002). Javorcik (2004) observes that it is useful to separate the two phenomena. Accordingly, the modelling of spillovers should filter out the effects of competition using variables such as the Herfindahl index of industry concentration.

<sup>11</sup> Lim (2001) provides a summary of the case studies.

<sup>12</sup> For example, in the 1990s, China's machine tool and aircraft industries suffered significant decline partly because their downstream customers insisted to source intermediate goods from overseas markets (Lin et al., 2009).

Foreign firms have an interest in the sales and efficiency achieved by its customers since that would, in time, translate into greater demand for their own goods and services. Foreign firms, therefore, have an incentive to transfer knowledge on production methods and processes, and international market access to their domestic consumers. Forward spillovers might materialise as a result of the foreign firm selling new or better quality intermediate inputs to its customers at more competitive prices. Domestic consumers may also gain from the services offered by the foreign firm as part of the formal engagement.

The evidence on forward spillovers is mixed. The Gorodnichenko et al., (2007) study on spillovers in emerging economies finds that forward spillover benefits are not as consistent as those from backward spillovers. Javorcik (2004) finds negative spillovers from forward linkages in the Lithuanian firm sample, as do Blalock and Gertler (2002) in their analysis of Indonesian firms. In contrast, Driffield et al. (2002) finds that forward spillovers are more significant in the UK, relative to other types of spillovers. Evidence for NZ from the Scott-Kennel (2004) survey can be interpreted along the same lines. Forty percent of surveyed foreign firms in NZ reported that they provide assistance to customers.

### *2.3 Spillovers from domestic firms to foreign firms*

Recently, some studies have suggested that foreign firms undertake FDI with intent to source technology from the cutting-edge firms in the domestic economy (e.g. Cantwell 1995; Driffield and Love 2003).<sup>13</sup> Fosfuri and Motta (1999) and Siotis (1999) present models of the FDI decision that embody the possibility of reverse spillovers. They demonstrate that a technological laggard firm may choose to enter a foreign market by FDI even where this involves set-up costs because of the positive 'reverse' spillover effects. Presumably, assimilation of the acquired technology decreases the production costs of the investing firm, both in its foreign subsidiary operations and in its home production base. Where the beneficial spillover effect is sufficiently strong, Fosfuri and Motta (1999) show that it may even pay the laggard firm to run its foreign subsidiary at a loss to incorporate the benefits of advanced technology in all the markets in which it operates.

The evidence on reverse spillovers is mixed. Early studies of Kogut and Chang (1991) and Anand and Kogut (1997), using data on German and British firms in the US, find that technology sourcing motive does not determine foreign firm entry. Likewise, Neven and Siotis (1996), investigating FDI flows between Japan, US, UK, Germany, France and Italy do not find evidence of technology sourcing motive. Martin and Velazquez (1997) observe that FDI flowed from countries with a high R&D intensity to countries with a lower R&D intensity. This observation is generally inconsistent with the view that FDI is undertaken with the motive of sourcing technology. More recently, using Chinese data, Buckley et al. (2002) find that the direction of the spillover relationship runs from foreign firms to domestic firms, as predicted by the traditional paradigm, rather than in the reverse direction.

Contrasting evidence in favour of the reverse spillovers emerged in Driffield and Love (2003, 2005). Driffield and Love (2003) present a test of the necessary condition for technology sourcing and are able to demonstrate that reverse spillovers indeed occur in the UK. Restricting the focus to the manufacturing sector, Driffield and Love (2005) again find evidence of reverse spillovers but only in the R&D intensive sectors. Survey results from Scott-Kennel (2004) suggest that reverse spillovers occur in NZ.<sup>14</sup>

Driffield and Love (2005) introduce the possibility that spillovers might also run between foreign firms. The foreign-to-foreign linkage is especially likely where a particular industry is composed principally of foreign firms that have chosen – or have been encouraged – to enter the domestic economy specifically because of potential access to superior technology. This possibility is consistent with the empirical evidence on the increasing internationalisation of R&D (Cantwell 1995). Under such conditions, it is possible that domestic firms may lack the ability to benefit from spillovers, and productivity effects may be restricted to the foreign sector alone.

---

<sup>13</sup> van Pottelsberghe de la Potterie and Lichtenberg (2001) have gone as far as to suggest that FDI flows are predominantly motivated by the desire to source technology.

<sup>14</sup> The Scott-Kennel survey results are suggestive of both conventional and reverse spillovers.

### 3. Model Specification and Econometric Methodology

The empirical modelling of FDI spillovers in this paper follows a two-step procedure, along the lines of Görg et al. (2009), Lin et al. (2009), Schoors and Merlevede (2007) and Vahter and Masso (2006), among others. In the first step, measures of multi-factor productivity (MFP) are estimated and in the second, MFP is regressed against a vector of variables that includes ones pertaining to spillovers.

#### 3.1 Step One: Obtaining estimates of MFP

MFP is estimated as the residual of the Cobb-Douglas production function specified as under:

$$\ln(MFP_{it}) = \ln(Y_{it}) - \hat{\theta}_k \ln(K_{it}) - \hat{\theta}_l \ln(L_{it}) \quad (1)$$

where  $Y_{it}$  is the value added of firm  $i$  at time  $t$ , and  $\hat{\theta}_k$  and  $\hat{\theta}_l$  are the estimated coefficients of capital and labour.

Computing MFP via the equation (1) could potentially suffer from an endogeneity bias if a part of the MFP was observed by the firm early enough to influence the factor input decision. Econometrically, this means that the regressor and the error term are correlated, i.e., the OLS estimates biased. This reverse causality cannot be ruled out especially when annual instead of quarterly data are used, as is the case here.

Olley and Pakes (1992) (OP) propose a semi-parametric estimation procedure to resolve the bias. Specifically, a production function is defined with two error components, one representing a white noise and another representing a firm specific productivity shock. OP model firm level investment as a function of the productivity shock and other state variables. Assuming that the investment function is invertible, the OP method is able to define a functional form for estimating productivity that corrects for endogeneity.<sup>15</sup> However, the OP approach is applicable only for firms that undertake non-zero investment. In datasets where investment data does not exist or where a substantial number of firms report zero investment, the OP approach is less useful – as is the case with the data in hand. Levinsohn and Petrin (2003) (LP) suggest an alternative approach where intermediate inputs, rather than investment, are used as proxy for the unobservable productivity shock. There are two advantages of using the LP approach. First, almost all firms use intermediate inputs. Thus, in datasets such as the current one, the LP procedure confers a data advantage. Second, intermediate inputs, arguably, provide a better proxy for productivity shock than investment since they are likely to respond quicker to productivity shocks. The estimation of productivity in this paper follows the LP procedure.<sup>16</sup>

#### 3.2 Step Two: MFP Regressions

Equation (2) below is the commonly applied baseline specification that models productivity with a focus on identifying spillovers from foreign firms.

$$MFP_{ijt} = \alpha_0 + \gamma_1 FDI_{ijt} + \alpha_1 HFDI_{jt-1} (1 - FDI_{ijt}) + \alpha_2 BFDI_{jt-1} (1 - FDI_{ijt}) + \alpha_3 FFDI_{jt-1} (1 - FDI_{ijt}) + \varphi_1 EX_{ijt} + \varphi_2 HI_{jt-1} + \varphi_3 SCALE_{ijt-1} + \delta_t + \delta_j + \varepsilon_{ijt} \quad (2)$$

where,

$MFP_{ijt}$  Multi-factor productivity of firm  $i$  in industry  $j$  at time  $t$ .

$FDI_{ijt}$  A dummy variable equal to one if firm  $i$  in industry  $j$  is a foreign owned firm at time  $t$ , and zero otherwise.<sup>17</sup> Therefore,  $(1 - FDI_{ijt})$  is a dummy equal to one if firm is a domestic one and zero otherwise.

<sup>15</sup> For applications see Olley and Pakes (1992), and Pavcnik (2000).

<sup>16</sup> The implementation uses the Stata module “levpet” developed by Petrin et al. (2004).

<sup>17</sup> Domestic firms which are acquired by foreign owners for the first time at time  $t$  are treated as domestic in all previous years. However, foreign firms which are sold to domestic owners at time  $t$  are treated as foreign for all

$HFDI_{jt}$	Horizontal spillovers from foreign firms in industry $j$ at time $t$ . $HFDI_{jt}$ is measured as the share of output produced by the foreign firms in the industry $j$ to the total output <sup>18</sup> in the industry $j$ , i.e., $HFDI_{jt} = \sum_i y_{ijt} FDI_{ijt} / \sum_i y_{ijt}$ . Thereby $HFDI_{jt-1}(1 - FDI_{ijt})$ is a measure of horizontal spillover from foreign to domestic firms, i.e. $HS_{FD}$ .
$BFDI_{jt}$	Backward spillovers from foreign firms in industry $j$ at time $t$ . Thereby $BFDI_{jt-1}(1 - FDI_{ijt})$ is a measure of backward spillovers from foreign to domestic firms, i.e. $BS_{FD}$ . $BFDI_{jt}$ is measured as $\sum_{k:k \neq j} \rho_{jk} HFDI_{kt}$ , where $\rho_{jk}$ is share of industry $j$ 's output supplied to industry $k$ . <sup>19</sup> $\rho_{jk}$ values are obtained from the IO tables for 2005-06 (Stroombergen 2008). <sup>20</sup> Note that $\sum_{k:k \neq j} \rho_{jk}$ is a constant but not necessarily equal to one.
$FFDI_{jt}$	Forward spillovers from foreign firms in industry $j$ at time $t$ . Thereby $FFDI_{jt-1}(1 - FDI_{ijt})$ is a measure of forward spillovers from foreign to domestic firms, i.e. $FS_{FD}$ . $FFDI$ is measured as $\sum_{g:g \neq j} \rho_{gj} HFDI_{gt}$ , where $\rho_{gj}$ represents the share of industry $j$ 's input sourced from industry $g$ . <sup>21</sup> $\rho_{kg}$ values are obtained from the IO tables.
$EX_{ijt}$	Dummy variable capturing if the firm is an exporter. <sup>22</sup>
$HI_{jt}$	Herfindahl index in industry $j$ at time $t$ . $HI_{jt}$ is constructed as $\sum_{i=1}^n (sales_{ijt} / sales_{jt})^2$ . It can be readily deduced that the $HI_{jt}$ is bound between 0 and 1 and that higher $HI_{jt}$ indicates greater market concentration, i.e., less competition.
$SCALE_{ipt}$	Firm sales relative to average firm sales, measured at the industry group level.
$\delta_j$ and $\delta_t$	Industry and time dummies, respectively.

There is an issue of selection bias associated with foreign firms 'cherry-picking' the more productive domestic firms for acquisition. This will result in an upward bias in the estimation of spillovers. To address this, we need

---

future years. The argument is that technological advantage is not completely lost after divestment of foreign ownership stake.

<sup>18</sup> An alternative method would be to use employment shares. The shares of output and employment are highly correlated in this sample.

<sup>19</sup> As an illustration (similar to Javorcik 2004), suppose that the viticulture industry sells half of its output to wine producers and half to fruit vendors. If none of the foreign firms are producing wine but all grape fruit sales is accounted for by foreign firms, the BFDI variable will be calculated as follows:  $(0.5*0)+(0.5*1)=0.5$ .

<sup>20</sup> In theory, the backward and forward spillover effects should be captured using firm level input-output tables, which we do not possess. Also, the backward and forward spillover variables are sector-specific, but not completely time invariant. HSPILL may also vary year by year. Therefore, in theory, the input-output coefficients should also vary over time to reflect the true underlying supply and use. However, in practice annual input output tables are not available for NZ.

<sup>21</sup> A more accurate measure of forward spillovers should exclude goods purchased by foreign firms for exports. Our data not permit this.

<sup>22</sup> Firms that first exported at time  $t$  are treated as non-exporters in all previous years. However, once a firm is labelled as an exporter, it remains one irrespective of whether it exported in any of the future years.



to control for firm heterogeneity by including a fixed effect ( $\delta_{ij}$ ) into the equation (Hale and Long 2007). Therefore equation (2) becomes:

$$MFP_{ijt} = \alpha_0 + \gamma_1 FDI_{ijt} + \alpha_1 HFDI_{jt-1} (1 - FDI_{ijt}) + \alpha_2 BFDI_{jt-1} (1 - FDI_{ijt}) + \alpha_3 FFDI_{jt-1} (1 - FDI_{ijt}) + \varphi_1 EX_{ijt} + \varphi_2 HI_{jt-1} + \varphi_3 SCALE_{ijt-1} + \delta_t + \delta_{ij} + \varepsilon_{ijt} \quad (3)$$

With the inclusion of  $\delta_{ij}$ ,  $\delta_j$  – the industry dummy is redundant.

There is then the other type of selection bias which relates to foreign firms self-selecting to locate in more productive industries. This would also lead to an upward bias in the estimation of spillovers. Including fixed effect ( $\delta_{ij}$ ) into the equation will not resolve the issue because spillover terms are correlated with the productivity of other firms (competitors or associated) and not the firm  $i$  itself. This issue can be addressed by including other spillover terms into the regression model.

$$MFP_{ijt} = \alpha_0 + \gamma_1 FDI_{ijt} + \alpha_1 HFDI_{jt-1} (1 - FDI_{ijt}) + \alpha_2 BFDI_{jt-1} (1 - FDI_{ijt}) + \alpha_3 FFDI_{jt-1} (1 - FDI_{ijt}) + \alpha_4 HDOM_{jt-1} (1 - FDI_{ijt}) + \alpha_5 BDOM_{jt-1} (1 - FDI_{ijt}) + \alpha_6 FDOM_{jt-1} (1 - FDI_{ijt}) + \varphi_1 EX_{ijt} + \varphi_2 HI_{jt-1} + \varphi_3 SCALE_{ijt-1} + \delta_t + \delta_{ij} + \varepsilon_{ijt} \quad (4)$$

where,

$HDOM_{jt}$  Horizontal spillovers from domestic firms in industry  $j$  at time  $t$ .  $HDOM_{jt}$  is measured as the share of output produced by the domestic firms in the industry  $j$  to the total output in the industry  $j$ , i.e.,  $HDOM_{jt} = 1 - \left( \sum_i y_{ijt} FDI_{ijt} \right) / \sum_i y_{ijt}$ . Thereby  $HDOM_{jt-1} (1 - FDI_{ijt})$  is a

measure of horizontal spillovers from domestic to domestic firms, i.e. HS<sub>DD</sub>.  
 $BDOM_{jt}$  Backward spillovers from domestic firms sourcing from industry  $j$  at time  $t$ . Thereby  $BDOM_{jt-1} (1 - FDI_{ijt})$  is a measure of backward spillovers from domestic to domestic firms, i.e. BS<sub>DD</sub>.

$$BDOM_{jt} = \sum_{k:k \neq j} \rho_{jk} HDOM_{kt} = \sum_{k:k \neq j} \rho_{jk} (1 - HFDI_{kt}) = \left( \sum_{k:k \neq j} \rho_{jk} \right) - BFDI_{jt} .$$

$FDOM_{jt}$  Forward spillovers from domestic firms supplying to industry  $j$  at time  $t$ . Thereby  $FDOM_{jt-1} (1 - FDI_{ijt})$  is a measure of forward spillovers from domestic to domestic firms, i.e. FS<sub>DD</sub>.

$$FDOM_{jt} = \sum_{g:g \neq j} \rho_{gj} HDOM_{gt} = \sum_{g:g \neq j} \rho_{gj} (1 - HFDI_{gt}) = \left( \sum_{g:g \neq j} \rho_{gj} \right) - FFDI_{jt} .$$

For horizontal spillovers (HS), if foreign firms self-select into industries of higher productivity, then  $\alpha_1$  (which captures HS<sub>FD</sub> – horizontal spillovers from foreign to domestic firms) should not be significantly larger than  $\alpha_4$  (HS<sub>DD</sub> – horizontal spillovers from domestic to domestic firms). Likewise, for vertical spillovers, if there is self-selection, then  $\alpha_2$  (BS<sub>FD</sub>) should not be significantly larger than  $\alpha_5$  (BS<sub>DD</sub>) and  $\alpha_3$  (FS<sub>FD</sub>) should not be significantly larger than  $\alpha_6$  (FS<sub>DD</sub>). Clearly, this specification does not eliminate the self-selection bias. But it does provide a means to test its empirical significance, if it exists.<sup>23</sup>

<sup>23</sup> In the case where foreign-to-domestic spillovers is not significantly larger than that of domestic-to-domestic spillovers, then whatever the underlying reasons might be, the implication to the FDI policy is practically the same.

To accommodate the 12-way spillovers, equation (4) is augmented as under:

$$\begin{aligned}
MFP_{ijt} = & \alpha_0 + \alpha_1 HFDI_{jt-1}(1 - FDI_{ijt}) + \alpha_2 BFDI_{jt-1}(1 - FDI_{ijt}) \\
& + \alpha_3 FFDI_{jt-1}(1 - FDI_{ijt}) + \alpha_4 HDOM_{jt-1}(1 - FDI_{ijt}) \\
& + \alpha_5 BDOM_{jt-1}(1 - FDI_{ijt}) + \alpha_6 FDOM_{jt-1}(1 - FDI_{ijt}) \\
& + \alpha_7 HFDI_{jt-1} FDI_{ijt} + \alpha_8 BFDI_{jt-1} FDI_{ijt} + \alpha_9 FFDI_{jt-1} FDI_{ijt} \\
& + \varphi_1 EX_{ijt} + \varphi_2 HI_{jt-1} + \varphi_3 SCALE_{ijt-1} + \delta_t + \delta_{ij} + \varepsilon_{ijt}
\end{aligned} \tag{5}$$

Equation (5) provides explicitly for 9-way spillovers rather than 12-way spillovers. This is because:

$$HFDI_{jt-1} FDI_{ijt} + HDOM_{jt-1} FDI_{ijt} = FDI_{ijt} \tag{6}$$

$$HFDI_{jt-1}(1 - FDI_{ijt}) + HDOM_{jt-1}(1 - FDI_{ijt}) = 1 - FDI_{ijt} \tag{7}$$

Together (6) and (7) add up to one. To avoid perfect multi-collinearity,  $HDOM_{jt-1} FDI_{ijt}$  or  $HS_{DF}$  (horizontal spillovers from domestic to foreign firms) is excluded from the equation. This simply means that the  $HS_{FD}$  (horizontal spillovers from foreign to domestic firms) is measured relative to  $HS_{DF}$ . In the unlikely scenario that  $HS_{DF} > HS_{FD}$ , the latter is negative. Applying the same argument,  $BDOM_{jt-1} FDI_{ijt}$  or  $BS_{DF}$  (backward spillovers from domestic to foreign firms) and  $FDOM_{jt-1} FDI_{ijt}$  or  $FS_{DF}$  (forward spillovers from domestic to foreign firms) are also excluded from equation (5).

It is also pointed out that equation (5) does not explicitly provide for a dummy variable to capture the effects of a foreign owned firm (unlike in the case of exporting firms:  $EX_{ijt}$ ). This is because  $HFDI_{jt-1} FDI_{ijt} + HDOM_{jt-1} FDI_{ijt} = FDI_{ijt}$ , that is, the effect of  $FDI_{ijt}$  is the sum of the effects of  $HFDI_{jt-1} FDI_{ijt}$  and  $HDOM_{jt-1} FDI_{ijt}$ . By being the excluded spillover term in the equation  $HDOM_{jt-1} FDI_{ijt}$  serves as the baseline. Therefore, the effect of  $FDI_{ijt}$  is essentially the same as that of  $HFDI_{jt-1} FDI_{ijt}$ . However, due to the existence of  $BFDI_{jt-1} FDI_{ijt}$  and  $FFDI_{jt-1} FDI_{ijt}$  in equation (5), the full effect of FDI will be equal to the sum of all three terms, provided that each of them is individually significant.

Another feature of equation (5) is that the spillover variables as well as Competition (HI) and scale variables are included in first lags to alleviate issues with endogeneity.<sup>24</sup> Noticeably, the equation has unit record information in the LHS and several industry level variables on the RHS. Moulton (1990) has demonstrated that regressions of micro units on variables aggregated at the industry level produce standard errors that are biased downwards, thereby giving raise to the possibility of spurious significance. To address this issue, throughout the paper we use corrected standard errors.<sup>25</sup>

<sup>24</sup> It is not apparent what the appropriate lag structure is. Given that an average firm in the sample has about three observations, only one lag is used. Since the data is annual, using one lag is not considered unduly restrictive.

<sup>25</sup> The corrected standard errors allow for intra-group correlation, relaxing the usual requirement that the observations be independent. That is, the observations are independent across clusters but not necessarily within groups. The models in this paper were also estimated without correcting for the standard errors. The standard errors were quantitatively different but did not change the statistical significance of any of the variables. In this instance, therefore, not correcting for standard errors would not have altered the findings of the study.

## 4. Data and Summary Statistics

The data used in this study comes from the LBD. The LBD contains data mainly for financial years 2000 to 2007 from a number of sources including the Annual Enterprise Survey (AES), Goods and Services Tax (GST), Business Activity Indicator (smoothed GST returns), financial returns (IR10 and IR4), Customs and some other surveys such as business operations survey, energy use survey, business finance survey etc. The spine of the LBD is the Longitudinal Business Frame (LBF) which contains demographical information pertaining to firms including data on foreign ownership interests. Appendix 1 lists the data sources for the variables applied in this study.

The data extraction is of two phases. In the first phase, data for the entire economy is drawn out from the AES which underpins the national accounts. Data from the entire economy is needed to construct measures of BS and FS from domestic and foreign firms. Specifically, data on 286,269 firms spanning the years 2000 to 2007 are compiled; 2,352 of these firms were foreign owned. In terms of value added, the firms in the sample account for between 50 and 60 percent of national GDP. Considering that the sample is restricted to private businesses, the coverage is considered satisfactory. In the second phase, data from the non-manufacturing economy is filtered out to keep with manufacturing sector focus of the paper. The filtered sample accounts, on average, for 89 percent of the manufacturing value added in NZ over 2000-07.

The manufacturing economy is represented in the analysis by 11,175 unique firms<sup>26</sup> with varying counts of annual observations. On average, there are between three and four annual observations per firm.<sup>27</sup> 10,878 (330) firms are domestically (foreign) owned. 1,566 firms had an exporting history.<sup>28</sup> 1,302 domestic firms exported while 291 exporters were foreign owned.<sup>29</sup> It can be deduced that while 12 percent of domestic manufacturing firms are exporters, 88 percent of foreign owned firms export. This evidence is in line with Fabling et al. (2008) who report that foreign owned firms are more likely to export.<sup>30</sup> Summary statistics pertaining to the output and factor inputs, distinguished by foreign owned and domestically owned firms are presented in Table 2.

**Insert Table 2 about here**

Foreign firms are dominant players in the NZ manufacturing economy. Just about 3 percent of the firms in the sample are foreign owned, yet, on average (across all years); they contribute 59 percent of value added, control 58 percent of the capital stock and employ 39 percent of the labour. This implies that foreign firms tend to be much larger than domestic firms. An average foreign firm in the manufacturing sector is 38 times larger than a

---

<sup>26</sup> In this paper, a firm is defined as a group of separate legal entities that are linked by ownership. For example, a parent and its subsidiaries will be classified as a single firm. This is necessary to obtain the true productivity effects of foreign ownership.

<sup>27</sup> Observations that have either negative or zero values for the production function variables are excluded since the production function is estimated in natural logarithms.

<sup>28</sup> The number of foreign and domestic firms does not add up to total number of firms given that the counts are random rounded.

<sup>29</sup> The number of foreign owned and domestic exporters need not add up to the total number of exporters. There are two reasons for this. First, as stated in the previous footnote, the counts are random rounded. Second, the difference is attributed to change in ownership during the period of observation. An exporting firm, whose ownership has changed hands from domestic to foreign, will figure in both categories for the summary statistics. In the panel regression, however, they fall into their appropriate categories based on whether the owner was foreign or domestic in the applicable year.

<sup>30</sup> Fabling et al. (2008) report that foreign firms are three times more likely to export. This study finds that foreign firms are 6 times more likely to export. This difference may be attributable to the manufacturing specific sample used in this paper. It is documented that FDI in the NZ service sector is taken up primarily to meet the local demand while foreign firms in manufacturing have an export objective (Scott-Kennel 2007).

domestic firm in terms of value added and capital employed and employs 18 times more labour. This observation, while dramatic, is an expected one. Small and medium sized firms (less than 19 employees) make up more than 97 percent of the NZ business population but their contribution to output is only around 40 percent.<sup>31</sup> It is established that the NZ economy in general is characterised by a large number of small firms; although most of the output is generated by the larger firms.

Consistent with the observation that foreign firms are larger sized, it appears that, on average, foreign firms enjoy a larger scale. The average ratio of foreign firm sales over industry sales is 10.65, while for domestic firms the ratio is only 0.50. The data, however, do not directly reveal whether foreign and domestic firms within the same industry group are heterogeneous in terms of technology and product portfolio.

Table 3 documents the average magnitude of horizontal, backward and forward linkages (foreign and domestic) in NZ manufacturing over the period 2000-07, as well as the growth rate of the linkages over the same period.

### **Insert Table 3 about here**

Among the non-confidentialised sectors, horizontal linkages of foreign firms - share of output produced by the foreign firms in the industry to the total output in the industry - increased for eight industries and decreased for four. It follows there from that horizontal linkages of domestic firms increased for the latter four industries and decreased for the former eight. To discuss specific instances, the contribution of foreign firms to the industry's total value added is 90% in beverages and 80% in rubber, plastic and other chemicals. The level of foreign contribution is lower in industries such as furniture manufacturing (less than 10%). The share of value added by foreign firms grew most noticeably in paper industries. In industries such as wood products, printing, textiles and other machinery, the share of foreign firms actually decreased over the observed period.

For all reported manufacturing sub-sectors<sup>32</sup>, the values of both backward linkages and forward linkages of foreign firms increased during the observed period. The growth in the linkages between foreign firms and their intermediate input suppliers was most noticeable in wood production industries. In this industry, the share of foreign production actually fell; yet, the linkage of foreign firms with the downstream sectors of the economy has strengthened. This might be suggesting some form of business re-organization. The backward linkages from foreign ownership values are highest for the printing and publishing and fabricated metals and, expectedly, lowest for primary goods industries such as meat and other foods.

The growth of forward linkages of foreign firms, i.e., links between foreign firms and consumers has been sober, with only printing and publishing and fertilizers sectors registering a linkage growth in excess of 5 percent. With printing and publishing, the strength of forward linkages increased even though the share of foreign production in these sectors diminished. The variation in foreign linkages across the sub-sectors is relatively low, implying that the linkages between foreign owned producers and consumer firms in NZ are stable across the manufacturing economy.

The lack of a systematic positive relationship between horizontal and vertical linkages either in levels or growth implies that an increase in foreign firm value added in one industry does not necessarily result in greater foreign-to-domestic linkages in the upstream and downstream industries. In fact, the suggestive evidence from Table 3 is to the contrary. Indeed, an inverse relationship between the two linkages is quite plausible. Foreign firms might source their intermediate inputs internationally, e.g. from their parent companies abroad, rather than buying domestically. NZ has a benevolent FDI policy regime with no obvious or disguised local content requirement rules which makes this scenario possible. Likewise, foreign firms may sell products (as final products for consumption or intermediate inputs) in international markets. Survey evidence from Scott-Kennel (2004) suggests that foreign firms in primary goods processing and manufacturing use NZ as a base for supplying inputs and finished goods to offshore markets and/or the wider corporate network.

The horizontal and vertical linkage variables are used to construct the 12-way spillovers, nine of which are included in equation (5). The correlations between the 12-way spillovers are presented in Table 4 below:

### **Insert Table 4 about here**

---

<sup>31</sup> Authors' calculations.

<sup>32</sup> Some sub-sectors are confidentialised to preserve anonymity.

With the exception of foreign-to-foreign spillovers, the correlations are not remarkable. This implies that the regressions reported in the next section are not particularly inhibited by collinearity issues surrounding the 12-way spillovers.

## 5. Results and Discussion

As described in Section 3, a two-step empirical strategy is employed. In the first step, a production function is estimated and the residual is interpreted as MFP. In the second step, MFP is regressed against a host of explanatory variables including those that reflect on spillovers. The parameters of the Cobb-Douglas production function estimated using the OLS and LP are presented in Table 5.

**Insert Table 5 about here**

The coefficients capital and labour obtained using the LP procedure are 0.26 and 0.46 respectively. The coefficient of labour is lower than what is obtained under the OLS estimation. This result is consistent with the theoretical and empirical results discussed in LP. As regards capital, the coefficient under LP is higher than OLS estimate. LP note, the capital coefficient obtained using their procedure may be more or less than the one obtained using OLS, depending on the degree of correlation among the inputs and the productivity shocks. The Chi-squared test examining the hypothesis that the sum of labour and capital coefficients under the LP is equal to one was rejected with a p-value close to 0.

The paper now turns to the MFP regression results primarily based on equation (5). In accordance with the specification, full sets of time and sector dummies are included. Keeping with the view that the effects of spillovers of exporters and non-exporters might be different, the regressions were run separately on these two sub-sets of firms. The models were estimated using fixed effects (FE), random effects (RE) and generalized method of moments (GMM) methods. The GMM method simultaneously addresses the issues of endogeneity and correlated fixed effects and is well suited to datasets consisting of a large number of cross-sections and short time series. The model diagnostics obtained using the GMM were reasonable. However, the lag of the dependent variable (MFP) picked up most of the dynamics. Therefore, there is merit in pursuing the RE estimation method which is favoured over the FE model by the Hausman test. Nine models are estimated and the results are presented in Table 6. RE based on equation (5) for the whole sample and for exporters and non-exporters separately. Likewise, with the GMM; for the GMM estimation, the lagged value of the dependent variable is introduced in equation (5).<sup>33</sup> The FE model for the whole sample is presented, as are RE models for the whole sample based on equations (3) and (4).

**Insert Table 6 about here**

The foreign ownership and export orientation dummy variables are positive and significant across all examined models. The notion of productivity premium associated with international linkages put forth in Fabling et al. (2008) is reinforced.

On average, a foreign firm is 62% ( $= [\exp(0.4820) - 1] \times 100$ ) more productive than a domestic firm (column 2 of table 6). Recall that the full effect of  $FDI_{ijt}$  is equal to the sum of those of  $HFDI_{jt-1}FDI_{ijt}$ ,  $BFDI_{jt-1}FDI_{ijt}$  and  $FFDI_{ijt-1}FDI_{ijt}$ ; however, only  $HFDI_{jt-1}FDI_{ijt}$  is individually significant here. The productivity inducing effects of foreign ownership exist independent of the firm's exporter status. In the model that contains only exporting firms, a foreign firm is 58% more productive than a domestic firm. The coefficient on foreign ownership is not significant in the non-exporters sample, but this result is less significant considering that almost 90 percent of foreign owned firms are exporters. Based on the exporter sample, it appears that foreign ownership confers productivity benefits to firms above and beyond what can be acquired through exposure to the international market place via trade. This is in accordance with the earliest literature on FDI which argues that foreign firms are more productive by definition, or else they would not be able to successfully

<sup>33</sup> Introducing the lagged dependent variable in the vector of explanatory variables in the case of RE and FE models is not advised.

foray into overseas markets. If the results from the more traditional modelling of spillovers are considered (i.e., equation 3), the premium from foreign ownership is upwardly biased at 96% (column 8 of table 6, coefficient on FDI).

The paper finds that exporters are 67% more productive than non-exporters. The productivity differential between exporters and non-exporters is more or less an established fact in the literature (Fabling and Sanderson 2009). Similar results on the productivity differential between exporters and non-exporters in NZ have been reported in Iyer et al. (2010). Based on point estimates, the effect of foreign ownership on non-exporters and exporters is not very different. This indicates the absence of a ‘substituting effect’ (or even ‘complementing effect’) between trade and foreign investment in terms of promoting firm productivity. In the GMM model (column 5 of table 6), the coefficient on the exporter indicator is not significant. The likely reason for this result is that the lag of the MFP which is positive and significant picks up all the time invariant elements embodied in the exporter dummy.

In general, it is perceived that FDI confers significant productivity gains for domestic firms in the economy, although the empirical evidence is often found to be sobering (see, Rodrik 1999). Public policy on FDI in NZ has been influenced by pieces of work based on this rather unsubstantiated perception as well as on theoretical constructs, select case studies and a subset of international empirical evidence that find in favour of spillovers from FDI (e.g., see, Davis 2003; BCG 2003). This paper finds mixed evidence on the spillover gains from FDI for domestic firms in NZ.

Domestic firms that do not have an exporting history do not appropriate productivity spillovers from FDI – neither intra-industry nor inter-industry. This is evidenced by the non-significant coefficients of the variables  $HS_{FD}$ ,  $BS_{FD}$  and  $FS_{FD}$  which represent horizontal, backward and forward productivity spillovers from foreign firms to domestic firms. Significantly, this finding is robust across all regression methods (FE, RE and GMM).

On the other hand, domestic firms that do export are observed to appropriate vertical spillovers. As per the RE model (column 4, table 6), on average, a one percentage point increase in foreign ownership concentration in a supplying industry causes the productivity of a domestic exporter in a consumer industry to go up by more than 1.35 times. Yet, this result was only marginally significant – at the ten percent level. This indicates that while the gain of having more foreign firms in the upstream on average is large, the size of gain varies a lot across the domestic firms. The GMM estimate of forward spillovers (column 7, table 6) is significant at the 5% level and suggests a 2.16 times productivity increase. Further, the GMM results also indicate gains through backward spillovers; a one percentage point increase in foreign ownership concentration in downstream industries causes the productivity of a domestic exporter in a supplying industry to go up by 67%. These findings are consistent with the argument that vertical spillovers— which are based on a symbiotic relationship between foreign and domestic firms, are more likely than horizontal spillovers—which are based on a competitive relationship. The finding of vertical spillovers from FDI is consistent with the Scott-Kennel (2004) survey where 40% of surveyed foreign firms in NZ reported that they provide assistance to customers and 22% reported providing assistance to suppliers and contractors; possibly the assistance was provided predominantly to exporters.

In the specification based on equation 3 (column 9, table 6), there is evidence of negative horizontal spillovers from foreign-to-domestic firms. However, the coefficient is very small compared to other significant terms. More importantly, the result is not robust to other specifications. When the specifications are improved to account for 12-way spillovers (equation 5), the coefficient turns insignificant.

Spillovers accruing amongst domestic firms appear to be negative in the RE model. The coefficients on the  $BS_{DD}$  and  $FS_{DD}$  variables are negative and significant at 10 and one percent respectively. This literally means that an increase in domestic ownership in supplying or customer industries reduces the productivity of domestic firms in the partner industry. Nevertheless, it is important to remember that the domestic-to-domestic spillovers are measured relative to the base—the domestic-to-foreign spillovers. Therefore, the negative coefficients can also be interpreted as that, a larger domestic presence in the supplying or customer industries have less negative impacts on foreign firms than domestic firms in the partner industry. This possibly reflects the ability of foreign firms to seek more technologically sophisticated suppliers or customers overseas. This explanation gains some support from the separated results for exporters and non-exporters. In the RE models (columns 3 and 4, table 6), though not significant, the effect of  $BS_{DD}$  is less negative for exporters and  $FS_{DD}$  even become positive. This is consistent with the above argument that domestic exporting firms are more likely to have access to sophisticated suppliers or customers overseas than non-exporting firms. While the GMM based estimates do not find any significant effect for  $BS_{DD}$  and  $FS_{DD}$  in all samples, the separated results for exporters and non-exporters continue to support the above argument.

It was observed in Table 4 that the  $HS_{FF}$ ,  $BS_{FF}$  and  $FS_{FF}$  variables are highly correlated. A number of regressions were run to examine if the results are sensitive to excluding one or two of these spillover variables. In all permutations,  $BS_{FF}$  and  $FS_{FF}$  were not statistically significant, while  $HS_{FF}$  was. Of course, the significance of  $HS_{FF}$  is no surprise since as per the specification in equation (5)  $HS_{FF}$  is equivalent to an independent foreign ownership dummy.

Cantwell (1995) observes that increasing R&D internationalisation in a country may give way to spillovers between foreign firms. The level of R&D intensity in NZ is particularly low by OECD standards. Therefore, the *a priori* expectation is that there would be no spillovers between foreign firms. The obtained results are in accordance with the *a priori* expectation. This result is also robust across regression methods.

In the RE model, the effect of scale on productivity is positive and significant. On average, a one percentage point increase in scale results in a 1.23% increase in productivity. There is a difference in the magnitude of scale effects for exporters and non-exporters. For exporters, the productivity effect of scale is 0.6%, while for non-exporters, the effect is to the tune of 5.4%. This difference can be attributed to the lower scale of operation for non-exporters and, therefore, greater marginal gains. In the GMM model, the scale effects disappear. Again, we think this might be because of the lag term of the dependent variable picking up the time invariant elements in the scale variable.

The Structure-Conduct-Performance paradigm of the competition literature provides that industry concentration (or the inverse of competition) is an important determinant of firm conduct and have a direct effect on firm MFP (see, Lin et al. 2009). However, the predictions of the theoretical literature on the impact of competition on productivity are ambiguous (Nickell 1996).<sup>34</sup> In this study, we report the effects of increased concentration (lower competition) to be positive for non-exporters and negative for exporters (although, only at the 10% level of significance). This result is possibly driven by some large domestically focused manufacturers. As in the case of the SCALE variable, the GMM method is not able to pick up this variation.

Lastly, the coefficients on the sector and time dummy variables are generally significant justifying their inclusion in the model.

## 6. Conclusion

This study investigated productivity spillovers in NZ manufacturing from foreign and domestic ownership using firm level data. A large panel dataset of 11,175 firms was compiled with annual observations from the year 2000 to 2007. Measures of multifactor productivity (MFP) were computed after taking into account the issues associated factor input endogeneity. The existence of spillovers was identified based on MFP regressions. A range of regression methods were applied including fixed effects, random effects and generalised method of moments.

Three types of FDI spillovers were modelled: horizontal, backward and forward. For each type, four directions of spillovers were identified: a) foreign to domestic, b) foreign to foreign, c) domestic to foreign, and d) domestic to domestic. In total, 12-way spillovers are modelled. Spillovers accruing from foreign ownership to exporters and non-exporters were distinguished.

It was observed that foreign firms, on average, were much larger than domestic firms, owned more capital and employed more workers. Productivity premium associated with foreign ownership and exporting was confirmed. The productivity effect of foreign ownership was substantial even after controlling for export orientation. There was no evidence of substitutability or complementarity between foreign ownership and exporter status.

There was evidence of domestic firms appropriating productivity spillovers from FDI. The result was conditional on exporting history. Non-exporting domestic firms did not benefit from foreign presence either in the same industry or elsewhere in the supply chain. Domestic exporters, on the other hand, recorded productivity gains as a result of increased foreign presence elsewhere in the supply chain (i.e., backward and forward spillovers). There was no evidence of spillovers accruing between foreign firms, which are consistent with the low R&D intensity in NZ. The evidence on spillovers between domestic firms was ambiguous.

---

<sup>34</sup> In his empirical analysis, Nickell (1996) finds evidence of competition being positively correlated with productivity growth.

The effect of scale on MFP was positive with non-exporters gaining more than exporters. The differential between exporters and non-exporters is an artefact of the marginal gains being larger for non-exporters who, on average, are smaller than exporters. Increased concentration (decreased competition) is found to decrease the productivity of exporters but increase the productivity of non-exporters. This result is possibly driven by some large domestically focused manufacturers.

## References

Aitken, B. & Harrison, A. (1999). "Do domestic firms benefit from direct foreign investment? Evidence from Venezuela", *American Economic Review*. 89: 605-618.

Aitken, B.J., A.E. Harrison, and R.E. Lipsey. (1997). "Wages and foreign ownership: A comparative study of Mexico, Venezuela, and the United States", *Journal of International Economics*. 40(3-4): 345-71.

Altenburg, T. (2000). "Linkages and Spillovers between Transnational Corporations and Small and Medium-sized Enterprises in Developing Countries: Opportunities and Best Policies", in UNCTAD, *TNC-SME linkages for development: Issues-experiences-best practices*. New York: United Nations: 3-61.

Anand, J. and B. Kogut (1997). "Technological Capabilities of Countries, Firm Rivalry and Foreign Direct Investment." *Journal of International Business Studies* 28(3): 445-65.

Attewell, J. and W. van Lijf (2005). "Investigation of New Zealand's Inward Foreign Affiliate Trade Statistics Using Existing Data Sources" *Official Statistics Research Series*, Vol 1. Available at: [www.statisphere.govt.nz/osresearch](http://www.statisphere.govt.nz/osresearch)

Blalock, G. (2002). "Technology from foreign direct investment: Strategic transfer through supplies chains", Dissertation at Haas School of Business, University of California, Berkeley.

Blalock, G. and Gertler, P. (2002), "Firm Capabilities and Technology Adoption: Evidence from Foreign Direct Investment in Indonesia", Working Paper, Department of Applied Economics and Management, Cornell University.

Blomström, M. (1986). "Foreign Investment and Productive efficiency: the case of Mexico." *Journal of Industrial Economics* 35: 97-112.

Blomström, M., A Kokko, and S Globerman. (2001). *The determinants of host country spillovers from foreign direct investment: A review and synthesis of the literature*: Palgrave in association with National Institute of Economic and Social Research.

Blomström, M and A Kokko. (2003). "Human capital and inward FDI." *EIJS Working Paper Series, The European Institute of Japanese Studies*, No. 167.

Boston Consulting Group. (2003). "Building the Future", report submitted to the Ministry of Economic Development.

Buckley, P. J., J. Clegg, and C. Wang. (2002). "The Impact of Inward FDI on the Performance of Chinese Manufacturing Firms", *Journal of International Business Studies*, 33 (4): 637-55.

Cantwell, J. (1995). "The Globalisation of Technology: What Remains of the Product Cycle Model?", *Cambridge Journal of Economics*, 19(1), 155-74.

Cohen, W. M. and D. A. Levinthal. (1990). "Absorptive capacity: A new perspective on learning and innovation." *Administrative Science Quarterly*, 35, pp. 128-52.

Crespo, N. and M.P. Fontoura. (2007). "Determinant Factors of FDI Spillovers .What Do We Really Know?", *World Development*. 35(3): 410-25.



- Davis, N. (2003). "Inward Direct Investment, Productivity Spillovers and Public Policy", Ministry of Economic Development.
- Driffield, N.L. and J. H. Love. (2003). "Foreign Direct Investment, Technology Sourcing and Reverse Spillovers", *The Manchester School*, 71(6): 659-72.
- Driffield, N. L. and J. H. Love. (2005). "Who Gains From Whom?: Spillovers, Competition and Technology Sourcing in the Foreign-Owned Sector of UK Manufacturing", *Scottish Journal of Political Economy*, 52(5): 663-86.
- Driffield, N.L., M. Munday, and A. Roberts. (2002). "Foreign direct investment, transactions linkages, and the performance of the domestic sector", *International Journal of the Economics of Business*, 9: 335-51.
- Easson, A. (2001). "Tax Incentives for Foreign Direct Investment Part 1: Recent Trends and Countertrends", *Bulletin for International Fiscal Documentation*. 55: 266-74.
- Fabling, R., Grimes, A., Sanderson, L., and Stevens, P., (2008), "Some rise by sin, and some by virtue fall: Firm dynamics, market structure and performance", *MED Occasional Paper*. 08/01.
- Fabling, R. and L. Sanderson. (2009). "Exporting and performance: The impact of destination characteristics on learning effects", Presented at NZAE Conference 2009
- Feenstra, R.C. and G.H. Hanson. (1997) "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras", *Journal of International Economics*, 42(3/4): 371-93.
- Fosfuri, A. and M. Motta. (1999). "Multinationals without advantages", *Scandinavian Journal of Economics*. 101(4): 617-30.
- Görg, H and D. Greenaway. (2004). "Much ado about nothing? Do domestic firms really benefit from foreign direct investment?", *World Bank Research Observer*, 19(2): 171-97.
- Görg, H., A. Hijzen, and B. Muraközy. (2009). "The role of production technology for productivity spillovers from multinationals: Firm-level evidence for Hungary," Kiel Working Papers 1482, Kiel Institute for the World Economy.
- Gorodnichenko, Y., J. Svejnar, and K. Terrell. (2007). "When Does FDI have Positive Spillovers? Evidence from 17 Emerging Market Economies" IZA Discussion Paper No. 3079. Institute for the Study of Labour (IZA), Bonn.
- Graham, E.M., and P.R. Krugman. (1991). "*Foreign Direct Investment in the United States*" Washington, DC: Institute for International Economics.
- Harrison A.E. (1994). 'Productivity, imperfect competition and trade reform.' *Journal of International Economics*, 36:53-73.
- Haskel, J. E., S.C. Pereira and M.J. Slaughter. (2002). "Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms?" National Bureau of Economic Research (Cambridge, MA) Working Paper No. 8724.
- Iyer, K., P. Stevens, and D. Austin. (2010). "Are Non-Exporters Locked out of Foreign Markets because of Low Productivity?: Evidence from New Zealand Agriculture and Forestry", Paper to be presented at the 2010 NZAE conference in Auckland.
- Javorcik, B. (2004). "Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages", *American Economic Review*. 94(3): 605-27.
- Kogut, B. and S. J. Chang. (1991). "Technological capabilities and Japanese foreign direct investment in the United States", *The Review of Economics and Statistics* 73: 401-13.

- Kokko, A. (1994). "Technology, market characteristics and spillovers", *Journal of Development Economics* 43: 279-93.
- Lall, S. (1980). "Vertical Inter-Firm Linkages in LDCs: An Empirical Study," *Oxford Bulletin of Economics and Statistics* 42: 203-06.
- Levinsohn, J. and A. Peterin. (2003). "Estimating Production Functions Using Inputs to Control for Unobservables", *Review of Economic Studies*. 70: 317-41.
- Lim, E-G. (2001). "Determinants of, and the Relation Between, Foreign Direct Investment and Growth: A Summary of the Recent Literature", IMF Working Paper 01/175, November. Available at: <http://www.imf.org/external/pubs/ft/wp/2001/wp01175.pdf>
- Lim, L. and P.E. Fong. (1982). "Vertical Linkages and Multinational Enterprises in Developing Countries", *World Development* 10(7): 585-95.
- Lin, P. and K. Saggi. (2007). "Multinationals, exclusivity, and the degree of backward linkages", *Journal of International Economics*. 71: 206-20.
- Lin, P., Z. Liu and Y. Zhang. (2009). "Do Chinese domestic firms benefit from FDI inflow?: Evidence of horizontal and vertical spillovers", *China Economic Review*. 20(4): 677-91.
- MacDuffe, J. and S. Helper. (1997). "Creating lean suppliers: diffusing lean production through the supply chain", *California Management Review*. 39: 118-52.
- Martin, C. and F. Velazquez. (1997). "The determining factors of foreign direct investment in Spain and the rest of the OECD: Lessons for the CEECS." Working paper no. 1637, Centre for Economic Policy Research (CEPR), London.
- Meyer, K. E. and Sinani, E. (2005). "Spillovers from Foreign Direct Investment: A Meta-Analysis", CEES Working paper no. 59, Copenhagen Business School, available at: <http://ir.lib.cbs.dk/paper/ISBN/x656504292>
- Moran, T. (1998). "Foreign direct investment and development", Washington D.C., Institute for International Economics.
- Moran, T. (2001). "*Parental Supervision: The New Paradigm for Foreign Direct Investment and Development*", Washington DC: Institute for International Economics.
- Moulton, B.R. (1990). "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units." *Review of Economics and Statistics*, Vol. 72(2): 334-38.
- Neven, D. and G. Siotis. (1996), "Technology Sourcing and FDI in the EC: An Empirical Evaluation", *International Journal of Industrial Organization*, 14(5): 543-60.
- Nickell, S.J. (1996). "Competition and Corporate Performance", *Journal of Political Economy*. 104(4): 724-46.
- OECD (2002). "Foreign Direct Investment for Development: Maximising Benefits, Minimising Costs", OECD, Paris.
- OECD (2003). "*Economic surveys: New Zealand*". Paris: Organisation for Economic Cooperation and Development.
- Olley G.S. and A. Pakes. (1992). "The Dynamics of Productivity in the Telecommunications Equipment Industry. NBER Working Paper No. 3977. Cambridge MA.
- Pavcnik, N. (2000). "Trade Liberalization, Exit and Productivity Improvement: Evidence From Chilean Plants", NBER Working Paper Series, No. 7852.
- Petrin, A. , B. Poi, and J. Levinsohn (2004). "Production Function Estimation in Stata Using Inpust to Control for Unobservables", *The Stata Journal*, 4(2): 113-23.

- Rodrik, D. (1999). *"The New Global Economy and Developing Countries: Making Openness Work"*, Overseas Development Council; distributed by Johns Hopkins University Press, Baltimore: Washington, D.C.
- Rodriguez-Clare, A. (1996). "Multinationals, linkages, and economic development", *American Economic Review*. 86: 852-73.
- Scott-Kennel, J. (2006). "Foreign direct investment to New Zealand", *University of Auckland Business Review*, 8 (2).
- Schoors, K and B. Van Der Tol. (2002). "Foreign Direct Investment Spillovers within and between Sectors: Evidence from Hungarian Data", Ghent University Working Paper 02/157, Belgium.
- Schoors, K and B. Merlevede. (2007). "FDI and the Consequences: Towards more complete capture of spillover effects," William Davidson Institute Working Papers Series wp886, William Davidson Institute at the University of Michigan Stephen M. Ross Business School.
- Scott-Kennel, J. (2004). "Foreign Direct Investment and the Competitiveness of New Zealand Industry: Key Findings from a Nationwide Survey", *University of Auckland Business Review*. 6 (2): 41-49.
- Scott-Kennel, J. (2007). "Foreign Direct Investment and Local Linkages: An Empirical Investigation", *Management International Review*. 41(1): 1-27.
- Siotis, G. (1999). "Foreign direct investment strategies and firms' capabilities", *Journal of Economics and Management Strategy*, 8: 251-70.
- Statistics New Zealand. (2007). "Improved Business Understanding via Longitudinal Database Development (IBULDD): Potential Outputs from the Longitudinal Business Database", *Statistics New Zealand*.
- Stroombergen, A. (2008). "ESSAM General Equilibrium Model: Estimation of 2005/06 Input-Output Tables", *Motu Working Paper* 08-01.
- UNCTAD. (1995). *"World Investment Report 1995 - Transnational Corporations and Competitiveness"*, New York and Geneva; United Nations.
- UNCTAD. (1999). *"World Investment Report 1999 - Foreign direct investment and the challenge of development"*, New York and Geneva; United Nations.
- UNCTAD. (2001). *"World Investment Report 2001 - Promoting Linkage"*, New York and Geneva; United Nations.
- Vahter, P and J. Masso. (2006). "Home versus Host Country Effects of FDI: Searching for New Evidence of Productivity Spillovers," William Davidson Institute Working Papers Series 820, William Davidson Institute at the University of Michigan Stephen M. Ross Business School.
- Van Pottelsberghe de la Potterie, B. and F. Lichtenberg. (2001). "Does foreign direct investment transfer technology across borders?", *Review of Economics and Statistics*. 83: 490-7.
- Wang, J.Y. and M. Blomstrom. (1992). "Foreign Investment and Technology Transfer: A Simple Model", *European Economic Review*, 36(1): 137-55.
- Wang, Y. and Gu, W. (2006) "FDI, Human Capital and Productivity: The Role of Vertical Linkages", forthcoming in the Statistics Canada Working Paper series.
- Xu, B. (2000). "Multinational enterprises, technology diffusion, and host country productivity growth." *Journal of Development Economics*, 32, pp. 1258-74.

**Table 1: 12-way spillovers effects**

<b>Spillover</b>	<b>Notation</b>
Horizontal Spillovers from foreign to domestic firms	$HS_{FD}$
Horizontal Spillovers from domestic to domestic firms	$HS_{DD}$
Horizontal Spillovers from foreign to foreign firms	$HS_{FF}$
Horizontal Spillovers from domestic to foreign firms	$HS_{DF}$
Backward Spillovers from foreign to domestic firms	$BS_{FD}$
Backward Spillovers from domestic to domestic firms	$BS_{DD}$
Backward Spillovers from foreign to foreign firms	$BS_{FF}$
Backward Spillovers from domestic to foreign firms	$BS_{DF}$
Forward Spillovers from foreign to domestic firms	$FS_{FD}$
Forward Spillovers from domestic to domestic firms	$FS_{DD}$
Forward Spillovers from foreign to foreign firms	$FS_{FF}$
Forward Spillovers from domestic to foreign firms	$FS_{DF}$

**Table 2: Summary Statistics (Average 2000-2007)\***

<b>Variables</b>	<b>Foreign Firms</b>		<b>Domestic Firms</b>	
	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD.</b>
<b>Value Added (000's)</b>	46,914	190,540	1,230	28, 110
<b>Capital (000's)</b>	10,239	61,566	270	9,958
<b>Employment (counts)</b>	267	687	15	246
<b>Herfindahl Index</b>	0.13	0.03	0.13	0.03
<b>Scale</b>	10.65	15.01	0.50	3.40

\* value added and capital in constant 2007Q1 NZ dollars; employment counts are random rounded to preserve confidentiality; summary statistics provided in Appendices 2 and 3.

**Table 3: Magnitude of Horizontal and Vertical Linkages (Average 2000-07)**

Industry	Horizontal Linkages				Backward Linkages				Forward Linkages			
	Foreign		Domestic		Foreign		Domestic		Foreign		Domestic	
	Avg.	CAGR	Avg.	CAGR	Avg.	CAGR	Avg.	CAGR	Avg.	CAGR	Avg.	CAGR
Meat	0.38	5.41	0.62	-2.49	0.04	0.28	0.05	-0.17	0.1	2.8	0.61	-0.43
Dairy	c	c	c	c	C	c	c	c	c	c	c	c
Other food	0.61	6.18	0.39	-8.73	0.07	3.01	0.11	-1.6	0.15	2.93	0.27	-1.57
Beverage, malt & tobacco	0.9	3.92	0.1	-22.66	0.1	1.38	0.12	-0.88	0.13	3.58	0.19	-2.23
Textiles & apparel	0.41	-2.63	0.59	1.55	0.11	4.14	0.17	-2.88	0.16	3.58	0.24	-2.13
Wood product	0.32	-12.77	0.68	5.94	0.18	14.74	0.38	-8.57	0.18	4.3	0.34	-2.31
Paper & paper product	0.71	30.54	0.29	-30.29	0.16	0.9	0.21	-0.67	0.18	1.09	0.24	-0.86
Printing, publishing & recorded media	0.67	-3.1	0.33	5.82	0.32	4.18	0.42	-2.98	0.17	8.56	0.15	-7.28
Petroleum refining & product	c	c	c	c	c	c	c	c	c	c	c	c
Fertiliser & other industrial chemicals	0.66	2.72	0.34	-4.42	0.17	2.39	0.34	-1.13	0.15	6.34	0.15	-6.03
Rubber, plastic & other chemicals	0.8	0.76	0.2	-2.73	0.18	5.65	0.35	-3	0.16	4.74	0.16	-3.82
Non-metallic mineral product	c	c	c	c	c	c	c	c	c	c	c	c
Basic metal	c	c	c	c	c	c	c	c	c	c	c	c
Structural, sheet & fabricated metal	0.31	2.23	0.69	-0.92	0.28	3.83	0.36	-3.08	0.19	1.46	0.12	-2.25
Machinery & other equipment	0.43	-2.55	0.57	1.73	0.09	7.04	0.15	-4.53	0.18	2.88	0.19	-2.61
Furniture & others (not elsewhere classified)	0.08	14.44	0.92	-1.29	0.1	7.35	0.2	-3.96	0.2	0.07	0.23	-0.06

\*CAGR: compounded annual growth rate; c: confidentialised, the data is confidentialised in this table but are included in the estimations.

**Table 4: Correlation Matrix of the Spillovers**

<b>Spillovers</b>	<b>HS<sub>FF</sub></b>	<b>BS<sub>FF</sub></b>	<b>FS<sub>FF</sub></b>	<b>HS<sub>FD</sub></b>	<b>BS<sub>FD</sub></b>	<b>FS<sub>FD</sub></b>	<b>HS<sub>DD</sub></b>	<b>BS<sub>DD</sub></b>	<b>FS<sub>DD</sub></b>
<b>HS<sub>FF</sub></b>	1.00								
<b>BS<sub>FF</sub></b>	0.85	1.00							
<b>FS<sub>FF</sub></b>	0.89	0.90	1.00						
<b>HS<sub>FD</sub></b>	-0.29	-0.28	-0.31	1.00					
<b>BS<sub>FD</sub></b>	-0.30	-0.29	-0.33	0.31	1.00				
<b>FS<sub>FD</sub></b>	-0.73	-0.71	-0.79	-0.05	0.32	1.00			
<b>HS<sub>DD</sub></b>	-0.42	-0.41	-0.45	-0.70	-0.04	0.64	1.00		
<b>BS<sub>DD</sub></b>	-0.36	-0.35	-0.38	0.42	0.72	0.28	-0.10	1.00	
<b>FS<sub>DD</sub></b>	-0.42	-0.41	-0.45	0.04	-0.21	0.11	0.31	0.09	1.00

**Table 5: Production Function Parameters**

<b>Parameter</b>	<b>Model</b>	
	<b>OLS</b>	<b>LP</b>
Labour	0.7763*** (0.0044)	0.4591*** (0.0105)
Capital	0.3630*** (0.0031)	0.2569*** (0.0090)
Intercept	2.9119*** (0.0049)	--
Sum	1.1394	0.7160

*Notes:* Standard errors are presented in parentheses; \*\*\* Significant at the 1 percent level;



Table 6: Regression Models of Firm Productivity

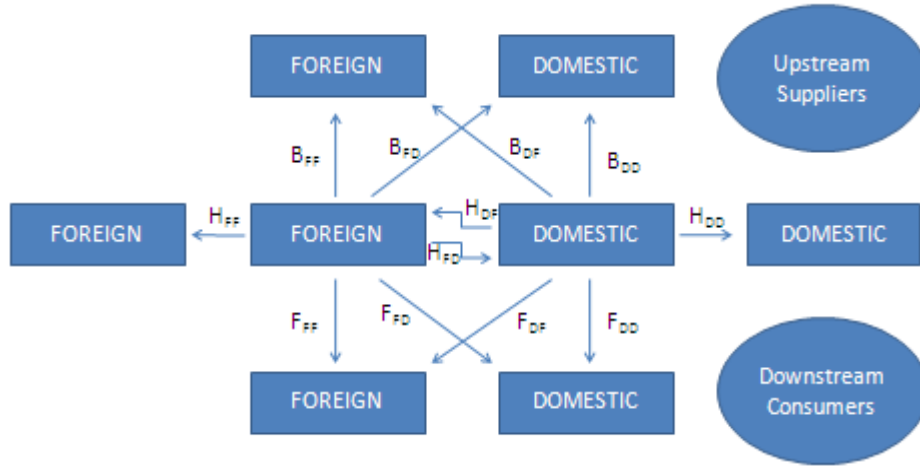
Variables	RE (Eq. 5)			GMM (Eq. 5)			FE (Eq. 5)	RE (Eq. 3)	RE (Eq. 4)
	Full Sample	Non-Exporters	Exporters	Full Sample	Non-Exporters	Exporters	Full Sample	Full Sample	Full Sample
Lag MFP	--	--	--	0.1369*** (0.0206)	0.1449*** (0.0207)	0.0491 (0.0706)	--	--	--
FDI	--	--	--	--	--	--	--	0.6729*** (0.0711)	0.3907*** (0.0509)
HS <sub>FD</sub>	-0.0909 (0.2366)	0.0059 (0.4935)	-0.1245 (0.2786)	0.2238 (0.2838)	0.3683 (1.0744)	-0.1673 (0.3496)	0.4962 (0.3225)	-0.0884** (0.0387)	-0.2041 (0.1414)
BS <sub>FD</sub>	0.0456 (0.2441)	0.1241 (0.2639)	0.0128 (0.2024)	0.1052 (0.2041)	-0.0299 (0.2498)	0.6689** (0.3085)	0.0440 (0.2127)	-0.0052 (0.2731)	0.0031 (0.2064)
FS <sub>FD</sub>	-0.3229 (0.3585)	-0.4285 (0.4362)	1.3501* (0.7914)	0.3672 (0.5570)	-0.0813 (0.7265)	2.1583** (0.8467)	0.2051 (0.4727)	-0.0914 (0.2778)	-0.1080 (0.3843)
HS <sub>DD</sub>	-0.1448 (0.2267)	0.0016 (0.4537)	-0.2595 (0.2853)	0.2090 (0.2805)	0.4035 (1.0700)	-0.3079 (0.3475)	0.4474 (0.2891)	--	-0.2315* (0.1265)
BS <sub>DD</sub>	-0.2678* (0.1522)	-0.2244 (0.2288)	-0.0613 (0.2247)	-0.0362 (0.1927)	-0.1486 (0.2522)	0.2108 (0.2646)	-0.1777 (0.1959)	--	-0.2706* (0.1413)
FS <sub>DD</sub>	-0.7916*** (0.2480)	-0.5997 (0.3777)	0.1043 (0.3967)	0.1970 (0.4915)	-0.0913 (0.6558)	1.1351 (0.7479)	-0.2797 (0.3265)	--	-0.5453* (0.3207)
HS <sub>FF</sub>	0.4820*** (0.1075)	0.4228 (0.3928)	0.4569*** (0.1335)	0.2951** (0.1456)	0.3420 (0.4980)	0.3697** (0.1548)	0.4054*** (0.1143)	--	--
BS <sub>FF</sub>	0.3373 (0.5690)	1.0879 (1.3114)	0.5352 (0.4285)	0.4352 (0.5553)	-1.4009 (2.4520)	0.8824 (0.6107)	0.2631 (0.4561)	--	--
FS <sub>FF</sub>	0.2383 (1.0617)	2.4966 (2.7148)	0.3144 (1.0489)	0.6757 (1.2004)	2.4064 (5.2152)	0.9767 (1.2095)	0.6926 (1.2895)	--	--
Exporter	0.5106*** (0.0380)	--	--	0.0050 (0.0322)	--	--	-0.0018 (0.0296)	0.5073*** (0.0365)	0.5031*** (0.0358)
HI	0.1850*** (0.0660)	0.2318*** (0.0804)	-0.1622* (0.0923)	-0.0244 (0.0628)	-0.0082 (0.0735)	-0.0810 (0.1032)	0.1190 (0.0768)	0.1174** (0.0527)	0.1605*** (0.0602)
Scale	0.0123*** (0.0034)	0.0537* (0.0279)	0.0063*** (0.0019)	0.0058 (0.0052)	0.0080 (0.0049)	0.0035 (0.0049)	0.0027** (0.0012)	0.0124*** (0.0033)	0.0122*** (0.0033)
Sector Dum 2	0.0788 (0.0559)	0.1346** (0.0629)	-0.3686*** (0.0597)	dropped	dropped	dropped	dropped	0.0744 (0.0494)	0.0767 (0.0517)
Sector Dum 3	-0.1704** (0.0746)	-0.1178 (0.1229)	-0.1545 (0.1023)	-0.1658 (0.1725)	2.7660*** (0.0465)	-0.0527 (0.1724)	0.0417 (0.0377)	0.0775*** (0.0194)	-0.0948 (0.0954)

Sector Dum 4	0.0357 (0.0994)	-0.0563 (0.1705)	-0.2489** (0.1130)	dropped	dropped	dropped	dropped	0.4106*** (0.0268)	0.1625 (0.1293)
Sector Dum 5	-0.4363*** (0.0804)	-0.2518** (0.1280)	-0.8593*** (0.0932)	-0.7760* (0.4547)	3.0782*** (0.1986)	-0.4824 (0.3105)	-0.3146** (0.1132)	-0.1991*** (0.0146)	-0.3547*** (0.1016)
Sector Dum 6	-0.2294*** (0.0753)	-0.0680 (0.1140)	-0.6923*** (0.1039)	-0.6502 (0.4516)	3.2275*** (0.1706)	-0.3259 (0.3555)	-0.2611** (0.1154)	-0.1273*** (0.0203)	-0.1723** (0.0792)
Sector Dum 7	0.0954 (0.0877)	0.2578* (0.1353)	-0.4262*** (0.0993)	-0.7701 (0.4751)	3.3893*** (0.2320)	-0.3424 (0.3065)	-0.2812 (0.1709)	0.3729*** (0.0426)	0.1876* (0.1129)
Sector Dum 8	-0.2944*** (0.1126)	-0.1208 (0.1812)	-0.4641*** (0.1378)	-0.9163 (0.7798)	dropped	0.0990 (0.2945)	-0.4042*** (0.1380)	-0.0070 (0.0625)	-0.1746 (0.1310)
Sector Dum 9	0.2517** (0.1220)	0.2556 (0.2002)	0.1401 (0.1483)	-0.5831 (0.4751)	dropped	-0.1282 (0.3100)	0.2887 (0.1745)	0.6146*** (0.0706)	0.3983*** (0.1489)
Sector Dum 10	0.2282* (0.1284)	0.3745** (0.1808)	-0.3221** (0.1516)	-0.6535 (0.4370)	3.2363*** (0.2276)	-0.3313 (0.3458)	-0.2286* (0.1229)	0.5428*** (0.0784)	0.3493** (0.1407)
Sector Dum 11	0.0771 (0.0970)	0.2274 (0.1664)	-0.4666*** (0.1197)	-0.6137 (0.4320)	3.3286*** (0.2223)	-0.3324 (0.3444)	-0.1859 (0.1102)	0.3845*** (0.0419)	0.1980 (0.1257)
Sector Dum 12	-0.5128*** (0.1111)	-0.3117* (0.1772)	-0.8837*** (0.1513)	-0.4084 (0.5410)	3.4550*** (0.1512)	0.4028 (0.3153)	-0.1410 (0.0987)	-0.2338*** (0.0706)	-0.3876*** (0.1273)
Sector Dum 13	-0.0472 (0.1048)	0.1218 (0.1657)	-0.3239*** (0.1233)	-0.5349 (0.4448)	3.3272*** (0.1513)	-0.3227 (0.3217)	-0.0325 (0.0898)	0.2842*** (0.0540)	0.0756 (0.1221)
Sector Dum 14	-0.0180 (0.1112)	0.1821 (0.1726)	-0.4175*** (0.1300)	-0.5293 (0.4504)	3.3540*** (0.1173)	-0.3154 (0.3360)	-0.0470 (0.0874)	0.2419*** (0.0447)	0.0868 (0.1287)
Sector Dum 15	-0.0301 (0.0894)	0.1766 (0.1408)	-0.4410*** (0.0982)	-0.5935 (0.4567)	3.2958*** (0.0597)	-0.4716 (0.3681)	-0.0247 (0.0931)	0.2425*** (0.0219)	0.0558 (0.1121)
Sector Dum 16	-0.3028*** (0.0833)	-0.1122 (0.1196)	-0.8337*** (0.1014)	-0.6330 (0.4553)	3.2743*** (0.1489)	-0.5508 (0.3814)	-0.2190* (0.1040)	-0.1323*** (0.0238)	-0.2394** (0.0970)
Year Dum 2	0.0554*** (0.0179)	0.0274 (0.0189)	dropped	dropped	dropped	dropped	0.0954* (0.0513)	0.0324* (0.0177)	0.0524*** (0.0178)
Year Dum 3	0.0496*** (0.0161)	0.0339* (0.0193)	-0.0302 (0.0213)	0.0171* (0.0103)	0.0214* (0.0122)	-0.0230 (0.0212)	0.0939* (0.0511)	0.0491*** (0.0167)	0.0506*** (0.0165)
Year Dum 4	0.0770*** (0.0192)	0.0683*** (0.0199)	-0.0039 (0.0233)	0.0409*** (0.0118)	0.0442*** (0.0138)	0.0015 (0.0229)	0.1276** (0.0521)	0.0788*** (0.0182)	0.0783*** (0.0189)
Year Dum 5	0.0820*** (0.0141)	0.0817*** (0.0137)	-0.0064 (0.0180)	0.0353*** (0.0122)	0.0446*** (0.0142)	-0.0076 (0.0248)	0.1416** (0.0517)	0.0798*** (0.0127)	0.0826*** (0.0138)
Year Dum 6	0.0512*** (0.0080)	0.0477*** (0.0077)	-0.0087 (0.0240)	0.0075 (0.0126)	-0.0015 (0.0147)	-0.0109 (0.0247)	0.1204*** (0.0386)	0.0443*** (0.0058)	0.0510*** (0.0075)
Year Dum 7	dropped	dropped	-0.0614** (0.0266)	-	-0.0601*** (0.0171)	-0.0825*** (0.0281)	0.0717* (0.0346)	dropped	dropped

				(0.0146)					
Year Dum 8	-0.0849*** (0.0307)	-0.0804** (0.0353)	-0.1534*** (0.0398)	- 0.1327*** (0.0183)	-0.1388*** (0.0215)	-0.1828*** (0.0342)	dropped	-0.0785*** (0.0298)	-0.0849*** (0.0310)
Intercept	3.8752*** (0.2511)	3.4623*** (0.4276)	4.9354*** (0.2298)	--	--	--	3.2021*** (0.2830)	3.2948* (0.0295)	3.8049*** (0.1213)
R-squared (F test for GMM)	0.3133	0.0984	0.2805	14.15***	235.41***	222.25***	0.0386	0.3135	0.3116
No. of Obs.	39,171	32,331	6,282	27,606	22,158	4,680	39,171	39,171	39,171
No. of firms	11,175	9,840	1,566	8,196	6,996	1,251	11,175	11,175	11,175
Hausman Test (Chi-squared)	1470.13***	183.03***	236.81***	--	--	--	1470.13***	1470.87***	1422.37***
Arellano-Bond Test For AR(1) in first diff.	--	--	--	-19.01***	-18.86***	-4.93***	--	--	--
Arellano-Bond Test For AR(2) in first diff.	--	--	--	1.81*	2.03**	-0.68	--	--	--
SarganTest for over-identifying restrictions	--	--	--	10.44	12.87	21.21**	--	--	--
Hansen Test for over-identifying restrictions	--	--	--	11.19	14.49	15.22	--	--	--

Notes: Robust standard errors are presented in parentheses; \*, \*\*, \*\*\* Significant at the 10-percent, 5-percent and 1 percent level, respectively.

Figure 1: Schematic displace of 12-way spillovers effects



### Appendix 1: Variables and Data Sources

Variable Acronym	Variable Name	Data Sources
Y	Value Added	Value added variable derived from the Annual Enterprise Survey (AES). Adjusted to constant 2007Q1 dollars using industry group specific deflators.
K	Capital	Derived as the summation of depreciation and cost of capital charge for owned assets. Data from AES. Adjusted to constant 2007Q1 dollars using asset specific deflators.
L	Labour	Rolling mean employment from LBF
FDI	FDI Dummy	Constructed as a binary variable: foreign owned and non-foreign owned; data from LBF and IR4 (company tax returns).
HFDI	Horizontal FDI Spillovers	LBF and IR4.
BFDI	Backward FDI Spillovers	Constructed using HFDI and IO Tables.
FFDI	Forward FDI Spillovers	Constructed using HFDI and IO Tables.
EX	Exports Dummy	Constructed as a binary variable: Exporter and Non-Exporter; data from Customs.

\*Intermediate consumption is used as a proxy variable for unobserved productivity shocks based on the Levinsohn Petrin approach. Data comes from AES and adjusted to constant 2007Q1 dollars using industry group specific producer price indices.

**Appendix 2: Summary Statistics, by Year**

Var	Year	Foreign Firms				Domestic Firms			
		Obs	Mean	SD	Total	Obs	Mean	SD	Total
Capital	2000	225	11,192	82,167	2,495,843	7,341	254	7,604	1,864,086
	2001	243	11,320	64,114	2,750,795	7,245	214	7,860	1,550,965
	2002	243	12,671	84,647	3,079,078	6,993	181	7,417	1,263,904
	2003	255	11,710	76,484	2,986,106	6,735	272	10,521	1,830,915
	2004	258	10,548	70,993	2,700,196	6,909	260	10,192	1,793,456
	2005	258	11,117	78,712	2,890,307	6,549	297	11,386	1,942,293
	2006	267	6,525	17,245	1,735,635	6,429	328	12,338	2,107,196
	2007	252	6,832	18,167	1,714,917	5,661	353	12,348	1,997,593
Emplo yment	2000	225	255	750	56,919	7,341	15	216	108,771
	2001	243	282	756	67,863	7,245	15	225	101,748
	2002	243	285	783	69,921	6,993	15	210	95,679
	2003	255	285	780	72,867	6,738	18	246	102,408
	2004	258	276	747	70,326	6,909	15	267	105,717
	2005	258	276	762	71,745	6,549	18	279	105,717
	2006	267	234	453	61,917	6,429	15	273	105,252
	2007	252	237	471	59,472	5,658	15	240	89,403
Value Added	2000	225	44,838	211,295	9,998,777	7,341	1,435	31,095	10,500,000
	2001	243	52,632	201,287	12,800,000	7,245	1,111	28,119	8,049,097
	2002	243	51,805	204,779	12,600,000	6,993	1,009	24,863	7,054,497
	2003	255	52,149	225,085	13,300,000	6,738	1,120	23,116	7,546,188
	2004	258	49,932	220,254	12,800,000	6,909	1,128	23,122	7,795,651
	2005	258	49,607	223,133	12,900,000	6,549	1,266	26,570	8,290,766
	2006	267	36,287	118,998	9,652,331	6,432	1,391	34,614	8,943,821
	2007	252	38,063	119,489	9,553,830	5,661	1,379	33,377	7,803,066

**Appendix 3: Herfindahl Index and Scale, by Sector**

Sector	Herifndahl Index				Scale			
	Foreign		Domestic		Foreign		Domestic	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Meat	0.19	0.03	0.20	0.03	5.49	5.50	0.68	3.50
Dairy	c	c	c	c	c	c	c	c
Other food	0.08	0.01	0.08	0.01	10.15	11.13	0.42	1.97
Beverage, malt & tobacco	0.22	0.02	0.22	0.01	4.01	5.71	0.17	0.79
Textiles & apparel	0.05	0.01	0.05	0.01	19.95	21.62	0.57	4.10
Wood product	0.24	0.14	0.23	0.14	14.77	25.64	0.69	12.36
Paper & paper product	0.27	0.12	0.29	0.13	5.85	7.16	0.37	3.23
Printing, publishing & recorded media	0.16	0.02	0.16	0.02	19.28	37.87	0.34	1.47
Petroleum refining & product	c	c	c	c	c	c	c	c
Fertiliser & other industrial chemicals	0.21	0.02	0.21	0.02	3.38	6.81	0.39	1.83
Rubber, plastic & other chemicals	0.04	0.00	0.04	0.00	4.68	6.91	0.22	0.51
Non-metallic mineral product	c	c	c	c	c	c	c	c
Basic metal	c	c	c	c	c	c	c	c
Structural, sheet & fabricated metal	0.02	0.00	0.02	0.00	13.70	12.62	0.71	3.44
Machinery & other equipment	0.03	0.01	0.03	0.01	14.93	29.59	0.55	3.67
Furniture & Others NEC	0.01	0.00	0.01	0.00	11.60	9.61	0.94	3.87