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Productivity spillovers from foreign direct investment in New Zealand

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The results in this paper are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure prototype (IDI) managed by Statistics New Zealand.

Access to the data used in this study was provided by Statistics New Zealand 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 person, business or organisation. The results in this paper have been confidentialised to protect individual people and businesses from identification. Careful consideration has been given to the privacy, security and confidentiality issues associated with using administrative data in the IDI. Further detail can be found in the privacy impact assessment for the IDI available from www.stats.govt.nz/browse_for_stats/snapshots-of-nz/integrated-data-infrastructure/privacy-impact-assessment-for-the-idi.aspx.

The results are based in part on tax data supplied by Inland Revenue to Statistics New Zealand under the Tax Administration Act 1994. These tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form or provided to Inland Revenue for administrative or regulatory purposes. Any person who has had access to the unit-record data has certified that they have been shown, have read and have understood section 81 of

the Tax Administration Act 1994, which relates to privacy and confidentiality. Any discussion of data limitations or weaknesses is in the context of using the Integrated Data Infrastructure prototype for statistical purposes and is not related to the data's ability to support Inland Revenue's core operational requirements.

Abstract

This paper examines whether foreign direct investment (FDI) has spillover effects on the productivity of domestic firms. Three types of potential spillovers are considered: horizontal (within industry) backward (foreign-owned customers) and forward (foreign-owned suppliers). The study uses data on a 10-year panel of firms and covers almost all business sectors in the New Zealand economy from 2000–2010. Panel methods are used to control for firm heterogeneity and the endogeneity of FDI. Separate estimates are obtained by industry group and by firm size. We find little evidence of substantial positive spillover effects from FDI to local firms' productivity. The presence of foreign-owned customers lifts productivity among small domestic firms and those in the primary sector, though the effects are small.

JEL classification: F21, L25

Key words: Foreign direct investment, productivity spillovers

Executive summary

This paper examines whether foreign direct investment (FDI) has spillover effects on the productivity of domestic firms that operate in the same industry or in connected industries.

In 2012, the estimated value of the stock of foreign investment in New Zealand was 47% of GDP, above the average for the developed world (33%). Given the relatively high degree of penetration by foreign firms into the New Zealand economy, any productivity spillovers from foreign to domestic firms should be more readily detectable in New Zealand than elsewhere.

In principle, increased FDI could raise or lower the productivity of domestic firms through a number of channels, including the movement of labour between firms, the provision of technical assistance or training, the effects of increased market competition on the performance or survival of domestic firms and changes in domestic firms' access to markets.

The firm-level panel dataset used in this paper is drawn from the Longitudinal Business Database (LBD) and spans the years from 2000–2010. It covers the majority of industries. The firms in the analysis sample accounted for approximately 75% of national output in an average year.

We combine firm-level data from the LBD with inter-industry transactional data from Statistics New Zealand's Input-Output tables to construct measures of domestic firms' exposure to foreign firms within the same industry and in upstream and downstream industries. To measure the effects of changes in FDI on the productivity of domestic firms, production functions are estimated with extensions to capture spillover effects. Panel data methods are used to control for the effects of unobserved firm heterogeneity and the likely endogeneity of foreign investment, whereby foreign investors gravitate towards more productive firms and sectors.

Our measures of domestic firms' exposure to FDI within their own industry and in upstream and downstream industries show little aggregate change during the study period, but some significant changes at the industry level. These industry-level changes in FDI penetration provide the basis for the identification of productivity spillovers.

Overall, the paper finds limited evidence of productivity spillovers flowing from foreign to domestic firms. We do not find evidence of positive spillovers from increased foreign penetration within the same industry (horizontal spillovers) or within supplying industries (forward spillovers).

We find evidence of a significant and positive productivity impact from increased foreign penetration in downstream (customer) industries. An increase in the proportion of firms in customer industries that are foreign owned, equivalent to 1% of industry output, is estimated to increase domestic firm productivity by 0.86%. Given that there was little overall change in downstream FDI penetration during the study period (a slight decline), the positive backward spillovers would not have made a substantial overall contribution to the actual productivity change recorded for domestic firms.

Separate estimates of spillover effects were obtained by broad industry group and by firm size. These additional results show that the positive backward spillovers occurred primarily within smaller firms (those with fewer than 10 employees) and within the primary sector. We hypothesise that the positive backward spillovers may reflect the role of larger foreign firms in providing stable demand for the output of small domestic firms, or a more cost-effective means of connecting to international markets.

Contents

Tables

Figures

1. Introduction

In recent decades, foreign direct investment (FDI) has become an important source of investment funding for both developing and developed countries. In countries that have perennially looked outwards to fill the savings-investment gap, the importance of attracting foreign direct investment forms a critical area in policy-making and public debate. There is a common view that, in addition to being less susceptible to sudden reversals, FDI embodies superior technology and is therefore a potential source of positive productivity 'spillovers'. Productivity spillovers occur when the increasing presence of foreign-owned firms has indirect effects (which can be positive or negative) on the productivity of domestic firms in the same industry or in connected industries. Whether FDI brings benefits to domestic firms in the host economies is still under debate. Rodrik (1999, p.37) notes that "today's policy literature is filled with extravagant claims about positive spillovers from DFI [sic] ... but the evidence is sobering'.

This paper uses a large-scale firm-level dataset for New Zealand to examine whether the presence of foreign firms has spillover effects on the productivity of domestic firms in the same industry or in connected industries. The data source for this paper is the Longitudinal Business Database (LBD) administered by Statistics New Zealand. The analysis uses an unbalanced panel dataset of more than 200,000 firms each year, spanning the years 2000–2010. The firms in the dataset account for approximately 83% of total value added as measured in the Annual Enterprise Survey, which in turn covers nearly 90% of national output. While the current paper adds to a growing list of FDI spillovers studies using country-specific firm-level data (for example, Arnold and Javorcik, 2009; Lin, Liu and Zhang, 2009; Haskel, Pereira and Slaughter, 2007; Javorcik, 2004), it makes a number of unique contributions.

First, it provides estimates for New Zealand, an open economy with historically high reliance on FDI (UNCTAD, 1999). In the late 1990s, the stock of FDI in New Zealand reached a peak of 59% of GDP, which at the time was considerably higher than the average of around 20% among developed countries. Since 2000, foreign penetration has ranged from 40% to 55% of GDP and, in 2012, was 47% – well above the average for the developed world (33%) and at a similar level to Europe (48%), where FDI penetration has been rising significantly.[1] In the sample used in this paper, in 2010, foreign-owned firms in New Zealand accounted for less than 1.6% of the total number of firms but generated 36.2% of total sales, 38.3% of value added and 23.9% of total employment in the measured sectors (see Table 1 in section 3.1).[2] Given the relatively high degree of penetration by foreign firms into the New Zealand economy, if FDI spillovers do exist, they should be more readily detectable in New Zealand than in other developed economies with lower FDI penetration.

Second, it provides estimates that are robust to alternative definitions of FDI. Although we use the standard threshold of 10% ownership to define FDI, in New Zealand, 83% of foreign firms in covered sectors have foreign ownership in excess of 50%, and 53% have a 100% ownership stake. This means that the measurement of FDI is robust to alternative standard thresholds of foreign ownership.

[1] UNCTAD (2013) Tables 5 and 7, available from http://unctad.org/en/Pages/DIAE/World%20Investment%20Report/Annex-Tables.aspx (downloaded 9 December 2013).

[2] See the description of the sample in section 3.3 and data exclusions in Appendix 1.

Third, our dataset covers most business sectors, whereas the vast majority of previous studies of FDI spillovers focus on the manufacturing sector. This provides better estimates of vertical spillovers. For instance, the financial or telecommunications industries in New Zealand, which are heavily dominated by foreign investment, presumably can provide world-standard services to firms in connected industries right across the economy. Being able to identify all inter-industry connections is likely to be particularly important in investigating 'vertical spillovers' that work through firms' supply chains.

The earlier international literature on FDI spillovers focused on 'horizontal' or 'intra-industry' spillovers. Recently, it has been recognised that the spillover phenomenon may spill across industries, influencing the productivity of 'vertically linked' industries. Indeed, Javorcik (2004, p. 606) observes that "spillovers from FDI are more likely to be vertical than horizontal in nature". In this paper, we will model all two types of spillovers: a horizontal or intra-industry effect and a vertical or inter-industry effect (backward and forward).

We find no evidence of either positive or negative horizontal spillovers from foreign ownership on domestic firms. We find some evidence of positive backward spillovers on domestic firms, with small domestic firms and firms in the primary sector benefiting from the presence of foreign-owned customers. However, the magnitude of the effects are small, and changes in FDI penetration have made only small contributions to productivity in New Zealand.

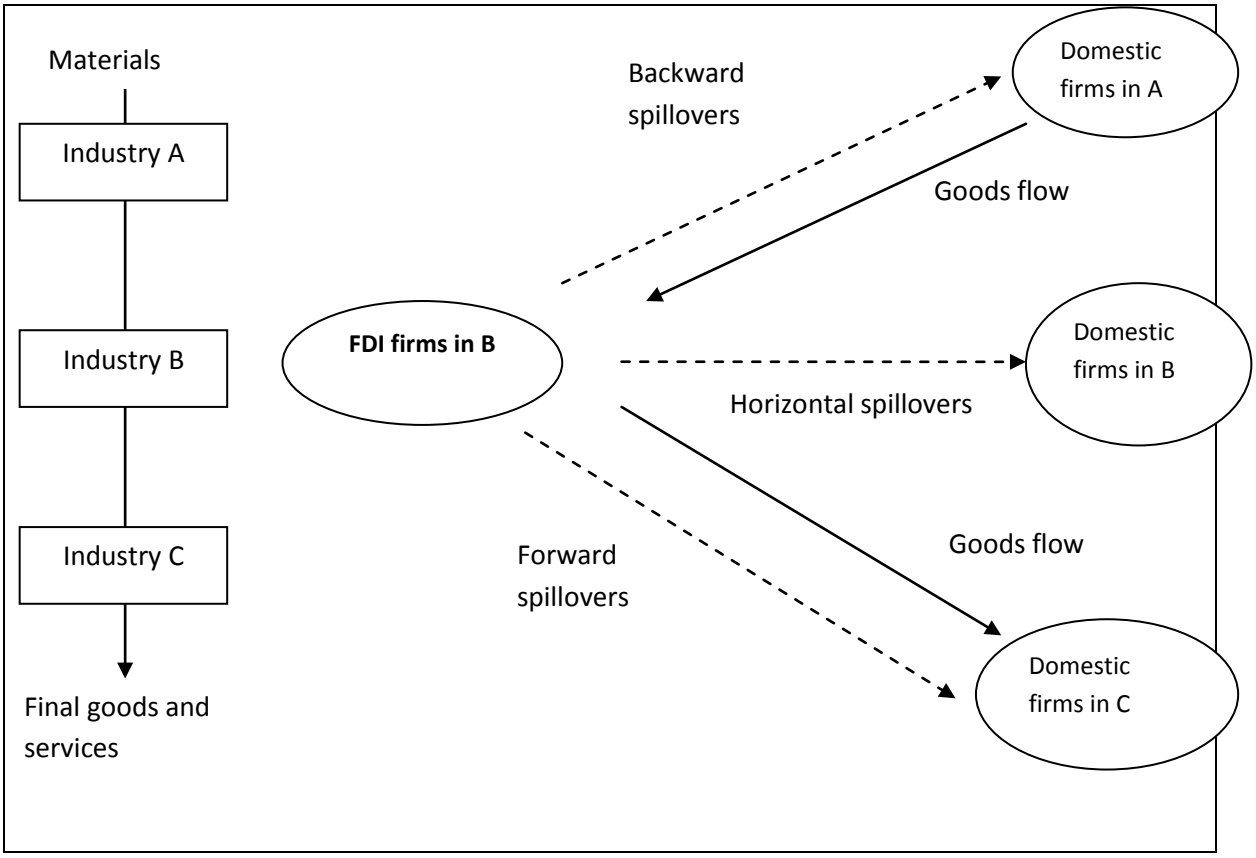
The remainder of the paper is organised as follows. The next section reviews the literature on FDI spillovers. This is followed by a description of the data and methods that we use and a discussion of the econometric models and identification issues. Following the presentation of the main results, we conclude with a summary and brief discussion.

2. Review of the literature

For a foreign firm to enter and succeed in the domestic market, it should have some firm-specific advantages (FSAs) such as technology, managerial expertise and access to international networks that enable it to compete with existing local firms, who presumably have better knowledge of local conditions (Graham and Krugman, 1991). When firms invest in foreign countries, they often bring with them technologies and management knowledge or know-how (Markusen, 1995). To some extent these will be adopted by domestic firms, potentially generating positive productive spillovers. However, the presence of foreign firms also increases competition within the industry that the foreign firms enter, which could have either positive or negative impacts on domestic firm productivity. Many countries offer generous incentives to attract more FDI in the hope that this will boost domestic firm productivity and performance.

The mechanisms by which foreign ownership can influence domestic firm productivity are shown in Figure 1, which highlights supply chain linkages. The figure shows how spillovers flow from foreign firms in an industry (B) to domestic firms in upstream industries (A) and downstream industries (C). Forward spillovers accompany a flow of goods from foreign to domestic firms – with domestic firms benefiting from having foreign suppliers. Backward spillovers arise from having foreign-owned customers and thus accrue to domestic firms that supply goods to foreign firms. It is important to note that, in relation to industry A, industry B is a downstream sector (buying), but in relation to industry C, industry B is the upstream sector (supplying).

Figure 1: The supply chain and spillovers



2.1 Horizontal spillovers

Horizontal spillovers from foreign-owned firms can occur through one or more of the following channels: movement of labour, imitation and observational learning, and competition.

Movement of labour

The relocation of workers from a foreign-owned firm to the domestic sector, either by changing jobs or starting new ventures, can potentially enhance the productivity of destination firms in two ways. First, the workers may carry with them knowledge of new technology, management skills, know-how and networking and even customers, becoming direct agents of technology transfer (Görg and Greenaway, 2004). Second, the workers may raise the productivity of co-workers in the domestic firms simply by association. While there is evidence of foreign firms paying higher wages to plug this 'leakage' (Aitken, Harrison and Lipsey, 1997; Feenstra and Hanson, 1997), domestic firms also have been observed to respond by increasing compensation to attract skilled workers (Aitken et al., 1997). Higher wage costs may however negatively affect the profitability of domestic firms in the short run (Aitken et al., 1997).

Imitation, observational learning and competition

Advanced technologies and new products introduced by a foreign firm in the domestic market may force the local players to respond by innovating. Often, innovation takes the form of imitation through reverse engineering (Wang and Blomström, 1992). However, when the foreign firm's products and technologies are vastly different from or superior to those of local firms, spillovers may not accrue (Kokko, 1994). Spillovers depend also on the capacity of domestic firms to absorb new ideas and methods, as discussed below. Although the effects of foreign firm-induced competition might be regarded as spillovers, their welfare consequences are different from those of technology spillovers. While technology spillovers are Pareto-improving externalities, competition is a double-edged sword. The effects of increased competition induced by foreign-owned firms may be positive or negative. On the one hand, competition might force firms to improve their productivity and efficiency (Blomström, 1986) to survive or to innovate to escape competition. On the other hand, domestic players may be crowded out by more efficient foreign entrants (Aitken and Harrison, 1999; Harrison, 1994). In the short run, foreign firms may draw demand away from domestic firms by offering lower prices and/or better quality products, causing domestic firms to cut production and hence raise unit costs because their fixed costs are spread over a smaller amount of output (Aitken and Harrison, 1999). In the long run, local firms may shrink or exit from the market. 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, as is the case of New Zealand.

Haddad and Harrison (1993), Aitken and Harrison (1999) and Stančík (2007) find negative effects of FDI on domestic productivity in Morocco, Venezuela and the Czech Republic and suggest that competition from FDI firms and the low absorptive capacity of domestic firms in developing countries are the reasons. On the other hand, Haskel et al. (2007) estimate that a 10 percentage point increase in foreign presence in UK manufacturing raises the total-factor productivity (TFP) of domestic plants in the same industry by about 0.5%.

2.2 Vertical spillovers

A vertical spillover occurs when the presence of foreign firms in one sector increases the productivity of domestic firms in connected sectors where there is no direct competitive pressure from the foreign firms. Unlike horizontal spillovers, foreign firms have no incentives to prevent technology diffusion to upstream and downstream sectors, thus leakages of their intellectual assets, management and technology to their customers/suppliers in connected sectors can happen more readily. This allows spillovers to accrue to domestic firms in connected sectors. The vertical spillover takes place through forward and backward linkages between domestic and foreign firms in different sectors.

Backward spillovers occur when domestic suppliers in upstream industries supply inputs to foreign firms in downstream industries. A foreign firm might directly transfer technology or provide technical assistance to its domestic suppliers to raise the quality of their products and to facilitate their innovations (Moran, 2001; UNCTAD, 2001; Aitken and Harrison, 1999). The foreign firms may require higher standards of product quality and on-time delivery, providing incentives for domestic firms to upgrade their production, management and technology (Javorcik, 2004). The foreign firm may also be able to assist in non-technical aspects of business such as through training of management (UNCTAD, 2001), opening up export opportunities for the supplier (Lall, 1980) and facilitating scale economies by expanding and guaranteeing a market for intermediate input suppliers (Javorcik, 2004; Lim and Fong, 1982). Lastly, the foreign buyer might be instrumental in bringing about competition amongst potential domestic suppliers (Crespo and Fontoura, 2007), with productivity impacts that could be either positive or negative.

Empirical evidence on backward spillovers is mixed. Blalock and Gertler (2002) report positive backward spillovers for Indonesian firms, and Javorcik (2004), Schoors and van der Tol (2002) and Wang and Gu (2006) find similar evidence for Lithuanian, Hungarian and Canadian firms respectively. Further evidence of positive backward spillovers in 17 emerging economies is provided by Gorodnichenko, Svejnar and Terrell (2007). Evidence of technology transfer via backward linkages is extensively documented in case studies (for example, MacDuffe and Helper, 1997; Moran, 1998; also see a summary in Lim, 2001). In contrast, Stančík (2007) finds that domestic firms in upstream sectors suffer from the presence of FDI firms. Fons-Rosen et al. (2013), in a study of 25 developed and developing countries in the EU, find that the effect is very small particularly in developing countries.

Backward spillovers may be constrained by several factors. The foreign firm may choose to import intermediate goods instead of sourcing them locally (Rodriguez-Clare, 1996). Even where a foreign firm sources intermediates locally, the suppliers may fail to learn and absorb the transferred technology if they lag too far behind their foreign partners technologically (Javorcik, 2004). Also, the entry of foreign firms can lower the degree of linkages between industries if the foreign firm requests exclusivity arrangements as a pre-condition for technology transfer (Lin and Saggi, 2007). In these cases, the positive spillover only occurs to firms with a certain level of absorptive capacity.

Forward spillovers occur when foreign firms in upstream industries sell their outputs to domestic firms in downstream industries. Foreign firms have an interest in the sales and efficiency of their customers because of the potential impacts on the demand for their own products in the future.

Foreign firms, therefore, have incentives to transfer knowledge on production and international market access to their domestic consumers. Forward spillovers might also materialise as a result of the foreign firm selling new or better-quality intermediate inputs and technologies to its domestic firm 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 also mixed. Javorcik (2004) and Blalock and Gertler (2002) find no significant evidence of forward spillovers. The study by Gorodnichenko et al. (2007) on spillovers in emerging economies finds positive forward spillovers but only for old firms and for the services sector. Schoors and van der Tol (2002) find positive linkage spillovers in Hungarian firms. Similarly, Driffield, Munday and Roberts (2002) find forward spillovers are more significant in the UK, relative to other types of spillovers. In New Zealand, a survey by Scott-Kennel (2004) shows that 40% of foreign firms are reported to provide assistance to domestic customers. This can potentially bring positive forward spillovers.

In summary, empirical studies do not show consistent evidence of positive spillovers from FDI to domestic firms (Javorcik, 2004; Gorg and Greenaway, 2004; Crespo and Fontoura, 2007; Stančík, 2007; Aitken and Harrison, 1999). The nature and strength of spillovers varies by country and industry and may depend on firm characteristics or firm absorptive capacity.

Absorptive capacity

Absorption of productivity spillovers is not automatic (Blomström and Sjöholm, 1999). It depends on host country, industry and firm characteristics. For instance, domestic firms may not be able to learn from foreign firms if there is a big technology gap. Many studies argue that spillovers from FDI depend critically on the absorptive capacity (AC) of the domestic firms, where AC is defined as the ability of domestic firms to identify, assimilate and exploit foreign technology (Görg and Greenaway, 2004; Sjöholm, 1999; Kokko, 1994; Cohen and Levinthal, 1990). It is argued that firms with more prior knowledge are better placed to utilise new technology. However, firms that are more technologically backward potentially have greater scope to benefit from exposure to new knowledge (Findlay, 1978). Therefore, theoretical predictions on the role of AC in appropriating spillovers are ambiguous.

AC is typically modelled using measures of infrastructure development, human capital or technology. Previous studies suggest that AC is mainly influenced by technology levels, human capital, financial market development and firm size (Békés, Kleinert and Toubal, 2009; Gorodnichenko et al., 2007; Girma, 2005; Alfaro, Chanda, Kalemli-Ozcan and Sayek, 2004; Blomström and Kokko, 2003; Blomström, Kokko and Globerman, 2001; Xu, 2000; Aitken and Harrison, 1999). Absorptive capacity depends on how much and how easily/cheaply firms can adopt more productive technology or knowledge. While technology gaps and high levels of human capital are likely good measures of absorptive capacity, they are not always available to us. In this paper, we use firm size as a proxy measure of absorptive capacity. Smaller firms may have greater potential to benefit when exposed to new technology or knowledge as there may be a big technology gap to fill or weaker potential to benefit if they lack the ability to adopt new technology or knowledge.

3. Data and methods

3.1 Data

Estimation of productivity spillovers from FDI requires data on firm production (value added, capital and labour inputs) together with indicators of foreign ownership, both at the firm level and by industry, to allow identification of foreign penetration in upstream and downstream industries. The primary dataset used in this paper is drawn from the prototype Longitudinal Business Database (LBD).[3] Within the LBD, our main analysis data are based on a combination of the Annual Enterprise Survey (AES) and tax-sourced accounts information (IR10).

Production data

The Annual Enterprise Survey (AES) provides annual data on the financial performance and financial position of New Zealand enterprises by industry. The target population is all economically significant enterprises in New Zealand, with some industry exclusions (such as residential property operators and religious organisations). The AES survey provides measures of total gross output (y_{it}) and intermediate consumption. Total gross output includes sales of goods manufactured, income from services provided, gross income from renting and leasing of land and buildings, fixed assets, depreciation and management fees.[4] Intermediate costs are purchases of materials for use by the enterprise itself or on a commission basis. Purchases include fuel and power, renting and leasing of land and buildings, telecommunication charges, business insurance premiums, management fees, payments for work done by others on the enterprise's own materials and accident insurance premia.[5]

The AES coverage captures approximately 90% of New Zealand's GDP, drawing on both survey and administrative data (tax data) from the Inland Revenue Department (IRD). The first block of Table 1 summarises the number of firms for which data are available from different sources. The first column shows the number of reporting units or 'kind of activity units' (KAUs) in the AES target population. The proportion of the population that is directly surveyed for AES has dropped from 5.8% in 2000 to 4.1% in 2010, though these are disproportionately larger firms. Tax data are the source of information for half to two-thirds of the population, with 27% (in 2000) to 45% (in 2008) having no AES information.

We use only surveyed observations in the AES, discarding information from administrative data. We do this because imputation methods such as carrying forward previous responses, while reasonable for cross-sectional estimation, are an unreliable basis for longitudinal firm-level analysis. Instead, we

[3] A detailed discussion of the LBD is available in Fabling et al. (2008), Fabling (2009) and Statistics New Zealand (2007).

[4] Gross output excludes income from interest, dividends and donations; government grants and subsidies; non-operating income (for example, sales on capital assets, exchange rate gains).

[5] Intermediate costs exclude commission paid to self-employed agents (finance and insurance, and property and business services sectors), indirect taxes (for example, excise duties, land tax, road user charges, licence fees and rates, fringe benefit tax and the energy resource levy – mining industry only), depreciation, non-operating expenses (for example, losses from writing off bad debts, sales of capital assets below book value and so on).

supplement directly surveyed AES responses with corresponding data from IR10 accounts information provided to IRD. Due to the combining of data from different sources, we are not able to use the AES sampling weights, so our results are not intended to represent population estimates.

The Accounts Information (IR10) form (now called the financial statements summary) is a set of financial accounts that all businesses are obliged to submit to Inland Revenue. It is designed to collect information for statistical purposes and to assist in the administration of the tax system. The IR10 is a two-page form. The first page contains information of sales and purchases, changes in stock and various categories of income and expenses and profit (or loss). The second page contains balance sheet items, i.e. various categories of assets, liabilities and proprietor or shareholder funds (equity). The IR10 supplements data on sales, value added (VA), intermediate consumption, depreciation, fixed assets and so on for firms that are not in AES-surveyed observations. Some imputation and modelling is required to improve consistency of measures across the two data sources and to refine the measurement of capital inputs.[6]

Table 1: Annual Enterprise Survey samples

Year	Population size (KAUs)	AES sample size			Final analysis dataset		
		Directly surveyed	Other surveys	Tax data	All firms	Ever-FDI firms	'Always domestic' firms
2000	354,820	20,540	4,555	233,888	201,762	3,555	198,207
2001	357,900	20,505	4,475	229,329	208,266	3,780	204,489
2002	356,836	20,590	4,358	222,462	205,398	3,879	201,519
2003	366,790	20,588	4,357	221,760	208,836	3,963	204,873
2004	399,563	20,854	4,151	239,569	208,191	4,026	204,162
2005	417,026	22,420	3,968	222,295	209,271	4,041	205,227
2006	433,880	24,298	3,895	225,223	210,480	4,164	206,316
2007	440,904	22,088	3,810	222,775	212,481	4,191	208,290
2008	451,248	22,509	3,711	221,185	217,614	4,257	213,357
2009	453,409	20,513	3,697	289,864	214,671	4,335	210,336
2010	445,215	18,394	3,648	302,235	207,420	4,128	203,289
Total	4,478,591	233,299	44,625	2,630,585	2,304,390	44,319	2,260,065

Source: Statistics New Zealand website and authors' calculations from LBD. Numbers in the final three columns have been randomly rounded to base 3, in accordance with Statistics New Zealand rules.

The main source of employment data in the LBD and also in our current paper is the Linked Employer-Employee Data (LEED) database. The primary source of information in LEED is the Employers Monthly Schedule (EMS or IR348). The EMS is the form used by businesses to send Inland Revenue the pay details of their workers and calculating Pay-As-You-Earn (PAYE) tax and other deductions. Employment is measured using an average of 12 monthly PAYE employee counts in the year. These monthly employee counts are taken as at 15th of the month and exclude working proprietors as identified in LEED (see Appendix). The employment count used in the current paper includes both employees and working proprietors, which may slightly overstate labour input if

[6] The methods used here were developed by Richard Fabling and David Maré and will be further documented in a forthcoming Motu Working Paper.

working proprietors are not actively working in the firm. We are not able to determine the extent of labour input. For succinctness, we use the term 'employees' for this employment count.

We identify enterprises longitudinally using the approach of Fabling (2011), which corrects for false firm births and deaths arising from administrative changes. We assign each longitudinally defined permanent enterprise to a unique industry, based on the industry that accounts for the highest proportion of observed employment months. The industry classification is chosen to match the 91-industry grouping available for foreign penetration, as described below.

Foreign ownership

The foreign ownership indicator is derived by combining information from the Longitudinal Business Frame (LBF) and company tax returns (IR4 form).[7] We identify a firm as foreign owned in a year if they are identified as foreign owned in either of the datasets.

The LBF is the spine of the LBD. It is a monthly longitudinal dataset of demographic-type data created from Statistics New Zealand's Business Frame. The LBF contains information on a range of information such as business type, industry, sector, location, parent-subsidiary relations and foreign ownership.

The LBF overseas ownership information for enterprises is collected from three main sources:

- Monthly Frame Update Survey (MFUS): a monthly survey for new businesses, with an average post-out sample of 1,000.
- Annual Frame Update Survey (AFUS): an annual survey covering approximately 30,000 businesses in New Zealand.
- Group Profile Survey (GPS): an annual survey covering approximately 250 large groups of companies in New Zealand.

There are approximately 400,000 enterprises on the Business Frame, although the quality of data is higher for larger firms. Because of their importance for key statistics like National Accounts, large economic units are surveyed relatively frequently by Statistics New Zealand to maintain accuracy – either annually or triennially.[8] Similarly, overseas equity information is collected only for medium and large enterprises that have six or more employees. Statistics New Zealand uses shareholding information from the Companies Office for maintaining/updating the shareholding structure between domestic companies. Smaller firms are also less well covered by administrative sources. Goods and Services Tax (GST) data from Inland Revenue are used (among other things) to track the births and deaths of firms. GST registration is, however, not required for non-employing firms with low turnover. Over the period of the LBD, the mandatory GST filing threshold has been $30,000, $40,000 and $50,000. It is now $60,000.[9]

[7] More detail of variable descriptions can be found in the Appendix. Further details on the consistency and reliability of available measures of foreign ownership can be found in Sanderson (forthcoming).

[8] Approximately 250 business groups receive the Business Frame Structure Update (Group Profile Survey) each year.

[9] See www.ird.govt.nz/gst/gst-registering/register-who/.

The degree of foreign ownership is recorded as a percentage share based on the residential status of the immediate parent of the enterprise. Therefore, if a New Zealand company is wholly owned by another New Zealand company, the value of this variable will be zero even though the ultimate parent of that company is an overseas company. We use this measure to identify firms with more than 10% foreign ownership. This is the threshold used to define foreign direct investment (FDI) in balance of payments statistics and is appropriate for the current study as an indicator of a meaningful link with a foreign owner. The percentage of foreign ownership field is not, however, always accurate because it was designed as an activity-based frame and is not always up to date (Attewell and van Lijf, 2005). We therefore also use a second source of foreign ownership – company tax returns (IR4 form).

The IR4 return is compulsory for businesses that are registered as companies (typically large firms). It includes income, tax calculation, refunds and/or transfers, provisional tax and disclosures. Companies are required to disclose whether they are "controlled or owned by non-residents". While this binary indicator is a more restrictive measure than the 10% threshold used with the LBF data, it nevertheless provides meaningful evidence of a foreign ownership link that could potentially support spillovers. The IR4 indicator has greatly superior coverage for companies and, for many businesses, more timely updating (Fabling et al., 2008) but misses a handful of smaller FDI firms that appear in the LBF.

In this paper, we define an enterprise as being foreign owned in a given year if the LBF FDI measure records ownership of 10% or more or if they are recorded as foreign owned or controlled in IR4 data. By this definition, we are likely to incorrectly classify some small foreign-owned firms, foreign-owned firms whose direct parent company is domestically owned and firms with missing LFB and IR4 information

Supply links and foreign penetration

To estimate intra and inter-industry spillovers, we identify backward and forward supply chain linkages from the Input-Output (IO) table developed by Statistics New Zealand (2012). The IO table summarises transactions between 106 industry groups, the goods and services they produce and which other industries use them as inputs. We drop some industries that are not meaningful in the context of FDI spillovers[10] and calculate annual foreign penetration measures for each of 91 groupings of Level 3 NZSIOC industries as used in the construction of input-output tables.

The IO inter-industry transactions table is used to compute the proportion of output supplied by each industry that is used by each other industry to capture downstream industries. Similarly, the proportion of each industry's inputs obtained from each other industry is used as a measure of backward linkages. For each industry, an annual measure of foreign penetration is calculated as the proportion of output accounted for by foreign-owned firms in the industry itself (horizontal), in

[10] The following industries are excluded: education; health; public administration and safety; library and museum; parks and gardens; superannuation; residential property operators; owned-occupied property operations; foreign government representatives; religious services, civil, professional and other interest groups; private households employing staff; and industries not elsewhere classified. We also exclude firms without an ANZSIC 2006 code and firms that never have employees.

downstream industries (forward) or in upstream industries (backward). Horizontal penetration in industry *j* in period *t* is:

$$Horizontal_{jt} = \frac{\sum_{i \in j} FDI_{ijt} * Y_{ijt}}{\sum_{i \in j} Y_{ijt}} \quad \text{Equation 1}$$

where *i* refers to enterprises, Y_{ijt} is the output of enterprise *i* and FDI_{ijt} is an indicator of whether firm *i* is foreign owned.

The forward and backward measures are calculated as weighted averages of horizontal penetration in other industries, where the weights are proportions of output or inputs respectively.

$$Backward_{jt} = \sum_{k \neq j} \alpha_{jk} Horizontal_{kt} \quad \text{Equation 2}$$

$$Forward_{jt} = \sum_{k \neq j} \beta_{jk} Horizontal_{kt} \quad \text{Equation 3}$$

where α_{jk} is the share of industry *j* output[11] supplied to industry *k* and β_{jk} is the share of industry *j* inputs[12] obtained from industry *k*, as calculated from IO tables. Within-industry transactions are excluded from the forward and backward measures as these are captured by the horizontal variable. The coefficients α_{jk} and β_{jk} are taken from the latest New Zealand 2007 Input-Output table.[13] The spillover (penetration) variables are time-varying industry-specific variables, while the coefficients taken from the Input-Output table are fixed for the period 2000–2010.

Final dataset

Our analysis dataset is an unbalanced panel of 2,304,390 annual enterprise observations spanning the years 2000–2010 or, on average, about 210,000 firms per annum. As shown in Table 1, our sample, which combines directly surveyed AES responses with IR10 information, has slightly lower coverage of the population (47% to 58%) than the AES sample (55% to 73%). However, we disproportionately retain larger firms. On average over the study period, our sample accounts for about 83% of total value added (VA),[14] providing greater confidence in the general validity of our findings.

Our econometric analysis outlined below estimates the impact of foreign penetration on domestic firms. For this, we select firms that are never observed as foreign owned to avoid misclassification and to ensure that our spillovers do not reflect direct effects of firms having themselves been

[11] The total output of sector (industry) *j*, which is used to compute the α_{jk}, consists of amounts sold to other industries *k*, exported and sold to final household consumption, so the sum of α_{jk} will be less than 1.

[12] Total input of industry *k*, which is used to compute the β_{jk}, includes amounts supplied by other industries as well as imported inputs.

[13] The IO table was mainly built on the 2007 Annual Enterprise Survey data and ANZSIC 2006 industry classification. A 2001 IO table is available but is based on a different (ANZSIC 1996) industry classification. We have chosen to use a single IO table for the entire period to avoid having to rely on imperfect industry concordances and interpolation of changes over time.

[14] Data for 2010 – we take Statistics New Zealand publicly released data of VA as the denominator.

foreign owned. The final column of Table 1 shows a total sample of 2,260,065 enterprise-year observations of 'never foreign-owned' firms. Around 8% of these are excluded from productivity estimation due to zero or missing value added, zero labour or capital services, or missing industry information, leaving 2,079,135 usable observations. All dollar variables are deflated to the base year of March 2011 using the Producer Price Index (PPI) for outputs and the Capital Goods Price Index (CGPI) for capital services, applied at the corresponding 2-digit ANZSIC 2006 sectors.

4. Econometric models and estimation issues

4.1 Measuring impacts of foreign penetration on domestically owned firm productivity

To estimate spillovers of FDI on domestic firm productivity, we estimate an augmented Cobb-Douglas production function, which is a common empirical specification in this literature (Fons-Rosen et al., 2013; Görg, Hijzen and Muraközy, 2009; Lin et al., 2009; Haskel et al., 2007; Merlevede and Schoors, 2007; Javorcik, 2004; Schoors and van der Tol, 2002). Specifically, we estimate a value added production function with inputs of capital and labour, augmented with measures of horizontal, forward and backward foreign penetration, which has the following form:

$$lnVA_{ijt} = \begin{matrix} \alpha + \beta_1 lnk_{ijt} + \beta_2 lnl_{ijt} \\ +\beta_3 Horizontal_{jt} + \beta_4 Backward_{jt} + \beta_5 Forward_{jt} + \beta_6 \mathbf{HHI_{jt}} \\ +\boldsymbol{\lambda_t + \lambda_j + \theta_j t + \lambda_i + e_{ijt}} \end{matrix} \quad \text{Equation 4}$$

where VA_{ijt} is real output (value added) of firm *i* in industry *j* at time *t*, k_{ijt} is cost of capital services and l_{ijt} is a count of employment. At the industry level, we include annual measures of foreign penetration and also a measure of industry competitiveness, as captured by HHI_{jt}, a Herfindahl-Hirschman index of output concentration for industry *j* at time *t*.[15] Equation 4 also contains dummy variables for year (λ_t), industry (λ_j) and firm (λ_i) as well as industry-specific time trends $\theta_j t$, although not all of these are separately identifiable.

Production function coefficients (β_1, β_2) are constrained to be common across industries, other than allowing for industry-specific intercepts (λ_j). This is a common parsimonious alternative to estimating separate capital and labour coefficients for each of 91 separate industry groups or using a two-step approach of regressing residuals from industry-specific production functions on foreign penetration measures, as in Fons-Rosen et al. (2013) or Merlevede and Schoors (2007). Due to the inclusion of industry fixed effects, the coefficients on the foreign penetration measures are identified by within-industry variation over time. By construction, there is no within-industry variation in foreign penetration in any given year.

4.2 Estimation issues

Direct estimation of Equation 4 may give biased estimates of the key parameters of interest (β_3, β_4, β_5) due to omitted variables that are correlated with both foreign penetration and value added or due to the endogeneity of factor inputs or of foreign penetration, whereby these covariates may respond to value added. Such biases may lead to estimates of positive (or negative) effects, even though no spillovers take place (Aitken and Harrison, 1999).

The inclusion of *HHI* is necessary to control for variation in market structure that may be correlated with foreign penetration. Foreign firms in New Zealand are much larger than domestic firms (see

[15] The *HHI* bounds between 0 and 1, and a higher value of *HHI* indicates greater market concentration or less competition.

Table 2 in section 5.1 below and Fabling and Sanderson (2011)) and thus have some market power. It is important not to attribute the impacts of market power to FDI spillovers. The competitiveness of an industry has ambiguous impacts on measured productivity. Increased competition may improve productivity but may also drive up input prices and, thus, affect the profitability of incumbent firms at least in the short run. Haskel et al. (2007) argue that the competition variables capture market power and industry competition, and it is important to control for market competition because competition affects firm efficiency (Nickell, 1996). Foreign firm entry may increase competition and thus productivity, but foreign firm entry may also adversely affect domestic firms because foreign firms tend to be larger and easily establish dominant market power (OECD, 2002).

The endogenous choice of factor inputs is a potential source of endogeneity bias. Firms may choose variable factor inputs in response to new information on their (possibly time-varying) firm-specific productivity (λ_i). This introduces an upward bias in the coefficients on variable inputs such as labour and a consequent downward bias on the capital coefficient (Griliches and Mairesse, 1998). The degree of bias that this form of endogeneity causes on estimates of foreign spillover estimates is an empirical question. Haskel et al. (2007) and Javorcik (2004) present estimates that control for the endogeneity of factor inputs by using structural identification approaches, as detailed in Olley and Pakes (1996) or Levinsohn and Petrin (2003). These approaches entail using a fully flexible input (investment or material inputs respectively) as a proxy for time-varying firm productivity effects. They find that spillover estimates are not greatly affected by the controls for factor endogeneity.

We rely on estimates that do not explicitly control for the endogeneity of factor inputs, focusing instead on controlling for the potential endogeneity of foreign penetration.[16] Whereas firms are expected to endogenously adjust factor inputs in response to annual changes in firm-specific productivity (λ_{it}), foreign ownership is likely to respond to changes in overall productivity performance within industries. The inclusion of industry fixed effects and industry-specific time trends control for the influence of foreign firms targeting particular industries on the basis of average industry productivity or relative productivity growth of industries over the sample period. Foreign investors maybe gravitate towards more productive growing firms and sectors. Foreign investors may also be attracted to low-growing sectors to take their greater competitive advantages. Therefore, the spillovers may flow in either direction (Arnold and Javorcik, 2009).

As a further means of limiting the potential bias from foreign firms entering during periods when industry productivity is high, we use lagged rather than current values of foreign penetration.[17] Haskel et al. (2007) argue that longer period lags of the spillover variables may be appropriate as spillovers would take time to materialise. However, using long changes restricts the sample as a result of dropping initial periods and also excluding firms that cease operation. The latter may lead to survivor bias – by estimating impact on only surviving firms, we will miss possible negative

[16] A further, practical, reason for not relying on structural identification methods is that the measure of intermediate consumption that is available in our data contains both variable and relatively fixed inputs, which limits the credibility of its use as a proxy variable.

[17] An alternative approach to endogeneity is to use instrumental variables (IV) methods. We followed Haskel et al. (2007) and testing instrumenting for spillover variables by using their lagged values. Our estimates suggested that the lagged instruments were weak and thus unreliable. We do not report the IV estimation results in this paper. We also considered using Australian inward and outward FDI by sector as instruments for foreign penetration in New Zealand. However, sufficiently detailed data were not readily available.

impacts of foreign penetration on firm survival. Consequently, we explicitly examine the impact of foreign penetration on survival.

We estimate Equation 4 in time-differenced form – regressing changes in firm value added against changes in factor inputs and (lagged) foreign penetration. The differencing has the effect of removing industry and firm-level variation in the level of productivity and the bias associated with their correlation with foreign penetration (Haskel et al., 2007; Aitken and Harrison, 1999). We present estimates using changes over 1, 2 or 3 years. Estimates based on longer changes better capture the impact of more persistent changes and are less affected by noise that biases the coefficients towards zero (Griliches and Hausman, 1986). The estimating equation is shown as Equation 5, with all variables included as *k*-period changes and foreign penetration variables lagged by *m* periods. Lagged changes are used to ensure that foreign penetration changes are predetermined relative to current plan productivity changes and to allow for the possibility that spillovers may take time to materialise (Haskel et al., 2007). Industry and firm dummies are removed by differencing, and the industry-specific time trends (θ_j) are included as constants in the change regression.

$$\begin{aligned}\boldsymbol{\Delta_k} lnVA_{ijt} = {} & \alpha + \beta_1 \Delta_k lnk_{ijt} + \beta_2 \Delta_k lnl_{ijt} \\ & + \beta_3 \Delta_k Horizontal_{jt-m} + \beta_4 \Delta_k Backward_{jt-m} + \beta_5 \Delta_k Forward_{jt-m} \\ & + \beta_6 \Delta_k \mathbf{HHI_{jt-m}} + \boldsymbol{\theta_t} + \boldsymbol{\theta_j} + \boldsymbol{\varepsilon_{ijt}}\end{aligned} \qquad \text{Equation 5}$$

Equation 5 is estimated with standard errors clustered by industry and year to allow for the fact that measured foreign penetration does not vary within industry and year (Moulton, 1990).[18]

The aim of this paper is to examine the spillover effects on domestic firms – all the above-mentioned models are estimated on a sample of 'always domestic' firms only. Firms that are FDI at any time during the sample frame are excluded. This reduces the risk of misclassification and avoids composition changes associated with high-productivity firms being bought out, which would induce a negative correlation between foreign ownership and domestic firm productivity.

[18] Clustering may be still problematic if the number of clusters (industry-years) is small relative to the units per cluster. Cameron, Gelbach and Miller (2008) suggest cluster bootstrapping techniques for inference. We tried both clustered and clustered bootstrapping for our main estimates and found very similar estimated standard errors. We report clustered standard errors in the paper.

5. Results

5.1 Summary statistics

In this section, we provide summary statistics for our study sample. On average, 1.4% of firms are foreign owned, yet they contributed on average (across all years in the sample) about 37.4% of total sales, 38.6% of VA and 24.2% of total employment (Table 2). Foreign-owned firms contributed considerably to both inputs and outputs. An average foreign firm in New Zealand has sales and value added around 40 times as large as that of an average domestic firm and employment that is around 20 times as large. Foreign firms thus have labour productivity, as measured by value added per worker, that is twice that of domestic firms.

Table 2: FDI firm contributions, 2000–2010

Year	FDI contribution (% of total)				Sales per firm ($1000)		VA per firm ($1000)		Employees per firm		VA per employee ($1000)	
	Firm%	Sales	VA	Emp	Dom	FDI	Dom	FDI	Dom	FDI	Dom	FDI
2000	1.3	39.6	39.5	25.7	643	32,257	260	12,995	4.0	104.5	65.7	124.3
2001	1.3	39.4	40.5	24.7	657	31,810	255	12,985	4.0	98.1	63.7	132.4
2002	1.4	40.5	40.2	24.5	671	32,837	269	13,000	4.1	95.7	65.4	135.9
2003	1.4	39.0	40.5	23.5	714	32,844	278	13,627	4.2	93.2	65.9	146.2
2004	1.4	35.2	35.5	23.0	779	30,720	309	12,323	4.4	95.1	70.5	129.6
2005	1.3	35.3	37.4	24.2	848	34,084	315	13,898	4.4	103.0	72.0	134.9
2006	1.4	38.1	38.7	24.8	776	33,033	320	14,028	4.4	101.6	72.1	138.1
2007	1.5	37.2	38.6	24.4	779	31,077	314	13,346	4.4	96.7	70.8	138.0
2008	1.5	35.1	38.8	23.5	798	28,629	313	13,185	4.5	92.2	69.2	143.0
2009	1.6	35.7	36.4	23.6	776	26,939	310	11,131	4.6	88.8	67.5	125.4
2010	1.6	36.2	38.3	23.9	764	27,070	312	12,038	4.5	88.6	68.8	135.8
Ave	1.4	37.4	38.6	24.2	746	31,027	296	12,960	4.3	96.1	68.3	134.9

Notes: 'Employees' include working proprietors and employees. Dollar variables are expressed in March 2011 values. 'Emp' is employment, 'Dom' is domestic firms, 'VA' is value added. The numbers are estimated from the sample used in this paper and do not fully represent the New Zealand firm population.

Foreign penetration varies across industries. Table 3 summarises our three focal measures of foreign penetration (horizontal, backward and forward) for each of 16 broad industry groups. Some industries have high levels of horizontal penetration (Mining; Wholesale Trade; Information Media and Telecommunications; Financial and Insurance Services) while others have relatively low levels of foreign penetration (Agriculture, Forestry and Fishing; Construction; Arts and Recreation Services). There is also variation in the degree of change over the study period, with relatively large increases in Mining; Electricity, Gas, Water and Waste Services; and Information Media and Telecommunications and declines in Accommodation and Food Services, Financial and Insurance Services and Other Services.

The degree of backward penetration is somewhat lower than the degree of forward penetration, suggesting that foreign firms are more prevalent as customers for domestic firms than as suppliers. While there is substantial variation across industries in backward and forward penetration, the variation is less than for own-industry (horizontal) penetration. Of relevance to our subsequent

regression analysis is the fact that changes over time in backward and forward penetration are generally smaller and less variable across industries than is the case for horizontal penetration. Estimates of the spillover effects of backward and forward foreign penetration will be less precise, as will be evident in higher standard errors.

Table 3: Summary of three foreign penetration variables

Description	Horizon	2000–10 change	Backward	2000–10 change	Forward	2000–10 change
Agriculture, Forestry and Fishing	0.0327	-0.0036	0.1311	0.0024	0.2338	-0.0094
Mining	0.5670	0.1780	0.3009	0.0425	0.3952	0.0023
Manufacturing	0.3404	-0.0268	0.1307	-0.0073	0.2604	-0.0203
Electricity, Gas, Water and Waste Services	0.3594	0.1195	0.1253	-0.0215	0.2067	0.0080
Construction	0.0869	-0.0270	0.1272	0.0089	0.2703	0.0028
Wholesale Trade	0.4406	-0.0534	0.1871	-0.0124	0.3193	-0.0238
Retail Trade	0.2224	0.0318	0.0490	-0.0097	0.2979	-0.0212
Accommodation andand Food Services	0.2186	-0.0974	0.0228	-0.0090	0.3359	0.0109
Transport, Postal and Warehousing	0.1681	-0.0018	0.2662	-0.0185	0.3004	-0.0236
Information Media and Telecommunications	0.5599	0.0838	0.2396	-0.0173	0.3029	0.0165
Financial and Insurance Services	0.4845	-0.0529	0.3683	-0.0166	0.2913	0.0043
Rental, Hiring and Real Estate Services	0.1108	-0.0177	0.2207	-0.0526	0.2606	-0.0143
Professional, Scientific and Technical Services	0.2478	0.0338	0.2477	-0.0035	0.2642	-0.0046
Administrative and Support Services	0.2927	-0.0224	0.1804	-0.0098	0.2731	0.0115
Arts and Recreation Services	0.0357	-0.0445	0.0224	-0.0029	0.2803	0.0045
Other Services	0.2366	-0.0681	0.1070	-0.0169	0.3127	-0.0063
Overall	0.1794	0.0012	0.1507	-0.0016	0.2723	-0.0045

Notes: Foreign penetration measures are calculated for each of 91 industries, based on the output shares of foreign-owned firms, as described in the text. The table entries are averages of these penetration measures across domestically owned ('never foreign') firms in each of the 16 broad industry groups.

5.2 Spillover effect estimates

The first and second columns of Table 4 present the results of ordinary least squares (OLS) and fixed effect (FE) estimation of Equation 4, which models value added as a function of contemporaneous factor inputs and foreign penetration. Columns 3, 4 and 5 of Table 4 show estimates of Equation 4, modelling changes in value added on contemporaneous (m=0) changes in inputs and penetration for changes over one, two and three years.

The coefficients for both labour input and the cost of capital services are highly significant across models and provide credible production function estimates. The OLS estimates are likely to be upward biased due to the correlation of factor inputs with firm fixed effects. The implied returns to scale coefficient (the sum of labour and capital coefficients) is 1.17. This is reduced to 0.94 when fixed effects are controlled for in column 2 and lies between 0.87 and 0.93 in the differenced

specification. The lowest estimate of 0.87 is for the first differenced specification, in which coefficients, especially the coefficient for labour, will be lower due to transitory fluctuations. The estimated impact of industry concentration (*HHI*) is to raise value added, consistent with competition raising input prices or constraining output prices.

The inclusion of concurrent foreign penetration variables in Table 3 may result in endogeneity bias. They provide baseline estimates and also some evidence of foreign investment's self-selection. All regressions include industry intercepts and time trends, so the estimated impact of foreign penetration reflects the association between productivity and penetration over time within industries. The first column offers results from the OLS estimation. A higher level of own-industry (horizontal) penetration has a negligible and statistically insignificant relationship with domestic firm productivity, with a 1 percentage point increase in penetration associated with productivity that is lower by 0.01%. Domestic firm productivity is relatively low in years when foreign penetration is higher in upstream or downstream industries, consistent with either a negative spillover or endogenous timing of entry. The estimate of forward spillovers is statistically significant. A 1 percentage point increase in the presence of foreign suppliers is associated with domestic firm productivity that is 0.7% lower.

Fixed effects estimates of foreign spillovers in the second column of Table 4 are very similar to those obtained from OLS estimation. In contrast, there is some variation in estimates across differenced specifications. The differences across these specifications reflect a combination of different samples, and the potential impact of endogeneity associated with using concurrent changes. Sample sizes are smaller when using longer changes because data are missing for short-lived firms.[19] The one-year differenced specification shows a positive impact of backward (foreign customer) penetration, though this may reflect an endogenous association between short-term changes in value added in an industry and the entry of foreign firms that use the output of that industry.

To remove endogeneity bias and reduce the influence of volatile short-term fluctuations, our preferred specification relies on lagged values of penetration changes, as in Equation 5, with changes measured over two years. The two-year and three-year estimates are similar though the two-year change estimates are more precise due to a somewhat larger sample size. We choose lag lengths to ensure that lagged changes are measured prior to output changes.

[19] Some observations are also lost even for continuing firms as a result of missing data in some years.

Table 4: Spillover effects of foreign penetration on domestic firm productivity, 2000–2010

Variables	OLS (*k*=0) (1)	Fixed effect (FE; *k*=0) (2)	One-year difference (*k*=1) (3)	Two-year difference (*k*=2) (4)	Three-year difference (*k*=3) (5)
$\Delta_k Horizon_t$	-0.008	-0.006	-0.017	0.021	-0.006
	(0.021)	(0.023)	(0.017)	(0.018)	(0.024)
$\Delta_k Backward_t$	-0.196	-0.139	0.248	-0.527**	-0.322
	(0.191)	(0.121)	(0.206)	(0.169)	(0.296)
$\Delta_k Forward_t$	-0.682**	-0.670**	-0.558**	-0.600*	-0.688*
	(0.181)	(0.247)	(0.176)	(0.259)	(0.268)
$\Delta_k lnL_t$	0.718**	0.551**	0.477**	0.530**	0.559**
	(0.010)	(0.025)	(0.009)	(0.010)	(0.011)
$\Delta_k lnK_t$	0.446**	0.393**	0.395**	0.366**	0.368**
	(0.010)	(0.014)	(0.006)	(0.005)	(0.006)
$\Delta_k HHI_t$	0.100**	0.069**	0.051*	0.095*	0.034
	(0.020)	(0.013)	(0.023)	(0.042)	(0.024)
Constant	5.776**	7.115**	-0.013	-0.010	0.050
	(0.129)	(0.152)	(0.048)	(0.070)	(0.052)
Observations	2,079,135	2,079,135	1,397,358	1,099,929	869,844
R-squared	0.59	0.25 (within)	0.17	0.21	0.24
Time trend by industry	Yes	Yes	No	No	No
Year effect	Yes	Yes	Yes	Yes	Yes
Industry controlled	Yes	No	Yes	Yes	Yes

*Notes: The dependent variable is the natural log of value added. Standard errors are in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%. k represents time length differences; 'k=0' indicates levels.*

Estimates of our preferred specification are shown in Table 5. As we use two-year differences, the shortest predetermined lag of spillover variables we can use is a 3-period lag. One of the costs of ensuring that spillover variables are predetermined is that the estimation sample is greatly reduced due to the absence of lagged values for early years. The estimation sample is reduced to 418,224, which is less than half the sample available for the two-year differenced specification in Table 4.

The first column of Table 5 presents our main estimates. Changes in foreign penetration are estimated to have a positive impact on domestic firm productivity, though the increase is significant only for backward spillovers – increasing prevalence of foreign-owned customers raises subsequent productivity growth in domestic firms. The coefficient of 0.864, however, implies a relatively small contribution to the overall productivity of domestic firms. Across all industries, the change in backward penetration from 2000–2010 was a decline of 0.0016, so the coefficient of 0.864 implies that the reduction in backward spillovers contributed only -0.14% to overall domestic productivity growth over 10 years. The implied impact is, however, more pronounced for industries that experienced large increases or decreases in backward penetration, with reduced foreign penetration lowering productivity by more than 1% over 10 years in seven of the 16 industry groups shown in Table 3. For horizontal and forward spillovers, not only are the coefficients statistically insignificant but also the implied overall contributions are small (0.001% and -0.07% respectively).

In the second column of Table 5, we repeat the specification of column 1 but for the subsample for which longer lags of foreign penetration are also available. The sample size is reduced to 204,399,

since we are now restricted to using only four years of data (to provide a 5-period lag of two-year growth in penetration). The main finding of a positive effect of backward penetration remains, with a higher point estimate (1.439) but with less precision due to the smaller sample. The estimated impact of horizontal penetration remains positive and becomes marginally significant. Although the estimated impact of forward penetration becomes negative, the associated standard error is large, and the estimate is only marginally significant. The final column of Table 5 includes a distributed lag of foreign penetration, allowing for the possibility that spillovers accrue over a longer period. The longer (*t-5*) lags show a partial reversal of the shorter (*t-3*) lagged effects. The combined long-term impact is calculated as the sum of the lag coefficients and is shown in the final rows of the table. None of the long-term impacts is statistically significant although the point estimates are broadly similar to the short-lag estimates in the second column, with a positive impact of backward penetration and a negative impact of forward spillovers. The estimated impact of horizontal penetration becomes negative but less precise.

Table 5: Spillover effects of foreign penetration on domestic firm productivity, 2000–2010, using lagged changes in foreign penetration

	Full sample	**Restricted sample**	
	(1)	**(2)**	**(3)**
$\Delta_2 Hor_{t-3}$	0.010	0.079*	0.023
	(0.028)	(0.038)	(0.050)
$\Delta_2 Back_{t-3}$	0.864**	1.439**	1.276**
	(0.332)	(0.316)	(0.481)
$\Delta_2 For_{t-3}$	0.146	-1.000*	-0.786+
	(0.324)	(0.441)	(0.442)
$\Delta_2 Hor_{t-5}$			-0.043
			(0.028)
$\Delta_2 Back_{t-5}$			-0.214
			(0.303)
$\Delta_2 For_{t-5}$			0.385
			(0.357)
$\Delta_2 lnL_t$	0.511**	0.502**	0.502**
	(0.014)	(0.019)	(0.019)
$\Delta_2 lnK_t$	0.332**	0.327**	0.328**
	(0.007)	(0.009)	(0.009)
Const	-0.077**	-0.128**	-0.119**
	(0.029)	(0.034)	(0.032)
Obs	418,224	204,399	204,399
R-squared	0.15	0.14	0.14
$\beta[\Delta_2 Hor_{t-3}] + \beta[\Delta_2 Hor_{t-5}]$			-0.019
			(0.073)
$\beta[\Delta_2 Back_{t-3}] + \beta[\Delta_2 Back_{t-5}]$			1.062
			(0.741)
$\beta[\Delta_2 For_{t-3}] + \beta[\Delta_2 For_{t-5}]$			-.401
			(0.610)

*Notes: The dependent variable is the two-year difference in the log of value added. Standard errors are in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%. All models include controls for year, 2-digit industry dummies, and the lagged two-year difference of the Herfindahl-Hirschman index of output concentration.*

Given the similarity of results, our preferred specification for subsequent analysis is the short-lag specification shown in the first column of Table 5 – favouring the use of a less restrictive sample to the extended lag specification.

Potential effects of foreign penetration on firm survival are not captured by the estimates in Table 5. Firms that cease operation within two years of a change in foreign penetration are automatically excluded from the estimating sample. The bias from excluding ceased firms will depend on whether firm death is raised or lowered and on whether the affected firms have high or low productivity levels. If the entry of foreign firms raises the probability that domestic firms with slow productivity growth cease operation, foreign penetration may appear to raise (average) productivity growth.

In order to gauge the possible impact of foreign penetration on firm survival, we estimate the probability of firms ceasing operation as a function of changes in foreign penetration. In order to focus on the subset of firms potentially excluded by our main specification, we estimate a firm's likelihood of ceasing operation within three years, following a two-year change in foreign penetration.[20] Table 6 presents estimates from a probit regression of firm death, with estimates reported as (average) marginal effects.

The positive coefficients on all three measures of foreign penetration change imply that increases in foreign penetration raise the probability of firm death, though the estimated effect is significant only for forward penetration (the entry of foreign-owned suppliers). The actual change in forward penetration over our sample period was a decline 0.0045. The coefficient of 0.0481 implies that this change contributed a decline in the probability of firm death within 3 years of around 0.02 percentage points, which is extremely small compared with the average rate of firm death in our sample of around 3.5% over three years.

The second and third columns of Table 6 examine whether changes in foreign penetration affect firm survival over a longer time period. As in Table 5, the inclusion of longer lags has the effect of restricting the sample to firms that have been operating for longer than 4 years. For these longer-lived firms, a 1 percentage point increase in foreign ownership among customers (backward spillovers) is estimated to reduce the likelihood of firm death within 3 years by 0.04 percentage points, with the impact somewhat stronger 2–4 years after the change in foreign ownership.

[20] Firm survival cannot be accurately identified by a firm's absence from our analysis data alone. A firm is classified as continuing if, in the following year, there is output or intermediate input recorded in either AES or IR10 data sources, if the firm has positive employment or if any sales or purchases are recorded in GST returns.

Table 6: Impact of increased foreign penetration on the likelihood of firm death

	Full sample	Restricted sample	
	(1)	(2)	(3)
$\Delta_2 Hor_t$	0.0012	-0.0000	0.0000
	(0.0015)	(0.0016)	(0.0019)
$\Delta_2 Back_t$	0.0017	0.0028	-0.0151
	(0.0058)	(0.0092)	(0.0094)
$\Delta_2 For_t$	0.0481**	0.0059	0.0134
	(0.0111)	(0.0119)	(0.0135)
$\Delta_2 Hor_{t-2}$			0.0003
			(0.0019)
$\Delta_2 Back_{t-2}$			-0.0281**
			(0.0057)
$\Delta_2 For_{t-2}$			0.0167+
			(0.0100)
$\Delta_2 lnL_t$	-0.0316**	-0.0345**	-0.0345**
	(0.0007)	(0.0007)	(0.0007)
$\Delta_2 lnK_t$	-0.0131**	-0.0149**	-0.0149**
	(0.0004)	(0.0004)	(0.0004)
$\beta[\Delta_2 Hor_t]+ \beta[\Delta_2 Hor_{t-2}]$			0.0003
			(0.0034)
$\beta[\Delta_2 Back_t]+ \beta[\Delta_2 Back_{t-2}]$			-0.0432**
			(0.0139)
$\beta[\Delta_2 For_t]+ \beta[\Delta_2 For_{t-2}]$			0.0301
			(0.0197)
Observations	940,500	466,233	466,233
Wald chi2	10127.02	7894.01	11725.89
Prob > chi2	0.0000	0.0000	0.0000

*Notes: The results shown are average marginal effects estimated from probit models. The dependent variable is an indicator of whether the firm ceases to operation within the following three years. It takes the value of 1 for three years prior to the death of a firm, and 0 otherwise. Robust clustered standard errors are given in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%. Regressions control for year and industry effects and the lagged two-year difference of the Herfindahl-Hirschman index of output concentration. The sample is restricted to 2000–2008 so that each firm's survival can be observed for the following three years.*

5.3 FDI spillover effects by firm size and sector

One potential explanation of the relatively weak estimated spillover effects is that domestic firms may have limited absorptive capacity to benefit from knowledge or technologies available from foreign-owned firms. The literature on FDI spillovers (for example, Blomström and Sjöholm, 1999; Görg and Greenaway, 2004) suggests that absorptive capacity depends on how much and how easily firms can adopt a more productive technology or knowledge. In this section, we investigate this question using firm size as a proxy for firm absorptive capacity. We hypothesise that larger domestic firms may benefit more from the presence of foreign-owned firms due to their generally more sophisticated technologies and business processes. The estimates are presented in the first two

columns of Table 7. We group domestic firms into two groups: the first group consists of firms with fewer than 10 employees and the second group consists of firms with 10 employees or more.[21]

Contrary to our hypothesis, the positive estimated impact of backward foreign penetration is evident only for the smaller firm-size category, with a coefficient of 0.890 – very similar to the overall estimate shown in Table 5. For larger firms, the estimated effect is negative, though not statistically significant. The results suggest that the productivity of small domestic firms is raised by the presence of larger, internationally connected foreign-owned customers. The heterogeneity in firm absorptive capacity may affect the size of the backward spillover effect that domestic supplying firms receive from foreign-owned firms in downstream industries.

Table 7: Decomposing spillover effects by firm size and sector, 2000–2010

	Firm size		Sector		
	Fewer than 10 employees	10 employees or more	Primary	Goods manufacturing	Services
Lag (*t-m*)	(1)	(2)	(3)	(4)	(5)
$\Delta_2 Horizon_{t-3}$	0.009	0.035	-0.303	0.084	0.006
	(0.029)	(0.034)	(0.325)	(0.069)	(0.023)
$\Delta_2 Back_{t-3}$	0.890**	-0.153	1.261+	-0.024	-0.333
	(0.339)	(0.401)	(0.662)	(0.344)	(0.535)
$\Delta_2 For_{t-3}$	0.169	0.224	-0.742	0.618+	0.710*
	(0.349)	(0.262)	(1.684)	(0.354)	(0.281)
$\Delta_2 lnL_t$	0.502**	0.639**	0.340**	0.648**	0.524**
	(0.015)	(0.017)	(0.024)	(0.013)	(0.009)
$\Delta_2 lnK_t$	0.336**	0.245**	0.379**	0.271**	0.339**
	(0.008)	(0.012)	(0.011)	(0.010)	(0.007)
Constant	-0.080**	-0.054	-0.055	-0.434**	-0.374**
	(0.029)	(0.040)	(0.076)	(0.143)	(0.065)
Observations	375,573	42,654	92,562	104,679	220,983
R-squared	0.15	0.23	0.10	0.16	0.19

*Notes: The dependent variable is the two-year difference in the log of value added. Standard errors are in parentheses; + significant at 10%; * significant at 5%; ** significant at 1%. Δ_2 is the two-year difference. All models controlled for year and 2-digit industry fixed effects and the lagged two-year difference of the Herfindahl-Hirschman index of output concentration. The primary sector includes Agriculture, Forestry and Fishing; and Mining; goods manufacturing includes Manufacturing; Electricity, Gas, Water and Waste Services and construction; services are the remaining industries in the study sample (see section 3 for more detail).*

The effect of foreign penetration may also be heterogeneous across industries. Columns 3 to 5 of Table 7 show separate estimates for each of three main industry groupings: the primary sector, the goods manufacturing sector and the services sector. As was the case by firm size, the overall positive estimated impact of backward spillovers is not evident across all subgroups. Only for the primary sector is there a positive and significant effect, suggesting that firms in the primary sector benefit particularly strongly from having foreign firms in the downstream industries to which they provide

[21] We also examined a finer size breakdown into 0–4, 5–9, 10–19 and 20+ employee firms. The estimated coefficients of the first two groups are quite similar as are those of the last two groups. Thus, we regroup them into two groups (fewer than 10 and 10 or more).

their output. In contrast, there is evidence that, for service sector firms, it is the presence of foreign-owned suppliers rather than customers that generates positive productivity spillovers.

We undertook more detailed industry-specific regressions for 18 industry groupings. The results are not shown here because the estimates are generally imprecise due to the smaller sample sizes, and the results are consequently not as robust as for those that are shown. While suggestive, these industry-specific results should be seen as an indication of areas that may be worth subsequent analysis and not as strong empirical findings.

The pattern of results suggests that positive backward spillovers within the primary sector occur within both agricultural and forestry and fishing industries. Despite the absence of a significant overall effect within the goods manufacturing sector, there is some evidence of backward spillovers in food processing, as well as in metal and equipment manufacturing and construction. There is also evidence of positive forward spillovers within some industries. Within manufacturing, estimates suggest positive forward spillovers from foreign suppliers in food processing, wood products and construction industries, and within the services sector, the effects arise within the construction services and retail industries. Own-industry (horizontal) spillovers are estimated to be positive for almost all industries, with the strongest effects for the mining and construction industries. In agricultural industries and wood processing, negative horizontal spillovers are estimated.

6. Summary and discussion

This paper examined whether productivity benefits accrue to domestic firms as a result of the increased presence of foreign-owned firms in the New Zealand economy. The analysis is carried out using a panel dataset of more than 200,000 firms each year spanning the years 2000–2010, making the sample comprehensive and representative of the New Zealand business population. The source of the data was the prototype Longitudinal Business Database administered by Statistics New Zealand.

The study distinguished horizontal, backward and forward spillovers. In contrast to the majority of studies in the literature that cover only the manufacturing sector, our dataset covers almost all business sectors in the New Zealand economy and therefore is able to capture both within-sector and across-sector spillovers. The study also examined if firm size and sectors matter.

Overall, the evidence for productive spillovers from foreign direct investment (FDI) is weak – many estimates are not statistically significant, and where they are, the magnitude of estimated effects is small. It is worth emphasising that the overall impact of FDI on the New Zealand economy is substantial, even in the absence of spillovers. As shown in Table 2, foreign-owned firms account for around a quarter of total employment in New Zealand and almost 40% of sales and value added. They are significantly larger than domestic firms, in terms of both employment and output, and have labour productivity that is almost twice as high as that of domestic firms. Foreign-owned firms clearly make a significant contribution to the economy.

By definition, domestic firms are over-represented in industries where FDI penetration is relatively low. The average domestic firm is in an industry where around 18% of output is produced by foreign firms. Domestic firms are also exposed to foreign firms through supply chain relationships, with 15% of their supplying industries foreign owned and 27% of the industries to which they supply output (Table 3).

We identify the impact of foreign penetration by examining within-industry variation in foreign penetration over the period 2000–2010 and use regression analysis to identify the contribution of these changes to firm-level productivity growth. On average, domestic firms' exposure to FDI within their own industry was little changed during the study period, with 0.12% more of output produced by foreign firms in 2010 than was the case in 2000. There was, however, considerable variation across industries, with large declines in Accommodation and Food Services (-9.7% of output), Wholesale Trade (-5.3%) and Financial and Insurance Services (-5.3%) and sizeable increases in Mining (17.8%), Electricity, Gas, Water and Waste Services (12.0%) and Information Media and Telecommunications (8.3%).

Our main results are shown in the first column of Table 5. The estimated impacts of own-industry foreign penetration (horizontal spillovers) and of penetration within supplying industries (forward spillovers) is not statistically significant. There is a significant positive impact of foreign penetration in downstream (customer) industries on domestic firm productivity, implying positive backward spillovers. An increase in downstream foreign penetration equivalent to 1% of industry output is estimated to increase domestic firm productivity by 0.86%. The positive impact is not caused by foreign firms driving less-productive domestic firms out of business. The impact of changing foreign

penetration on firm survival is very small (Table 6). There was little change in downstream FDI penetration during the study period (a slight decline), and therefore the backward spillover effects made little contribution to the actual productivity change recorded for all domestic firms in aggregate.

We find that positive backward spillovers occur primarily within smaller firms (fewer than 10 employees) and within the primary sector. The evidence does not support the suggestion that larger firms are better able to absorb new knowledge and technologies from foreign firms due to their size and sophistication and thus better 'absorptive capacity'. Instead, we hypothesise that positive backward spillovers may reflect the role of larger foreign firms in providing stable demand for the output of domestic firms or a more cost-effective means of connecting to international markets. Careful testing of this hypothesis remains a task for future research.

From the analysis by sector, we find some weak evidence of positive forward spillovers associated with the presence of foreign-owned suppliers within the Manufacturing and Services sectors. Industry-specific regressions not shown in the paper suggest that these effects are concentrated in the construction and retail industries. The industry-specific regressions alone are not, however, definitive. Any further statistical analysis would usefully be complemented by a more in-depth analysis of industry functioning.

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Appendix

Appendix Table 1: Key variables and sources

Variable acronym	Variable name	Data sources
Y	Value added (VA)	Taken mainly from AES-surveyed observations then supplemented with IR10 for administration data observations in AES, adjusted to constant 2011 Q1 dollars using the Producer Price Index for output. VA is the difference between firm output (sales) and intermediate consumption (IC).
K	Cost of capital services	Derived as the summation of depreciation, rent and lease, and cost of capital charge for owned assets, mainly from AES-surveyed observations then supplemented with IR10 for administration data observations in AES, adjusted to constant 2011 Q1 dollars using the Capital Goods Price Index.
L	Labour input	Employees plus working proprietors (see below) from the Linked Employee-Employer Data (LEED).
FOR	FDI firms	Constructed as a binary variable using a combination of data from LBF and IR4.
Dom	Domestic firms	Firms that have never received foreign investment during the study period.
Horizon (Hor)	Horizontal spillover variable	Constructed using data on foreign presence and sales. See text for formula.
Backward (Back)	Backward spillover variable	Constructed using data on foreign presence, sales and IO tables (Statistics New Zealand, 2012). See text for formula and definition.
Forward (For)	Forward spillover variable	Constructed using foreign presence, sales and IO tables (Statistics New Zealand, 2012). See text for formula and definition.
HHI	Herfindahl-Hirschman Index of market concentration	Constructed using data on firm and industry sales. It is defined as the sum of the squares of the market shares of all the firms within the industry. It can range from 0 to 1.0, moving from a huge number of very small firms to a single monopolistic producer. Increases in the Herfindahl-Hirschman index generally indicate a decrease in competition and an increase of market power, whereas decreases indicate the opposite.

Identifying working proprietors

Working proprietors are self-employed persons who were paid taxable income during the tax year (at any time). Working proprietors are identified from several sources within the LBD. In LEED, a working proprietor is assumed to be a person who (i) operates his or her own economic enterprise or engages independently in a profession or trade and (ii) receives income from self-employment from which tax is deducted. From tax data, there are five ways that people can earn self-employment income from a firm:

- As a sole trader working for themselves (using the IR3 individual income tax form – this is used for individuals who earn income that is not taxed at source).

- Paid withholding payments either by a firm they own or as an independent contractor (identified through the IR348 employer monthly schedule).
- Paid a PAYE tax-deducted salary by a firm they own (IR348).
- Paid a partnership income by a partnership they own (IR20 annual partnership tax form, which reports the distribution of income earned by partnerships to their partners, or the IR7 partnership income tax return).
- Paid a shareholder salary by a company they own (IR4S annual company tax return – this reports the distribution of income from companies to shareholders for work performed, known as shareholder-salaries).