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Productivity spillovers from multinational activity to indigenous firms in Ireland

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Abstract: As well as their direct effects on output and employment, the attraction of foreign direct investment is sometimes argued to provide further economic benefits through spillover effects that potentially increase the productivity performance of domestic firms. Empirical evidence on this has however tended to be mixed. This paper uses Irish firm-level data on both manufacturing and services firms to re-examine and update tests of intra-industry and intra-region spillovers and then extends the previous research by examining if spillovers are more likely to occur through supply chain linkages. We further test for the sensitivity of these vertical spillover effects to alternative supply chain measures. Overall, we find fairly limited evidence of a link between the presence of foreign-owned firms and the performance of domestic firms with considerable sensitivity of results to changes in specification. Important variation across sectors is identified, however, with more robust evidence of intra-industry spillovers on the productivity performance of firms in services. Examining forward and backward linkages through supply chains indicates some negative impacts from obtaining supplies from and supplying foreign-owned firms although these are mitigated for domestic firms which invest in R&D, which appears to increase the absorptive capacity of the firms to benefit from productivity spillovers.

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1. Introduction

The attraction of foreign direct investment has been a central plank of Irish economic policy for several decades and multinational enterprises make a considerable direct contribution to the Irish economy in the form of employment and exports. In the manufacturing sector, foreign-owned firms account for approximately fifteen per cent of firms and in the region of ninety percent of exports.[2] In addition to the direct contribution of these firms, policy initiatives to attract multinational firms in countries across the world have frequently been further justified on the grounds that multinationals may also provide an indirect contribution in the form of learning opportunities or technology transfer to domestic firms. Spillovers of this type from multinational enterprises (MNEs) could potentially increase the productivity performance of domestic firms and may work through several different channels such as demonstration effects, as domestic firms learn about new technologies and markets from the activities of multinationals, competition effects, and knowledge spillover effects through labour turnover. Even more direct spillover effect can arise from supply chain linkages between MNEs and local firms. Conversely, negative spillovers could also arise if multinationals crowd out domestic firms through direct competition or diversion of resources.

The presence and extent of spillovers could be affected by many factors such as the characteristics of the MNEs, regional factors and the absorptive capacity and technological gaps of the domestic firms. A number of papers find that even though spillovers may be present, there are substantial differences across domestic firms in their ability to absorb any positive demonstration or technological benefits. For example, Girma, Görg and Pisu (2008) find that the export status of domestic firms is an important factor in this regard. Other papers have found that absorptive capacity is a crucial element in determining if local firms can benefit from multinational presence (e.g Girma and Görg, 2007; Barrios, Görg and Strobl, 2005 and Girma and Görg, 2005, Barrios, Dimelis, Louri and Strobl, 2004). In addition to the potential for spillovers to the productivity performance of domestic firms, the presence of multinationals has also been shown to have impacts on firm survival (Görg and Strobl, 2001) and export participation (Kneller and Pisu, 2007) in some circumstances.

The question we examine in this paper is the extent to which there are productivity spillovers from multinationals to local firms in Ireland either because they're located in the same industry and in the same region or through supply chain channels. Internationally, these questions have been looked at across a range of countries and in general the evidence has been somewhat mixed as can be found in meta-analyses over different sample periods and sets of countries that have been carried out by Görg and Strobl (2001), McQuinn and Siedschlag (2013) and Demena and van Bergeijk (2017). Previous work on this issue in Ireland has tended to focus on horizontal spillovers in manufacturing and service sectors separately (e.g. Ruane and Ugur 2005, and Haller 2014). Tests of horizontal spillovers use measures of the presence of MNEs within a sector or region to examine if this has any effect on the performance of domestic firms within the same sector or same region. The findings in this regard for

[2] Based on CSO Census of Industrial Production 2012 data.

Irish data have shown a mix of positive and negative effects but generally the estimates have been statistically insignificant.

While evidence on horizontal spillovers is very mixed, more recent research on vertical spillovers (Javorcik, 2004; Javorcik and Spatareanu, 2009) suggests that supply chains are a better conduit for positive information and technology flows between multinationals and domestic firms. Measurement of linkages are a critical building block for the assessment of vertical spillovers and Barrios, Görg and Strobl (2011) argue that multinationals use more imported inputs and this should be controlled for in the measure of sector links. They allow for the input sourcing behaviour of multinationals to be different from that of domestic firms and, in doing so, they find positive and statistically significant spillovers via backward linkages and negative but statistically insignificant horizontal spillovers and via forward linkages. In further support of this argument, Javorcik and Spatareanu (2010) find evidence for Romanian firms that the sourcing behaviour of multinationals can vary depending on how far away the home country is (as this can affect the share of intermediates obtained locally relative to those sourced from the home country or via intra-firm trade) and by whether trade agreements make local sourcing cheaper than imports that would be subject to tariffs. Consistent with this, they identify spillovers from US and Canadian firms but not from European-owned multinationals. In an extensive meta-analysis, Havranek and Irsova (2011)
find that spillovers are more likely to be observed from multinationals coming from more distant countries with a small productivity advantage over local firms. Morgenroth et al. (2015) find that productivity spillovers from multinationals to indigenous firms in Vietnam varied across provinces and sectors. Using information on direct technology transfers from foreign-owned to indigenous firms in Vietnam, Newman et al. (2015) find evidence on both direct and indirect productivity spillovers via supply chain linkages.

We expand on previous work done on this topic in Ireland in a number of ways by looking at the impact on total factor productivity (TFP), rather than labour productivity and by using a richer set of measures of spillovers and of linkages across firms. The TFP estimates that we utilise are based on developments in productivity estimation by Berlingieri et al. (2017) and applied to Irish firm level data by Department of Finance (2018). Given that the degree to which spillovers occur is affected by many factors such as the characteristics of the MNEs, regional factors and the absorptive capacity and technological gaps of the domestic firms, we include a very rich set of firm characteristics to examine different potential routes for productivity spillovers to occur. This paper first re-examines and update the tests of the horizontal channel to examine if spillovers can be detected within sectors and to test if the strength of effects is significantly different between manufacturing and services firms (which have not been examined jointly before). Then, we build on the more recent international focus on vertical spillovers through supply chain linkages by testing for the existence of spillovers via forward and backward linkages (i.e. the supply chain channel). We further test the sensitivity of these measures to measurement effects by comparing the impact of using Irish Input-Output tables, broadly based on the methodology of Javorcik (2004), to results based on alternative supply chain measures.

Overall, our findings are that there is limited evidence of a link between the presence of foreign-owned firms in the same industry and the performance of domestic firms with considerable sensitivity of results to changes in specification. Important variation across sectors is identified, however, with more robust evidence of intra-industry spillovers on the productivity performance of firms in services. Examining linkages through supply chains indicates some negative impacts from obtaining supplies from foreign-owned firms although this is mitigated for domestic firms in manufacturing which invest in R&D, which appears to increase the absorptive capacity of the firms to benefit from spillovers. Taken as a whole, the evidence provided by this analysis suggests that the presence of foreign direct investment is not sufficient to generate benefits to indigenous firms but that enabling production linkages between indigenous and multinational firms has the potential to be beneficial for aggregate productivity.

The paper is structured as follows: Section 2 describes the data sources used and Section 3 outlines the methodological approach. Section 4 presents the results. Section 5 concludes.

2. Data

This analysis primarily uses two data sets provided by Ireland's Central Statistics Office (CSO), one covering manufacturing firms - the Census of Industrial Production (CIP) - and the other covering services - the Annual Service Inquiry (ASI). These are supplemented with information from the Business Register to establish the firm's age based on its first year of registration.

The CIP covers all manufacturing firms with three or more persons engaged. The information collected with the CIP survey includes location of ownership, turnover, employment and gross earnings, changes in capital assets, purchases of goods and services other than capital items. A more detailed questionnaire including information on changes in intangible assets, as well as exports and imports, is sent to firms with over twenty employees. The ASI covers all firms that have their main activity in the distribution and services sector. The ASI coverage has two components with a census carried out to cover all firms with over twenty employees and a stratified random sample for firms with less than twenty employees. As with the CIP, a more detailed questionnaire is sent to the larger firms (those with 20 or more persons engaged).

For the variables needed for this analysis, the broadest coverage for CIP and ASI microdata data is for the period 2008-2014. Combining the CIP and ASI sources, our analysis is based on an unbalanced panel of annual data over the seven year period, which results in 62,340 observations. In order to estimate total factor productivity for the firms in these two data sources, a number of important steps had to be taken. The variables were converted in a format compatible with the OECD guidelines on the estimation of productivity from the MultiProd project (Berlingieri et al., 2017) which also generated a separate analysis of productivity distributions (Department of Finance, 2017).

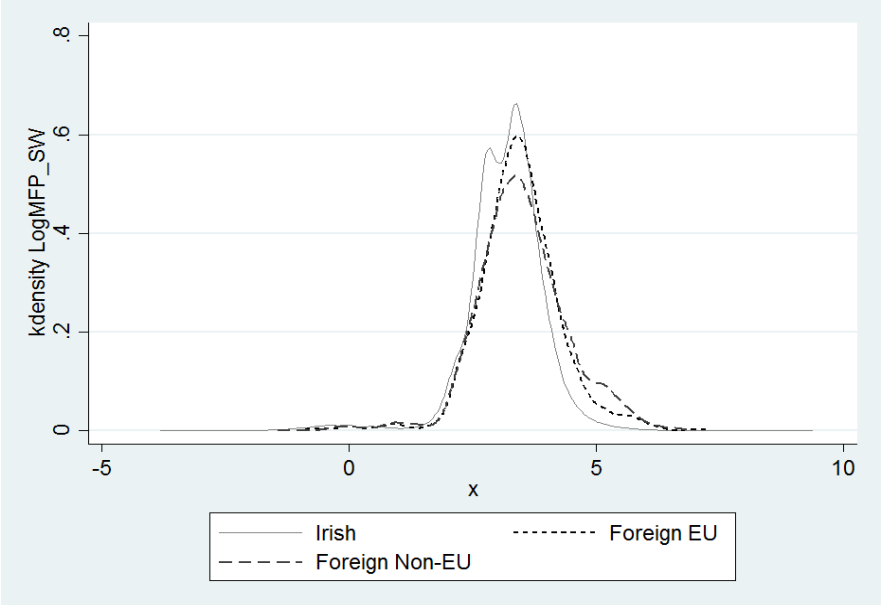
Of particular importance is that both original data sources include information on investments (changes in capital assets) but not on the firm capital stocks. As this is an important component of TFP estimation, capital stocks are estimated using the Perpetual Inventory Method (PIM) and utilising

data from prior to the start of our main sample. In addition, some transformations of the investment series had to be made as a result of a reclassification of R&D by the CSO from an expenditure item to an investment component from 2008. To ensure a harmonised treatment for our purposes, this necessitated adding the pre-2008 value of R&D spending by the enterprise to total capital additions and cross-checking for consistency against data from the Business Expenditure on R&D (BERD) which was used to adjust some values for capitalised R&D.

Detailed variables definitions and data sources are given in the Appendix A. Summary statistics for the firm characteristics are presented in Table 1. These summary statistics show that, as would be expected, estimated average TFP is lower for domestic firms than the average for foreign firms. This comparison provides the first indication of potential spillovers from foreign-owned firms to domestic firms. Productivity is widely dispersed and the standard deviation is rather larger for foreign than for domestic firms. The distributions of firm productivity are described in detail in Department of Finance (forthcoming). Figures B1-B12 show additional descriptive statistics of average productivity broken down by ownership, sector, and year as well as patterns of productivity dispersion. These statistics show that the productivity gap between Irish-owned and foreign-owned firms is higher for non-EU owned affiliates and it has increased over time. The figures also indicate an increasing productivity dispersion particularly for Irish-owned firms in manufacturing.

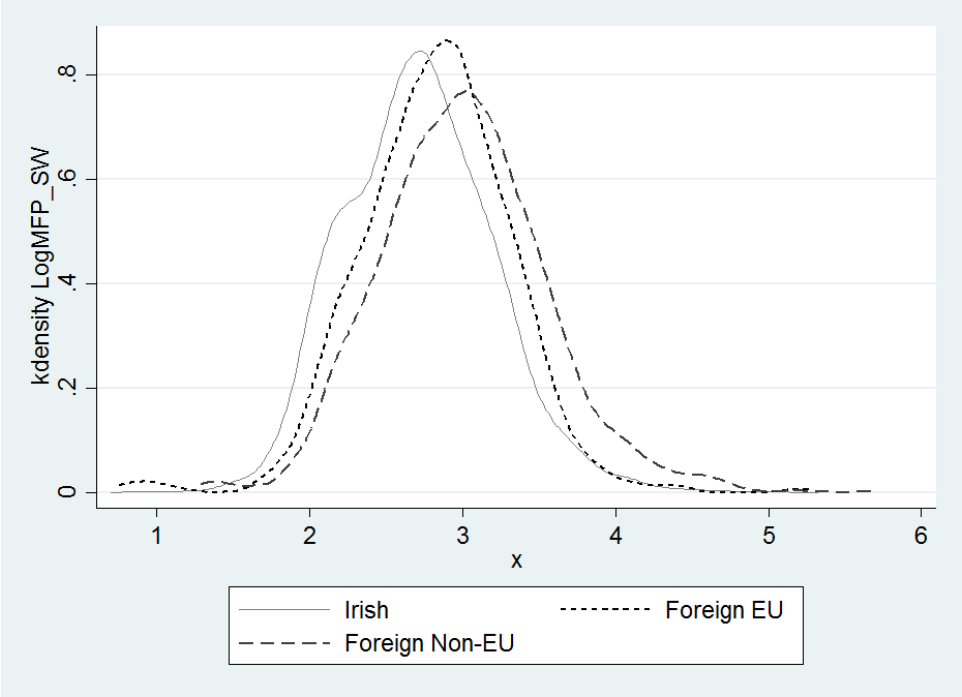
Figures 1-3 show the distributions of TFP for Irish-owned and foreign-owned firms broken down by EU-owned and non-EU owned affiliates. As shown below, foreign-owned firms appear to be more productive than Irish-owned firms. Among foreign-owned affiliates, non-EU owned affiliates appear to be more productive than EU-owned affiliates.

Figure 1: Productivity distribution by Irish, foreign EU and foreign non-EU firms



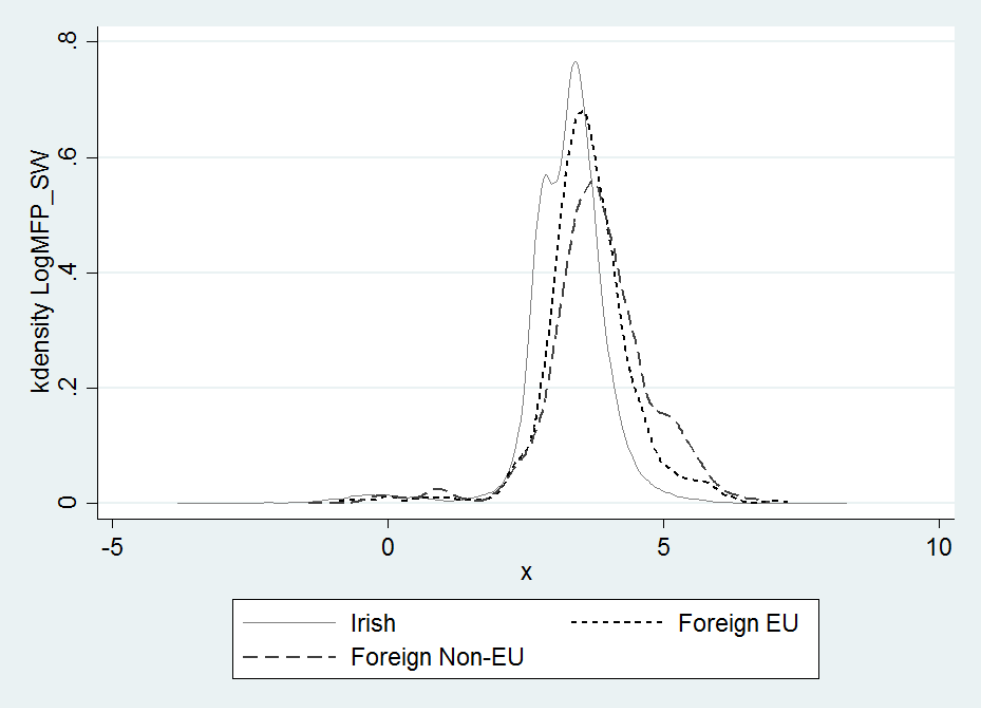
Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.

Figure 2: Productivity distribution by Irish, foreign EU and foreign non-EU firms, in manufacturing



Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.

Figure 3: Productivity distribution by Irish, foreign EU and foreign non-EU firms, in services



Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.

Table 1 also shows that capital, labour and intermediate inputs are all also on average higher for foreign than for domestic firms.

[Table 1 here]

Additional descriptive evidence on the foreign–ownership *premia* is provided in Table 2 showing the estimated productivity gap between foreign-owned firms and domestic firms by size classes.[3] The productivity of foreign-owned firms appears to be significantly higher relative to the productivity of indigenous firms within the same size class with the exception of EU-owned large firms. With the exception of the group of micro firms, the foreign-ownership *premia* appear to be higher for non-EU owned affiliates relative to EU-owned affiliates. The productivity gap[4] relative to domestic firms in the same size class is the highest for non-EU owned affiliates micro firms in services (122%) and the lowest for EU-owed affiliates in the group of medium-sized EU-owned affiliates in manufacturing (4.6%).

[Table 2 here]

Table 3 shows comparisons of the average intensity of horizontal and vertical linkages with intra-industry and intra-region estimates being the highest while those weighted by input-output linkages are more diluted.

[Table 3 here]

Table 4 shows the correlation coefficients of the firm variables. Higher productivity is strongly associated with higher inputs, particularly of intermediates, and higher gross output as expected. Productivity levels are also positively correlated with firm age, wages per employee and importer status. No significant link in the average correlations is found for export status or R&D activity while sector concentration (HH Index) has a negative relationship with average productivity.[5]

[Table 4 here]

3. Empirical Methodology

This section outlines the methodology used to estimate the extent of spillovers from multinationals on Irish domestic firms. In order to accurately capture any productivity effect, the first stage of the overall estimation procedure was to measure TFP of the domestic firms. This was done using a Solow-residual measure of TFP based on the Irish firm-level data and applying median elasticities from the sectoral factor shares in the cross-country sample of the OECD MultiProd project (see Berlingieri et

[3] The foreign-ownership *premia* are obtained by regressing firm-level productivity on indicator variables for EU-owned and non-EU owned affiliates.
[4] The productivity gap is obtained as [exp(coefficient)-1]*100.
[5] It is worth noting that the analysis by the Department of Finance (2018) finds that the degree of sector concentration in Ireland has increased over time in both manufacturing and services. Among the OECD countries included in the analysis in 2011, Ireland's degree of concentration was the highest in services and the second highest in manufacturing. The negative correlation between sector concentration and average productivity uncovered above suggests that enabling more competition in services as well as manufacturing could be beneficial for aggregate productivity.

al., 2017 and Department of Finance 2018, for details).[6] The second stage was then to use these estimates of firm TFP as the dependant variable and examine to what extent (if any) they were affected by measures of multinational activity, in either the same sector, region or supply chain as the domestic firm.

3.1 Baseline Model Specification

The baseline model specification to estimate productivity spillovers from foreign-owned firms to domestic firms is as follows:

$$\ln TFP^{d}_{ijrt} = \beta_0 + \beta_1 HOR_{j,t-k} + \beta_2 HOR_{r,t-k} + \beta_3 FOR_{j,t-k} + \beta_4 BAC_{j,t-k} + \beta_5 Z^{d}_{ijrt} + \beta_6 \Delta SALES_{jt} + \beta_7 HHI_{jt} + \\ + \mu_i + \lambda_j + \rho_r + \tau_t + \varepsilon_{it} \quad (1)$$

The dependent variable, TFP^{d}_{ijrt} is the total factor productivity of domestic firm *i,* in industry *j*, region *r*, at time *t*.

The key explanatory variables are four main channels through which spillovers might occur:

- Horizontal intra-industry channel: $\mathbf{HOR}_{\mathrm{j,t-k}} = \mathbf{Y}^{\mathrm{f}}_{\mathrm{j,t-k}} / \mathbf{Y}_{\mathrm{j,t-k}}$: the share of foreign affiliates' employment[7] in total employment in industry j, at time t-k (k is the time lag= 0,…,T)
- Horizontal intra-region channel: $\mathbf{HOR}_{\mathrm{r,t-k}} = \mathbf{Y}^{\mathrm{f}}_{\mathrm{r,t-k}} / \mathbf{Y}_{\mathrm{r,t-k}}$: the share of foreign affiliates' employment in total employment in region r, at time t-k (k is the time lag = 0,…,T)
- Forward linkages: $\mathbf{FOR}_{\mathrm{j,t-k}} = \sum_{\mathrm{l}} \delta_{\mathrm{lj}} \mathbf{HOR}_{\mathrm{l,t-k}}, \mathrm{l} \neq \mathbf{j}$; δ_{lj} : the share of inputs of industry j purchased from industry l;
- Backward linkages: $\mathbf{BAC}_{\mathrm{j,t-k}} = \sum_{\mathrm{l}} \gamma_{\mathrm{lj}} \mathbf{HOR}_{\mathrm{l,t-k}}, \mathrm{l} \neq \mathbf{j}$; γ_{lj} : the share of output of industry j supplied to industry l;

[6] The estimates of TFP based on the Solow index at firm level were obtained as part of the *MultiProd* project. We thank Brendan O'Connor, Javier Papa, and Luke Rehill for sharing with us these estimates. While TFP measures based on the Solow-residual are obtained under the assumption of constant returns to scale, it has been shown that these compare relatively well to TFP estimates assuming increasing returns to scale (see Van Biesebroeck 2007 and Berlingieri et al. 2017). Additional estimates of productivity spillovers using labour productivity for indigenous firms as dependent variable are qualitatively similar with those reported in this paper. These results are available from the authors upon request. Furthermore, given that productivity and input choices could be correlated (see for example Van Beveren (2012), additional TFP measures based on a production function approach were estimated using the methodology by Wooldridge (2009). However, these estimates appeared to be affected by measurement error for firms at the bottom of the productivity distribution, particularly for firms in services.

[7] In previous studies, foreign presence has been also measured as the share of foreign-owned firms in output or capital. In a meta-analysis of the productivity spillovers literature, Görg and Strobl (2001) find that estimates using employment or output shares appear to be similar, while using capital shares leads to lower estimates of productivity spillovers. Our choice for employment-based measures of foreign presence is motivated by the fact that these are less likely to be distorted by transfer pricing.

In addition to average spillover effects from all foreign-owned firms, we distinguish spillovers linked to affiliates owned by EU multinationals and by non-EU multinationals. To obtain these, the shares of employment in affiliates owned by EU and by non-EU multinationals, respectively in total industry/region employment are used.

Following from Barrios et al. (2011), we allow the input sourcing behaviour of foreign-owned firms to be specific to the home country of the parent company. To this purpose we use the available information from the latest release of the World Input-Output (WIOT) data base.[8]

Z_{ijrt}^{d} captures a range of firm characteristics for domestic firms. These include the age (taken in logs) and size of the firm[9] as well as its import and export status (both included as categorical variables). To capture the absorptive capacity of the firm to benefit from spillovers, we also include the R&D investment per employee (taken in logs) and a proxy for human capital (wages per employee taken in logs).

At the industry level, $\Delta SALES_{jt}$ measures sales growth to control for industry-specific demand shocks which might affect the measures of spillovers. HHI_{jt} is the Herfindahl-Hirschman index in industry j at time t which controls for within industry competition. For each industry j, the HHI index is computed as follows:

$$HHI_{jt} = \sum_{i}^{N} s_{ijt}^{2} \tag{2}$$

s_{ijt}^{2} denotes the market share of firm i at time t in industry j.

Firm, industry, region and time fixed effects are included in all specifications to control for unobserved characteristics. Endogeneity could also remain a concern, as foreign firms may be systematically attracted to particular industries or regions due to their productivity performance. To address this concern, in our approach, we use lagged variables for each of the spillover channel.[10] Self-selection of foreign firms into high productivity industries is also avoided by restricting the analysed sample to domestic firms.[11] Additionally, all standard errors are clustered at the industry and year level to control for their possible correlation.

[8] The latest 2016 release includes input-output tables for 43 countries and a model for the rest of the world over the period 2000-2014. http://www.wiod.org/home. Details about using the WIOT data base are provided by Timmer et al. (2015).

[9] Size is controlled for using the following four size classes: micro (1-9 employees); small (10-49 employees); medium (50-249 employees); large (250 and more employees). The reference category in regressions is micro firms.

[10] This approach has been used among others by Haskel, Pereira and Slaughter (2007), and Barrios, Görg, and Strobl (2011).

[11] See for example, Javorcik and Spatareanu (2008) and Barrios Görg, and Strobl (2011).

3.2 Testing for the Role of Absorptive Capacity

To test for the role of absorptive capacity of domestic firms in productivity spillovers, we add to the model described by Eq. (1) variables obtained by interacting the spillover measures with firms' investment in R&D intensity that captures the ability of firms to internalise knowledge spillovers. The augmented econometric model is as follows:

$$\ln TFP^{d}_{ijrt} = \beta_0 + \beta_1 HOR_{j,t-k} + \beta_2 HOR_{r,t-k} + \beta_3 FOR_{j,t-k} + \beta_4 BAC_{j,t-k} + \beta_5 RD_{ijrt} * HOR_{j,t-k} + \beta_6 RD_{ijrt} * HOR_{r,t-k} +$$
$$+ \beta_7 RD_{ijrt} * FOR_{j,t-k} + \beta_8 RD_{ijrt} * BAC_{j,t-k} + \beta_9 Z^{d}_{ijrt} + \beta_{10} \Delta SALES_{jt} + \beta_{11} HHI_{jt} + \mu_i + \lambda_j + \rho_r + \tau_t + \varepsilon_{it} \quad (3)$$

On the basis of previous evidence (see for example Griffith et al. 2004), we expect positive values for the parameters $\beta_5, \beta_6, \beta_7, \beta_8$ indicating larger productivity spillovers for domestic firms investing in R&D relative to those without investment in R&D.

4. FDI Spillover Estimates

This section presents our estimates of the extent to which the productivity of domestic Irish firms can be found to be affected by the presence of multinationals and if these effects differ across the various channels through which linkages could operate – intra-industry, intra-region, forward and backward supply connections. As discussed in the previous sections, an important factor in the measurement of the connections along the supply chain relates to the choice of input-output tables used. We present a range of results using different measures of exposure of domestic firms to potential spillovers from multinationals. The first of these is the standard approach initially proposed by Javorcik (2004) by using Irish input-output tables to capture the strength of forward and backward links across industries. We then adopt the more recent Barrios, Görg and Strobl (2011) method and re-estimate the strength of the supply linkages using input-output tables for the home country of each multinational, thereby allowing the sourcing behaviour of the multinationals to vary by nationality rather than restricting them to the same pattern of purchasing and sales as domestic Irish firms.

We further distinguish between spillover strength coming from different types of multinational, specifically depending on whether they have EU or non-EU ultimate owners. Our final set of specifications examine if the absorptive capacity of the domestic firm, proxied by its R&D activity, affects how engagement with multinationals affects its performance.

The estimates of baseline specifications for a range of spillover channels are presented in Table 5, which examines the effects of the potential spillover channels on the productivity (TFP) of all domestic firms and how sensitive they are to different combinations being included. Beginning with intra-industry spillovers from the presence of multinationals within the same sector, we find little evidence of an effect on the productivity of domestic firms. There are marginally significant negative coefficients

when the measure is included alone or with regional presence (columns 1 and 2 respectively), but these are not robust to the inclusion of additional channels of interaction with multinationals and are insignificant in the subsequent columns. The next key finding is that there is no statistically significant evidence of multinational presence (employment share of foreign firms) in a region having any effect on the productivity of Irish firms in the same locality; the coefficients on horizontal regional spillovers are all indistinguishable from zero.

[Table 5 about here]

We find more evidence of effects on domestic productivity coming from supply linkage channels with on average domestic firms experiencing a negative productivity spillover (i.e. coming through the channel of supplies from foreign-owned firms). The measure of forward linkages suggests that domestic firms in industries which purchase a larger share of their inputs from industries with a larger share of multinationals tend to have systematically lower productivity levels than firms with more domestically sourced inputs. Again this effect is robust to the inclusion of a range of other controls. For example, the estimate of forward spillovers in column 5 implies that a 10 percentage point increase in foreign presence is associated with a 32% decrease of the productivity of domestic firms in downstream sectors. Merlevede and Schoors (2009) suggest that forward spillovers can be negative either if the inputs from multinationals are more expensive than domestic inputs or if the purchased inputs are less adapted to the requirements of the domestic purchasers which could weigh against the expected higher technological content of goods produced by multinationals. We also find an average negative effect of backward linkages with the productivity of all domestic firms implying that selling to foreign-owned firms has less of a technology transfer effect than anticipated. For example the estimate for backward spillovers in column 5 implies that a 10-percentage point increase in foreign presence is associated with a 79% decrease of the productivity of domestic firms in upstream sectors. However, we will see in further robustness tests that these findings of negative forward and backward spillovers are sensitive to the measures used and vary across sectors.

The first measures of forward and backward linkages are based on the standard approach using the Irish input-output tables as discussed above. To focus more closely on domestic supply linkages, the next set of measures use the same input-output tables but exclude imports so as to more accurately capture local sourcing behaviour. Although the coefficients remain negative and significant for both forward and backward linkages when we make this adjustment to the linkage measure, the size of the estimated effects declines considerably indicating that differences in measurement approach are an important consideration in the identification of spillover channels. To illustrate this case, the estimate for forward spillovers based on domestically sourced inputs only in column 9 implies that a 10-percentage point increase in foreign presence is associated with an average 18% decrease of the productivity of domestic firms in downstream sectors.

Making a further adjustment to the linkage measure reduces the estimated coefficients still further. Based on the argument of Barrios, Görg and Ströbl (2011) that the formulation of supply chain linkages based on domestic input-output tables may be problematic if multinational firms have different purchasing patterns than domestic firms, the “Backward home” and “Backward home - no imports”

variables substitute the input-output weights from the multinationals home country for the Irish input-output tables used in the previous measures. Allowing for the input sourcing behaviour of foreign-owned firms to be specific to the home country of their parent company in this way, we find that on average the productivity of all domestic firms continues to be linked negatively to supplies by domestic firms to foreign-owned firms but to a much smaller degree. For example the estimate of backward spillovers in column 11 implies that a 10-percentage point increase in foreign presence is associated with 12.8% decrease in the productivity of domestic firms in upstream sectors.

Turning to some of the additional control variables, we find that there is little change in the coefficients on the spillover measures across the specifications but a number of the characteristics included have an impact on firm productivity. In particular, we find that firm age and wage per employee are both consistently associated with higher productivity in line with our expectations. Overall sector growth is generally insignificant but does have a slight positive impact at the 10 per cent significance level in the specifications with linkages measured using the multinational home country input-output tables, potentially suggesting some offsetting correlation between sector growth and linkages when both were measured using domestic sources.

The export and import status of the firm do not show any link with productivity across the different specifications, which is somewhat surprising given the substantial literature linking trade status with productivity (see Love and Roper, 2015, for an overview). This result is perhaps supportive of theories of selection into exporting rather than those suggesting learning links between international activities and productivity, although Girma, Greenaway and Kneller (2004) find evidence of both channels. Another somewhat surprising result in Table 5 is the insignificance of the effect of being R&D active on productivity. We will see in later specifications however that investing in R&D can be a factor in the ability to benefit from linkages with multinationals when it is interacted with the spillover channels. Relative to the base category of micro firms (fewer than ten employees), firms in each of the larger size classes show high productivity levels. The difference between medium-sized and large firms is relatively modest in this regard.

The next two tables repeat the specifications of Table 5 but spilt the sample into manufacturing firms (Table 6) and services firms (Table 7). The positive correlations with productivity between firm age, wages per employee and size are significant for both sets of firms, although the impact of size is somewhat larger for services firms compared to manufacturing. The most notable difference in the effects of firm characteristics when splitting the sample in this way is the opposite effects of being an importer on productivity which cancelled out in the pooled sample of all firms – now we find that the effect of importing is negative for manufacturing firms and positive for services firms. Industry concentration (measured using the HH Index) also shows different effects with greater concentration associated with higher productivity in services firms but no effect being evident for manufacturing.

[Table 6 about here]

[Table 7 about here]

In terms of the effects of exposure or interaction with multinationals, a number of differing effects appear between manufacturing and services firms that were not apparent in the previous pooled specification. The marginal effect of horizontal spillovers is found to be the same in manufacturing as we observed in the overall sample. However, we now find a significantly positive effect of multinational presence in the same sector for services firms. A rationale for this difference in effect could be that ways in which to adapt or improve productivity in services delivery are more observable to others within the same industry without direct technology transfer needing to occur. For example the estimate of intra-industry spillovers in services in column 5 in Table 7 implies that a 10-percentage point increase in foreign presence is associated with a 2% increase of the productivity of domestic firm in the same industry. There is little evidence for spillovers, either positive or negative, through any of the channels for manufacturing firms with the exception of some negative backward linkage effects. Supply chain measures of linkages also show little impact on services above the direct effect of the horizontal spillovers from multinational presence in the same sector.

Our initial sets of estimates therefore show some evidence of positive horizontal industry spillovers for firms in services. There is also some indication of negative effects of backward linkages for firms in both manufacturing and services sectors when Irish measures of supply integration are used but these largely disappear if we assume a different sourcing behaviour for multinationals and replace our measure of linkages with one based on the home country input-output links of the multinationals. The important change in the significance of the overall spillover effect when we allow for differences in sourcing behaviour for multinationals compared to domestic firms then raises the supplementary question as to whether spillover effects to domestic firms might also differ (either in direction or magnitude) depending on the ownership of the multinational. To investigate this point, we separate the multinationals into two broad groups – those owned by EU parent firms and those with non-EU parents. As access to the EU market is one of the key attractions of locating in Ireland for non-EU firms, they may differ in many regards to EU-owned multinationals that chose to locate an affiliate in Ireland (Davies, Siedschlag and Studnicka, 2016).

[Table 8 about here]

The next set of tables investigate whether there are differences between the two groups of multinationals in terms of technology transfer to domestic firms. Table 8 presents the results for all firms and shows negative intra-industry spillovers from non-EU owned competitors in the same industry. The estimate for intra-industry spillover in column 4 indicates that a 10 percentage point increase in the presence of non-EU owned affiliates is associated with a decrease of the productivity of domestic firms in the same industry by 1.4%. No other significant evidence of horizontal spillovers from either EU-owned or non-EU owned affiliates is found. Further, there is no significant evidence of spillovers via supply chain linkages from non-EU-owned multinationals. Forward and backward linkages with EU multinationals however show significant signs of negative spillover effects. This effect differs across firm types and, breaking the sample down into manufacturing and services in Tables 9 and 10 respectively, we find that any negative impact is driven by the experience of firms in manufacturing and their links to EU-owned multinationals. In contrast, domestic firms in services

appear to benefit from supplying EU-owned affiliates. As in the baseline results, services firms show more evidence of overall intra-industry spillovers having a positive effect on productivity and that this is coming largely from EU-owned multinationals. The estimates suggest that a 10-percenatge point increase in the presence of EU-owned affiliates in services is associated with a 2% increase in the productivity of domestic firms in the same service industry.

[Table 9 about here]

[Table 10 about here]

The extent to which spillovers affect firm productivity depends not just on exposure of domestic firms to more advanced technologies or business processes in multinationals but also on the capacity of the domestic firm to adopt them. Previous studies (see for example Blalock and Gertler 2008; Jude 2016) suggest that accounting for absorptive capacity is a crucial factor in understanding how technology may be transferred. One potential proxy for this absorptive capacity of domestic firms is their R&D intensity. In the remaining specifications, we investigate the extent to which this affects our previous results. In order to do this, we interact the R&D investment per employee of the domestic firms with the different spillover channels to examine if the effects of multinational presence or linkages have differing effects on domestic firms depending on their levels of investment in R&D. Table 11 presents the results for the interactions pooling all multinationals and Table 12 examines if the effects differ by the nationality of foreign ownership.

[Table 11 about here]

Intra-industry spillovers, primarily in the services sector, are stronger for firms with higher R&D investment intensity. When this effect is broken down by multinational ownership in Table 12, the result appears to be driven by EU-owned multinationals and the effect is significant only for services firms. Interactions between both backward and forward linkages and R&D per employee show positive relationships with productivity in Table 11 when the home country measures of the extent of supply linkages are used. In the case of backward linkages, we find that although the overall effect of spillovers is negative, higher absorptive capacity of the domestic firms can counteract this to some extent. This suggests that positive spillover effects are not transmitted passively and that any benefits from multinational presence or linkages will be felt only by firms that are in a position to take on board the opportunities for technology acquisition. For other firms, some competitive crowding out may dominate. This may help explain the sensitivity of the overall results, as the intensity of the linkages are measured at a sectoral level which may mask a certain amount of heterogeneity in the intensity of individual firms' linkages with multinationals and capacity to benefit from different linkage channels.

5. Summary and Policy Implications

This paper re-examines the question of whether and to what extent multinationals can affect the performance of domestic firms. Using productivity estimates for Irish firms we find that, on average, there is limited evidence of a link between the presence of foreign-owned firms in the same industry and the performance of domestic firms. There is however important variation across sectors and, when manufacturing and service firms are analysed separately, the estimates indicate some fairly robust evidence of intra-industry productivity spillovers on domestic firms in services. We find no evidence of intra-region productivity spillovers, with presence within the same sector being more important as a learning channel than closeness in terms of location for services firms.

While the presence of multinationals in an industry or region has been the traditional method to capture spillovers to domestic firms, supply chain links between domestic and foreign-owned firms could be a more important source of technology transfer. We therefore examine if there is any evidence of productivity spillovers to domestic firms from forward and backward linkages with foreign-owned affiliates. Looking across all firms, the productivity of domestic firms in upstream industries is negatively linked to purchases by foreign-owned firms, in particular, among manufacturing firms. In order to examine the robustness of linkage measures, we use alternative assumptions on the input sourcing behaviour of multinationals. Specifically, we generate measures of supply chain linkages based on Irish input-output tables, as well as those based on the input-output tables of the home country of the parent company of foreign affiliates to consider their input sourcing and supply patterns. In doing so, we find that the above mentioned negative effects either disappear or reduced greatly.

In order to decompose the potential learning channels further, we allow for different effects for affiliates owned by EU and non-EU multinationals. In doing this, we find that the average productivity of domestic firms is negatively linked to the presence of non-EU based multinationals in the same industry. Again looking at manufacturing and services separately, the estimates indicate the productivity of domestic firms in manufacturing is negatively linked with the presence of both EU and non-EU based multinationals in the same industry. In contrast, the productivity of domestic firms in services is positively linked to the presence of EU-based multinationals in the same service industry. While the productivity of domestic firms in manufacturing is negatively linked to supplies by affiliates owned by non-EU multinationals, the productivity of domestic firms in services is enhanced by purchases from EU-based multinationals.

Finally, this paper shows that R&D investment, standing for the absorptive capacity of firms, is an important conduit of productivity spillovers. Domestic firms investing in R&D benefit from knowledge spillovers from foreign-owned competitors in the same service industry more than those without investment in R&D. Moreover, domestic firms which invest in R&D appear to be successful in internalising spillovers from supplies by foreign-owned firms, while domestic firms in services which invest in R&D appear to benefit more from supplying foreign-owned firms. Across the two different sectors, the productivity of domestic firms in services investing in R&D is more responsive to spillovers

via purchases by EU-multinationals, while this is also the case for domestic firms in manufacturing investing in R&D which supply non-EU multinationals.

The evidence provided by this analysis indicates that attracting foreign direct investment is not sufficient to generate benefits to indigenous firms via involuntary knowledge spillovers and demonstration effects. Since productivity spillovers are not automatic, enhancing the absorptive capacity of indigenous firms is key in order to ensure they can benefit from advanced knowledge and technologies associated with multinational firms.

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Table 1: Descriptive Statistics by Firm Ownership

	All Firms		Irish-owned		Foreign-owned	
	Mean	Sd.Dev.	Mean	Sd.Dev.	Mean	Sd.Dev.
Ln MFP (Solow)	3.17	0.77	3.14	0.75	3.48	0.86
Ln Capital	14.91	1.57	14.71	1.44	16.49	1.63
Ln Labour	2.72	1.46	2.54	1.36	4.17	1.41
Ln Intermediates	13.61	2.09	13.32	1.92	15.86	2.01
Sector growth	-0.02	0.13	-0.03	0.13	0.00	0.15
Ln Age	2.55	0.89	2.53	0.89	2.75	0.84
HH Index	0.07	0.14	0.06	0.13	0.11	0.17
Exporter	0.20	0.40	0.16	0.37	0.53	0.50
Importer	0.15	0.36	0.12	0.33	0.39	0.49
Ln Wage per Employee	10.11	0.65	10.04	0.63	10.63	0.56
R&D active dummy	0.42	0.49	0.43	0.50	0.31	0.46
N	62,340		55,389		6,951	

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO).

Table 2: Foreign ownership *premia* – TFP (Solow residual)

	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW
	ALL	**Man.**	**Services**	**ALL**	**Man.**	**Services**	**ALL**	**Man.**	**Services**	**ALL**	**Mant.**	**Services**
Size	Micro	Micro	Micro	Small	Small	Small	Medium	Medium	Medium	Large	Large	Large
Foreign EU	0.671***	0.231***	0.734***	0.211***	0.0743***	0.240***	0.105***	0.0449***	0.128***	0.0240	0.227***	0.00201
	(0.0281)	(0.0646)	(0.0315)	(0.0120)	(0.0220)	(0.0140)	(0.0136)	(0.0161)	(0.0185)	(0.0255)	(0.0423)	(0.0338)
Foreign non-EU	0.663***	0.370***	0.798***	0.390***	0.159***	0.464***	0.188***	0.120***	0.215***	0.153***	0.242***	0.134***
	(0.0362)	(0.0547)	(0.0441)	(0.0125)	(0.0202)	(0.0151)	(0.0125)	(0.0138)	(0.0175)	(0.0271)	(0.0365)	(0.0382)
Constant	2.183***	2.231***	3.413***	2.198***	2.225***	3.557***	2.061***	2.109***	3.403***	2.087***	2.020***	3.591***
	(0.0405)	(0.0498)	(0.0369)	(0.0270)	(0.0354)	(0.0296)	(0.0408)	(0.0407)	(0.0548)	(0.154)	(0.120)	(0.0455)
N	27211	3861	20820	30663	6019	22582	10455	2941	7103	2304	847	1338

Notes: Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. All regressions include industry, region and time fixed effects. Standard errors in parentheses.

* p<0.1, ** p<0.05, *** p<0.01.

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO).

Table 3: Spillover Descriptive Statistics		
	mean	sd
Intra-industry	0.482	0.270
Intra-region	0.319	0.157
Forward link	0.030	0.017
Backward link	0.029	0.039
Forward no imports	0.046	0.022
Backward no imports	0.045	0.059
Backward Home	0.082	0.074
Backward no imports Home	0.096	0.086
Intra-industry_EU	0.159	0.115
Intra-industry_nonEU	0.329	0.261
Intra-region_EU	0.118	0.115
Intra-region_nonEU	0.204	0.112
Backward_EU	0.018	0.021
Backward_nonEU	0.024	0.034
Forward_EU	0.017	0.011
Forward_nonEU	0.025	0.013
Forward no imports_EU	0.025	0.015
Forward no imports_nonEU	0.039	0.021
Backward no imports_EU	0.026	0.030
Backward no imports_nonEU	0.038	0.052

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO).

Table 4 Correlation Matrix

	Ln MFP (Solow)	Ln Gross Output	Ln Capital	Ln Labour	Ln Intermediates	Sector growth	Ln Age	HH Index	Exporter	Importer	Ln Wage/Emp	R&D active
Ln MFP (Solow)	1											
Ln Gross Output	0.267***	1										
Ln Capital	0.0613***	0.798***	1									
Ln Labour	0.0307***	0.843***	0.883***	1								
Ln Intermediates	0.174***	0.946***	0.737***	0.764***	1							
Sector growth	0.152***	0.0314***	0.0592***	0.0161***	0.0218***	1						
Ln Age	0.0110**	0.286***	0.200***	0.262***	0.273***	0.0148***	1					
HH Index	-0.0311***	0.049***	0.035***	0.0412***	0.0281***	0.209***	0.0116**	1				
Exporter	0.0035	0.438***	0.284***	0.367***	0.405***	0.0231***	0.207***	0.149***	1			
Importer	0.124***	0.405***	0.372***	0.368***	0.401***	0.0430***	0.166***	0.0134***	0.408***	1		
Ln Wage/Emp	0.287***	0.450***	0.269***	0.239***	0.369***	0.0691***	0.148***	0.179***	0.301***	0.205***	1	
R&D active	-0.00519	-0.269***	-0.307***	-0.361***	-0.251***	0.116***	-0.106***	0.0711***	-0.073***	-0.218***	-0.024***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO).

Table 5: Baseline spillover results – All firms

All firms	(1) LogMFP_SW	(2) LogMFP_SW	(3) LogMFP_SW	(4) LogMFP_SW	(5) LogMFP_SW	(6) LogMFP_SW	(7) LogMFP_SW	(8) LogMFP_SW	(9) LogMFP_SW	(10) LogMFP_SW	(11) LogMFP_SW
Intra-industry	-0.108*	-0.108*		-0.0734	-0.0731		-0.116	-0.0705	-0.0702	-0.0901	-0.0898
	(0.0558)	(0.0558)		(0.0756)	(0.0756)		(0.0758)	(0.0831)	(0.0831)	(0.0843)	(0.0843)
Intra-region		-0.0264			-0.0152		-0.0188		-0.0145		-0.0161
		(0.0363)			(0.0362)		(0.0362)		(0.0364)		(0.0365)
Forward link			-3.330***	-3.208***	-3.202***			-2.760***	-2.754***		
			(0.832)	(0.841)	(0.843)			(0.806)	(0.806)		
Backward link			-7.923***	-7.936***	-7.934***						
			(1.734)	(1.780)	(1.781)						
Forward no imports						-2.463***	-2.367***			-1.870***	-1.865***
						(0.711)	(0.718)			(0.634)	(0.634)
Backward no imports						-5.816***	-5.969***				
						(1.547)	(1.576)				
Backward Home								-1.223*	-1.221*		
								(0.718)	(0.719)		
Backward_no imp_H										-1.279**	-1.277**
										(0.600)	(0.601)
Industry growth	0.0291	0.0292	0.0152	0.0173	0.0174	0.0144	0.0178	0.0387*	0.0387*	0.0374*	0.0374*
	(0.0227)	(0.0226)	(0.0198)	(0.0198)	(0.0198)	(0.0207)	(0.0207)	(0.0202)	(0.0202)	(0.0206)	(0.0206)
Ln Age	0.0403***	0.0404***	0.0453***	0.0462***	0.0463***	0.0427***	0.0445***	0.0478***	0.0479***	0.0470***	0.0470***
	(0.0151)	(0.0150)	(0.0149)	(0.0150)	(0.0150)	(0.0149)	(0.0150)	(0.0158)	(0.0158)	(0.0158)	(0.0158)
HHI (industry)	-0.0499	-0.0499	0.0200	0.0201	0.0201	0.01000	0.0116	-0.0169	-0.0169	-0.0190	-0.0190
	(0.0366)	(0.0366)	(0.0314)	(0.0312)	(0.0313)	(0.0314)	(0.0310)	(0.0353)	(0.0353)	(0.0352)	(0.0353)
Exporter	0.00508	0.00509	0.00394	0.00393	0.00393	0.00381	0.00379	0.00342	0.00342	0.00375	0.00376
	(0.00794)	(0.00794)	(0.00798)	(0.00799)	(0.00799)	(0.00796)	(0.00798)	(0.00796)	(0.00797)	(0.00796)	(0.00796)
Importer	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0110	0.0120	0.0120	0.0120	0.0120
	(0.00825)	(0.00825)	(0.00808)	(0.00807)	(0.00806)	(0.00808)	(0.00806)	(0.00796)	(0.00796)	(0.00798)	(0.00798)
Ln Wage	0.223***	0.223***	0.226***	0.226***	0.226***	0.226***	0.226***	0.226***	0.226***	0.226***	0.226***
	(0.0276)	(0.0276)	(0.0276)	(0.0276)	(0.0276)	(0.0277)	(0.0277)	(0.0277)	(0.0277)	(0.0278)	(0.0278)
R&D (1/0)	-0.000296	-0.000273	-0.00356	-0.00342	-0.00340	-0.00363	-0.00339	-0.00296	-0.00295	-0.00304	-0.00303
	(0.00447)	(0.00447)	(0.00452)	(0.00451)	(0.00451)	(0.00451)	(0.00450)	(0.00444)	(0.00444)	(0.00443)	(0.00443)
Small	0.0722***	0.0722***	0.0700***	0.0695***	0.0695***	0.0704***	0.0696***	0.0708***	0.0708***	0.0705***	0.0705***
	(0.0195)	(0.0195)	(0.0192)	(0.0193)	(0.0193)	(0.0192)	(0.0193)	(0.0191)	(0.0191)	(0.0190)	(0.0190)
Medium	0.146***	0.146***	0.145***	0.144***	0.144***	0.145***	0.144***	0.146***	0.146***	0.145***	0.145***
	(0.0238)	(0.0238)	(0.0236)	(0.0237)	(0.0237)	(0.0235)	(0.0236)	(0.0235)	(0.0235)	(0.0235)	(0.0235)
Large	0.147***	0.147***	0.141***	0.141***	0.141***	0.143***	0.141***	0.143***	0.143***	0.143***	0.144***
	(0.0362)	(0.0362)	(0.0361)	(0.0363)	(0.0363)	(0.0359)	(0.0363)	(0.0362)	(0.0362)	(0.0363)	(0.0363)
Constant	0.647**	0.654**	0.931***	0.948***	0.951***	0.982***	1.022***	0.788**	0.791**	0.815**	0.819**
	(0.292)	(0.295)	(0.308)	(0.310)	(0.311)	(0.315)	(0.319)	(0.313)	(0.315)	(0.316)	(0.318)
N	21299	21299	21090	21090	21090	21090	21090	21090	21090	21090	21090

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO). Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

Table 6: Baseline spillover results – Manufacturing firms

Manufacturing	(1) LogMFP_SW	(2) LogMFP_SW	(3) LogMFP_SW	(4) LogMFP_SW	(5) LogMFP_SW	(6) LogMFP_SW	(7) LogMFP_SW	(8) LogMFP_SW	(9) LogMFP_SW	(10) LogMFP_SW	(11) LogMFP_SW
Intra-industry	-0.121*	-0.121*		-0.0862	-0.0868		-0.0545	0.0355	0.0355	0.0344	0.0343
	(0.0675)	(0.0674)		(0.190)	(0.190)		(0.196)	(0.203)	(0.203)	(0.199)	(0.199)
Intra-region		-0.0828			-0.0760		-0.0769		-0.0729		-0.0730
		(0.0730)			(0.0717)		(0.0717)		(0.0728)		(0.0730)
Forward link			3.994	5.158	5.123			-2.722	-2.795		
			(4.430)	(3.866)	(3.878)			(3.457)	(3.453)		
Backward link			-25.47	-27.82*	-27.96*						
			(16.72)	(14.36)	(14.36)						
Forward no imp						0.636	0.947			-2.171	-2.210
						(2.039)	(2.004)			(2.147)	(2.149)
Backward no imp						-14.76	-15.62*				
						(9.246)	(8.176)				
Backward_Home								0.365	0.368		
								(0.702)	(0.703)		
Backward_noimp_H										0.340	0.339
										(0.625)	(0.626)
Industry growth	0.0218	0.0219	0.00275	0.0111	0.0112	0.00163	0.00691	0.00224	0.00223	0.00106	0.00108
	(0.0238)	(0.0239)	(0.0252)	(0.0317)	(0.0318)	(0.0253)	(0.0324)	(0.0324)	(0.0324)	(0.0324)	(0.0324)
Ln Age	0.0836**	0.0830**	0.0868**	0.0871**	0.0866**	0.0870**	0.0868**	0.0898**	0.0894**	0.0898**	0.0893**
	(0.0356)	(0.0356)	(0.0363)	(0.0365)	(0.0365)	(0.0363)	(0.0365)	(0.0374)	(0.0374)	(0.0373)	(0.0373)
HHI (industry)	0.0244	0.0243	0.00785	-0.00353	-0.00364	0.0166	0.00999	0.0513	0.0515	0.0537	0.0538
	(0.0422)	(0.0423)	(0.0406)	(0.0413)	(0.0413)	(0.0383)	(0.0413)	(0.0493)	(0.0493)	(0.0491)	(0.0492)
Exporter	0.00785	0.00798	0.00587	0.00580	0.00593	0.00590	0.00599	0.00617	0.00630	0.00622	0.00635
	(0.0155)	(0.0155)	(0.0157)	(0.0157)	(0.0157)	(0.0157)	(0.0158)	(0.0157)	(0.0157)	(0.0157)	(0.0157)
Importer	-0.0259***	-0.0258***	-0.0261***	-0.0261***	-0.0261***	-0.0259***	-0.0258***	-0.0260***	-0.0260***	-0.0258***	-0.0258***
	(0.00902)	(0.00897)	(0.00906)	(0.00907)	(0.00902)	(0.00910)	(0.00905)	(0.00902)	(0.00897)	(0.00906)	(0.00901)
Ln Wage	0.0393**	0.0393**	0.0433**	0.0431**	0.0431**	0.0431**	0.0430**	0.0425**	0.0425**	0.0424**	0.0424**
	(0.0164)	(0.0164)	(0.0169)	(0.0170)	(0.0170)	(0.0170)	(0.0170)	(0.0171)	(0.0171)	(0.0171)	(0.0171)
R&D(1/0)	0.00623	0.00640	0.00397	0.00389	0.00406	0.00399	0.00412	0.00387	0.00403	0.00385	0.00401
	(0.00682)	(0.00681)	(0.00686)	(0.00689)	(0.00689)	(0.00686)	(0.00689)	(0.00681)	(0.00681)	(0.00680)	(0.00680)
Small	0.0318	0.0318	0.0287	0.0281	0.0281	0.0286	0.0283	0.0290	0.0290	0.0290	0.0291
	(0.0257)	(0.0256)	(0.0263)	(0.0262)	(0.0262)	(0.0263)	(0.0261)	(0.0261)	(0.0261)	(0.0261)	(0.0261)
Medium	0.114***	0.115***	0.112***	0.111***	0.111***	0.111***	0.111***	0.112***	0.113***	0.112***	0.113***
	(0.0315)	(0.0317)	(0.0316)	(0.0315)	(0.0317)	(0.0316)	(0.0317)	(0.0311)	(0.0312)	(0.0310)	(0.0312)
Large	0.0999**	0.100**	0.0984**	0.0972**	0.0974**	0.0979**	0.0973**	0.0984**	0.0986**	0.0987**	0.0989**
	(0.0442)	(0.0442)	(0.0438)	(0.0441)	(0.0441)	(0.0438)	(0.0441)	(0.0439)	(0.0439)	(0.0439)	(0.0439)
Constant	2.004***	2.026***	2.117***	2.148***	2.171***	2.190***	2.234***	1.936***	1.957***	1.971***	1.993***
	(0.217)	(0.220)	(0.251)	(0.241)	(0.244)	(0.269)	(0.261)	(0.254)	(0.258)	(0.258)	(0.262)
N	6719	6719	6560	6560	6560	6560	6560	6560	6560	6560	6560

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO). Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

Table 7: Baseline spillover results – Services firms

Services	(1) LogMFP_SW	(2) LogMFP_SW	(3) LogMFP_SW	(4) LogMFP_SW	(5) LogMFP_SW	(6) LogMFP_SW	(9) LogMFP_SW	(7) LogMFP_SW	(8) LogMFP_SW	(9) LogMFP_SW	(10) LogMFP_SW
Intra-industry	0.272***	0.272***		0.197**	0.197**		0.199**	0.246***	0.246***	0.231**	0.231**
	(0.0796)	(0.0796)		(0.0818)	(0.0818)		(0.0819)	(0.0891)	(0.0891)	(0.0905)	(0.0905)
Intra-region		0.0328			0.0304		0.0298		0.0310		0.0307
		(0.0371)			(0.0384)		(0.0384)		(0.0389)		(0.0388)
Forward link			-1.157	-0.684	-0.692			0.0588	0.0522		
			(0.864)	(0.833)	(0.836)			(0.726)	(0.726)		
Backward link			-5.061**	-4.128*	-4.133*						
			(2.216)	(2.222)	(2.224)						
Forward no imp						-0.796	-0.333			0.206	0.200
						(0.716)	(0.689)			(0.625)	(0.626)
Backward no imp						-3.758**	-2.847				
						(1.795)	(1.807)				
Backward_Home								-0.823	-0.827		
								(0.836)	(0.837)		
Backward noimH										-0.816	-0.818
										(0.684)	(0.685)
Industry growth	0.00275	0.00274	0.00281	0.00382	0.00386	0.00252	0.00286	0.0105	0.0106	0.00865	0.00870
	(0.0296)	(0.0296)	(0.0311)	(0.0292)	(0.0291)	(0.0315)	(0.0296)	(0.0294)	(0.0294)	(0.0288)	(0.0288)
Ln Age	0.0505***	0.0504***	0.0449***	0.0464***	0.0463***	0.0456***	0.0469***	0.0498***	0.0497***	0.0498***	0.0498***
	(0.0159)	(0.0159)	(0.0151)	(0.0151)	(0.0152)	(0.0153)	(0.0153)	(0.0161)	(0.0161)	(0.0160)	(0.0160)
HHI(industry)	0.178*	0.178*	0.206**	0.214**	0.214**	0.212**	0.217**	0.184*	0.184*	0.193*	0.193*
	(0.106)	(0.106)	(0.102)	(0.104)	(0.104)	(0.101)	(0.102)	(0.103)	(0.103)	(0.0986)	(0.0985)
Exporter	-0.00593	-0.00590	-0.00656	-0.00638	-0.00635	-0.00673	-0.00648	-0.00642	-0.00639	-0.00610	-0.00606
	(0.00613)	(0.00614)	(0.00612)	(0.00614)	(0.00614)	(0.00609)	(0.00611)	(0.00616)	(0.00616)	(0.00618)	(0.00619)
Importer	0.0321***	0.0320***	0.0318***	0.0317***	0.0317***	0.0318***	0.0316***	0.0321***	0.0320***	0.0320***	0.0320***
	(0.00885)	(0.00884)	(0.00867)	(0.00869)	(0.00868)	(0.00868)	(0.00868)	(0.00860)	(0.00859)	(0.00863)	(0.00862)
Ln Wage	0.334***	0.334***	0.334***	0.334***	0.334***	0.334***	0.334***	0.334***	0.334***	0.334***	0.334***
	(0.0314)	(0.0314)	(0.0315)	(0.0315)	(0.0315)	(0.0315)	(0.0315)	(0.0315)	(0.0315)	(0.0315)	(0.0315)
R&D(1/0)	-0.00786	-0.00783	-0.00751	-0.00817	-0.00814	-0.00748	-0.00808	-0.00804	-0.00802	-0.00799	-0.00797
	(0.00564)	(0.00565)	(0.00564)	(0.00561)	(0.00561)	(0.00564)	(0.00562)	(0.00560)	(0.00560)	(0.00560)	(0.00560)
Small	0.151***	0.151***	0.148***	0.148***	0.148***	0.148***	0.148***	0.147***	0.147***	0.147***	0.147***
	(0.0309)	(0.0309)	(0.0301)	(0.0300)	(0.0300)	(0.0301)	(0.0300)	(0.0299)	(0.0299)	(0.0299)	(0.0299)
Medium	0.227***	0.227***	0.225***	0.225***	0.225***	0.225***	0.225***	0.224***	0.224***	0.224***	0.224***
	(0.0385)	(0.0385)	(0.0381)	(0.0381)	(0.0381)	(0.0381)	(0.0381)	(0.0380)	(0.0381)	(0.0380)	(0.0381)
Large	0.263***	0.263***	0.259***	0.259***	0.259***	0.259***	0.259***	0.260***	0.260***	0.261***	0.260***
	(0.0571)	(0.0571)	(0.0572)	(0.0570)	(0.0571)	(0.0572)	(0.0571)	(0.0569)	(0.0570)	(0.0569)	(0.0570)
Constant	-0.467	-0.476	-0.135	-0.244	-0.252	-0.109	-0.250	-0.373	-0.381	-0.362	-0.370
	(0.337)	(0.339)	(0.378)	(0.374)	(0.374)	(0.389)	(0.385)	(0.371)	(0.372)	(0.374)	(0.374)
N	14580	14580	14530	14530	14530	14530	14530	14530	14530	14530	14530

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO). Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

Table 8: Spillovers from EU and non-EU multinationals - All firms

All firms	(1) LogMFP_SW	(2) LogMFP_SW	(3) LogMFP_SW	(4) LogMFP_SW
Intra-industry_EU	-0.0590		-0.0183	-0.0526
	(0.0922)		(0.0771)	(0.0784)
Intra-industry_nonEU	-0.165**		-0.0825	-0.140**
	(0.0767)		(0.0626)	(0.0620)
Intra-region_EU	0.0460			0.0378
	(0.0642)			(0.0636)
Intra-region_nonEU	-0.0121			-0.0122
	(0.0416)			(0.0407)
Forward noimp_EU		-2.525***	-1.696***	-1.636**
		(0.770)	(0.647)	(0.657)
Forward noimp_nonEU		0.795	-0.559	-1.184
		(1.051)	(0.943)	(1.005)
Backward noimp_EU		-2.410**	-2.045**	-2.148**
		(0.995)	(1.007)	(1.044)
Backward noimp_nonEU		-0.366	-0.160	-0.195
		(0.829)	(0.863)	(0.894)
Industry growth	0.0230	0.0187	0.0144	0.0141
	(0.0257)	(0.0207)	(0.0235)	(0.0255)
Ln Age	0.0451***	0.0454***	0.0478***	0.0477***
	(0.0150)	(0.0150)	(0.0152)	(0.0152)
HHI (industry)	-0.0423	-0.00139	-0.0263	-0.0166
	(0.0328)	(0.0323)	(0.0313)	(0.0316)
Exporter	0.00620	0.00349	0.00471	0.00576
	(0.00720)	(0.00803)	(0.00715)	(0.00727)
Importer	0.0168**	0.0105	0.0152*	0.0169**
	(0.00808)	(0.00813)	(0.00796)	(0.00809)
Ln Wage	0.252***	0.226***	0.246***	0.252***
	(0.0293)	(0.0277)	(0.0292)	(0.0293)
R&D (1/0)	-0.00424	-0.00242	-0.00260	-0.00421
	(0.00483)	(0.00452)	(0.00467)	(0.00486)
Small	0.0722***	0.0708***	0.0746***	0.0721***
	(0.0214)	(0.0193)	(0.0210)	(0.0216)
Medium	0.146***	0.145***	0.146***	0.145***
	(0.0265)	(0.0236)	(0.0261)	(0.0268)
Large	0.148***	0.142***	0.153***	0.146***
	(0.0405)	(0.0362)	(0.0391)	(0.0411)
Constant	0.358	0.689**	0.524	0.498
	(0.315)	(0.306)	(0.322)	(0.328)
N	19215	21090	19891	19215

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO). Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

Table 9: Spillovers from EU and non-EU multinationals – Manufacturing firms

Manufacturing	(1) LogMFP_SW	(2) LogMFP_SW	(3) LogMFP_SW	(4) LogMFP_SW
Intra-industry_EU	-0.262*		-0.172	-0.242*
	(0.147)		(0.124)	(0.132)
Intra-industry_nonEU	-0.245***		-0.141**	-0.229***
	(0.0750)		(0.0613)	(0.0755)
Intra-region_EU	0.0580			0.0628
	(0.159)			(0.159)
Intra-region_nonEU	-0.0971			-0.106
	(0.0981)			(0.0979)
Forward_no imp_EU		1.090	6.019	4.834
		(4.698)	(4.254)	(4.207)
Forward_noimp_nonEU		-2.872	-3.571**	-5.335***
		(1.986)	(1.709)	(1.976)
Backward_noimp_EU		-5.876	-6.287	-6.933
		(5.691)	(5.542)	(5.530)
Backward_noimp_nonEU		-2.619	-3.577	-4.352
		(3.828)	(3.826)	(3.789)
Industry growth	0.0632*	-0.00382	0.0241	0.0296
	(0.0348)	(0.0249)	(0.0296)	(0.0395)
Ln Age	0.110**	0.0874**	0.108**	0.107**
	(0.0437)	(0.0364)	(0.0421)	(0.0437)
HHI (industry)	-0.000734	-0.00622	-0.0938**	-0.0834**
	(0.0446)	(0.0433)	(0.0363)	(0.0371)
Exporter	0.0146	0.00602	0.0110	0.0147
	(0.0151)	(0.0157)	(0.0147)	(0.0149)
Importer	-0.0146	-0.0255***	-0.0162*	-0.0129
	(0.00985)	(0.00902)	(0.00967)	(0.00991)
Ln wage	0.0391*	0.0427**	0.0327	0.0395*
	(0.0212)	(0.0172)	(0.0202)	(0.0215)
R&D (1/0)	0.00231	0.00362	0.00395	0.00161
	(0.00807)	(0.00675)	(0.00745)	(0.00800)
Small	0.00734	0.0286	0.00920	0.00665
	(0.0279)	(0.0263)	(0.0272)	(0.0280)
Medium	0.0818**	0.111***	0.0797**	0.0806**
	(0.0362)	(0.0312)	(0.0333)	(0.0360)
Large	0.0481	0.0983**	0.0687	0.0497
	(0.0510)	(0.0439)	(0.0477)	(0.0515)
Constant	2.027***	2.125***	2.197***	2.331***
	(0.290)	(0.374)	(0.427)	(0.453)
N	5077	6560	5371	5077

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO). Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

Table 10: Spillovers from EU and non-EU multinationals – Services firms

Services	(1) LogMFP_SW	(2) LogMFP_SW	(3) LogMFP_SW	(4) LogMFP_SW
Intra-industry_EU	0.190*		0.200**	0.188**
	(0.0979)		(0.0828)	(0.0845)
Intra-industry_nonEU	0.0941		0.165	0.142
	(0.101)		(0.101)	(0.100)
Intra-region_EU	0.0359			0.0432
	(0.0647)			(0.0649)
Intra-region_nonEU	0.0245			0.0239
	(0.0408)			(0.0401)
Forward no imp_EU		1.117	1.583*	1.622*
		(0.859)	(0.878)	(0.901)
Forward no imp_nonEU		-1.950	-1.997	-2.199
		(1.544)	(1.513)	(1.565)
Backward noimp_EU		-0.877	-0.665	-0.766
		(1.095)	(1.020)	(1.038)
Backward no imp_nonEU		-0.373	-0.235	-0.220
		(1.031)	(0.968)	(0.984)
Industry growth	-0.00491	-0.0145	-0.0215	-0.0208
	(0.0334)	(0.0341)	(0.0344)	(0.0344)
Ln age	0.0460***	0.0447***	0.0422***	0.0434***
	(0.0160)	(0.0156)	(0.0153)	(0.0154)
HHI (industry)	0.126	0.143	0.109	0.109
	(0.112)	(0.0992)	(0.107)	(0.110)
Exporter	-0.00701	-0.00685	-0.00756	-0.00683
	(0.00602)	(0.00606)	(0.00605)	(0.00609)
Importer	0.0316***	0.0316***	0.0309***	0.0314***
	(0.00903)	(0.00863)	(0.00860)	(0.00901)
Ln Wage	0.335***	0.335***	0.335***	0.336***
	(0.0316)	(0.0315)	(0.0315)	(0.0316)
R&D (1/0)	-0.00881	-0.00744	-0.00825	-0.00923
	(0.00579)	(0.00567)	(0.00569)	(0.00582)
Small	0.146***	0.149***	0.151***	0.147***
	(0.0313)	(0.0303)	(0.0305)	(0.0314)
Medium	0.224***	0.225***	0.227***	0.224***
	(0.0390)	(0.0383)	(0.0385)	(0.0392)
Large	0.266***	0.263***	0.269***	0.267***
	(0.0565)	(0.0571)	(0.0567)	(0.0567)
Constant	-0.432	-0.307	-0.367	-0.377
	(0.343)	(0.360)	(0.353)	(0.354)
N	14138	14530	14520	14138

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO). Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

Table 11: Baseline spillover results - The role of absorptive capacity						
	(1)	(2)	(3)	(4)	(5)	(6)
	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW	LogMFP_SW
	All firms		**Services**		**Manufacturing**	
Intra-industry	-0.119	-0.0918	0.191**	0.221**	-0.0736	0.0139
	(0.0758)	(0.0843)	(0.0823)	(0.0909)	(0.190)	(0.195)
Intra-industry*RD/Emp	0.110***	0.103***	0.0793***	0.0774**	0.232	0.390
	(0.0329)	(0.0315)	(0.0282)	(0.0296)	(0.602)	(0.510)
Intra-region	-0.0168	-0.0142	0.0330	0.0322	-0.0802	-0.0733
	(0.0363)	(0.0365)	(0.0383)	(0.0386)	(0.0707)	(0.0726)
Intra-region* RD/Emp	-0.0791**	-0.0779**	-0.0694**	-0.0646*	-0.0109	0.00208
	(0.0326)	(0.0328)	(0.0333)	(0.0338)	(0.400)	(0.404)
Forward (no imp)	-2.373***	-1.887***	-0.348	0.143	1.215	-2.012
	(0.714)	(0.630)	(0.688)	(0.625)	(1.982)	(2.105)
Backward (no imp)	-5.978***		-2.836		-16.21*	
	(1.571)		(1.806)		(8.140)	
Forward (no imp)* RD/Emp	1.479**	0.853	0.828	0.122	7.330	7.893
	(0.632)	(0.662)	(0.529)	(0.555)	(6.876)	(7.013)
Backward (no imp)* RD/Emp	-0.126*		-0.0338		3.646	
	(0.0691)		(0.0581)		(4.968)	
Backward H (no imp)		-1.284**		-0.833		0.266
		(0.603)		(0.687)		(0.601)
Backward H (no imp)* RD/Emp		0.133*		0.184***		-1.183
		(0.0716)		(0.0694)		(3.090)
Industry growth	0.0162	0.0352*	0.000181	0.00557	0.00800	0.00290
	(0.0203)	(0.0203)	(0.0295)	(0.0284)	(0.0317)	(0.0319)
Ln Age	0.0440***	0.0467***	0.0470***	0.0499***	0.0791**	0.0827**
	(0.0150)	(0.0159)	(0.0153)	(0.0161)	(0.0372)	(0.0380)
HHI (industry)	0.00982	-0.0203	0.200*	0.174*	0.00366	0.0477
	(0.0313)	(0.0356)	(0.102)	(0.0979)	(0.0397)	(0.0488)
Exporter	0.00373	0.00384	-0.00632	-0.00567	0.00665	0.00691
	(0.00796)	(0.00795)	(0.00612)	(0.00626)	(0.0156)	(0.0156)
Importer	0.0109	0.0118	0.0319***	0.0319***	-0.0260***	-0.0262***
	(0.00807)	(0.00797)	(0.00868)	(0.00863)	(0.00911)	(0.00897)
Ln Wage	0.226***	0.225***	0.334***	0.334***	0.0438**	0.0429**
	(0.0276)	(0.0277)	(0.0315)	(0.0314)	(0.0170)	(0.0170)
Ln(RD/Emp)	-0.0735*	-0.0709*	-0.0445	-0.0393	-0.398	-0.371
	(0.0390)	(0.0382)	(0.0369)	(0.0366)	(0.593)	(0.710)
Small	0.0698***	0.0708***	0.149***	0.148***	0.0274	0.0277
	(0.0193)	(0.0190)	(0.0302)	(0.0301)	(0.0260)	(0.0259)
Medium	0.144***	0.145***	0.226***	0.225***	0.109***	0.111***
	(0.0237)	(0.0234)	(0.0382)	(0.0381)	(0.0320)	(0.0315)
Large	0.142***	0.144***	0.260***	0.262***	0.101**	0.102**
	(0.0363)	(0.0364)	(0.0572)	(0.0573)	(0.0441)	(0.0442)
Constant	1.026***	0.825**	-0.250	-0.361	2.253***	2.009***
	(0.319)	(0.317)	(0.384)	(0.373)	(0.256)	(0.255)
N	21090	21090	14530	14530	6560	6560

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO).
Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

Table 12: Spillovers from EU and non-EU multinationals – The role of absorptive capacity

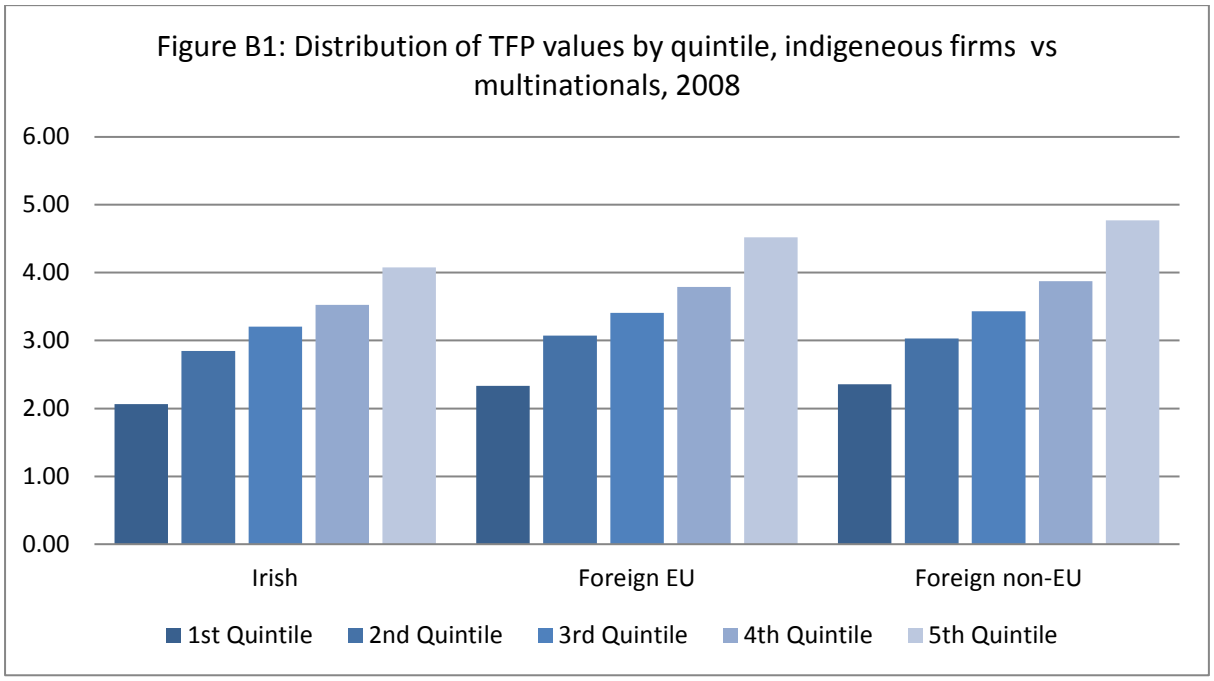
	(2) LogMFP_SW	(4) LogMFP_SW	(6) LogMFP_SW
	All firms	**Services**	**Manufacturing**
Intra-industry_EU	-0.0494	0.192**	-0.227
	(0.0794)	(0.0826)	(0.136)
Intra-industry_nonEU	-0.137**	0.149	-0.228***
	(0.0619)	(0.0986)	(0.0767)
Intra-region_EU	0.0434	0.0474	0.0504
	(0.0634)	(0.0651)	(0.153)
Intra-region_nonEU	-0.00987	0.0265	-0.138
	(0.0409)	(0.0402)	(0.0953)
Intra-industry_EU* RD/Emp	-0.0260	-0.0170	-0.896
	(0.102)	(0.118)	(0.658)
Intra-industry_nonEU* RD/Emp	0.0479*	0.0320	-0.634
	(0.0285)	(0.0247)	(0.394)
Intra-region_EU* RD/Emp	-0.121***	-0.103**	-0.0569
	(0.0408)	(0.0418)	(0.522)
Intra-region_nonEU* RD/Emp	-0.0821	-0.101	0.454
	(0.0696)	(0.0707)	(0.629)
Forward no imp_EU	-1.649**	1.618*	4.274
	(0.662)	(0.911)	(4.286)
Forward no imp_nonEU	-1.221	-2.197	-4.822**
	(0.994)	(1.547)	(1.966)
Backward no imp_EU	-2.207**	-0.834	-7.235
	(1.038)	(1.034)	(5.596)
Backward no imp_nonEU	-0.233	-0.241	-5.599
	(0.891)	(0.977)	(3.779)
Forward no imp_EU* RD/Emp	-0.870	-1.352	17.27
	(1.235)	(1.272)	(11.64)
Forward no imp_nonEU* RD/Emp	1.313	1.525	-18.36**
	(1.481)	(1.499)	(8.459)
Backward no imp_EU* RD/Emp	0.775*	1.052***	-26.59***
	(0.406)	(0.394)	(7.774)
Backward no imp_nonEU* RD/Emp	-0.594**	-0.738**	23.43***
	(0.297)	(0.300)	(4.515)
Industry growth	0.0125	-0.0244	0.0298
	(0.0250)	(0.0337)	(0.0392)
Ln Age	0.0470***	0.0433***	0.116**
	(0.0152)	(0.0154)	(0.0453)
HHI (industry)	-0.0165	0.102	-0.0934**
	(0.0317)	(0.106)	(0.0357)
Exporter	0.00578	-0.00647	0.0151
	(0.00728)	(0.00624)	(0.0150)
Importer	0.0170**	0.0317***	-0.0103
	(0.00814)	(0.00906)	(0.0102)
Ln Wage	0.252***	0.336***	0.0431**
	(0.0294)	(0.0316)	(0.0215)
Ln(RD/Emp)	0.00963	0.0121	0.736*
	(0.0277)	(0.0295)	(0.406)
Small	0.0723***	0.148***	0.00890
	(0.0216)	(0.0315)	(0.0280)
Medium	0.146***	0.225***	0.0819**
	(0.0268)	(0.0393)	(0.0363)
Large	0.147***	0.268***	0.0626
	(0.0412)	(0.0569)	(0.0512)
Constant	0.504	-0.374	2.292***
	(0.329)	(0.355)	(0.450)
N	19215	14138	5077

Source: Authors' estimates using data from Ireland's Central Statistics Office (CSO).
Estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01. All regressions include time, firm, industry, and region fixed effects.

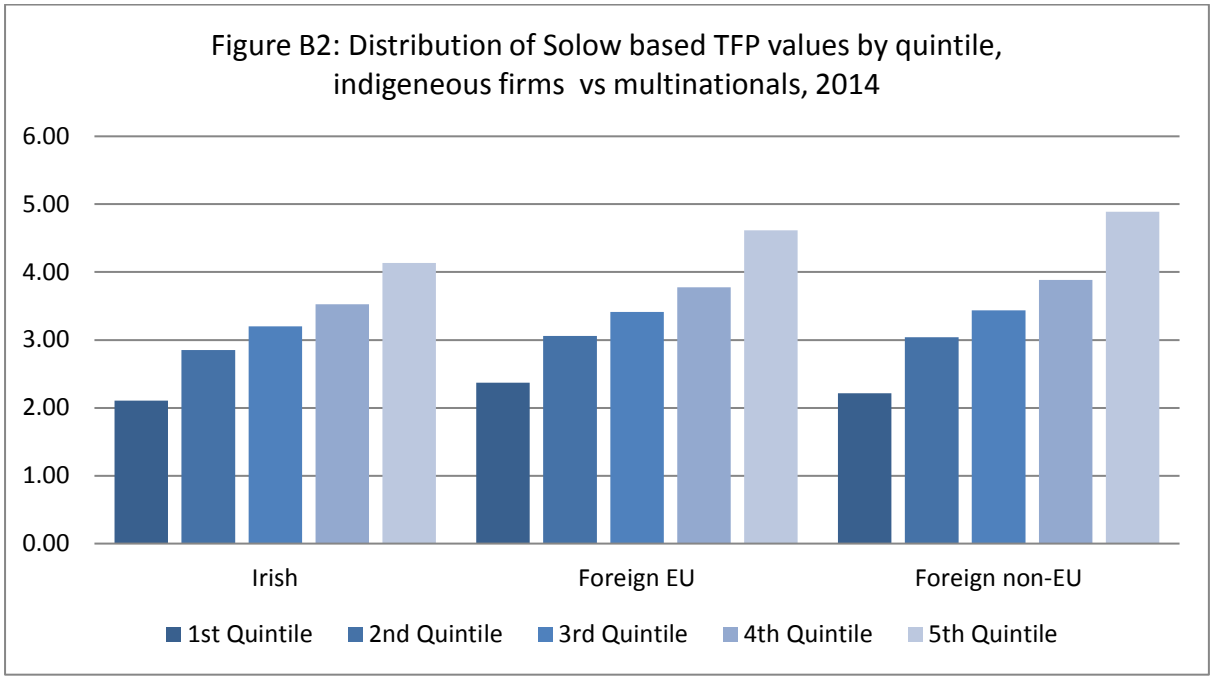
APPENDIX A: VARIABLE DEFINITIONS AND DATA SOURCES

Variable	Definition	Data Source
TFP	Total factor productivity based on a Solow Index using input factors shares.	*MultiProd*
HOR_{jt}, intra-industry foreign presence	The share of foreign-owned affiliates' employment in total employment of industry *j*, at time *t.*	CIP and ASI 2008-2014
HOR_{rt}, intra-region foreign presence	The share of foreign-owned affiliates' employment in total employment of region *r*, at time *t*.	CIP and ASI 2008-2014
FOR_{jt}, forward supply chain link	Variable capturing the intermediate inputs available from foreign affiliates in upstream industries to domestic firms in industry *j*.	WIOD 2014 and CIP and ASI 2008-2014
BAC_{jt}, backward supply chain link	Variable capturing the indigenous firms' output in upstream industries available to foreign affiliates in industry *j.*	WIOD 2014 and CIP and ASI 2008-2014
FOR_{jt}_noimp, forward supply chain link with no imported inputs	Variable capturing the intermediate inputs available to indigenous firms in industry j from foreign affiliates in upstream industries, net of imported inputs (domestically sourced inputs).	WIOD 2014 and CIP and ASI 2008-2014
BAC_{jt}_noimp, backward supply chain link with no imported inputs	Variable capturing the indigenous firms' output in upstream industries available to foreign affiliates in industry *j,* net of imported inputs.	WIOD 2014 and CIP and ASI 2008-2014
BAC_{jt}_Home, backward supply chain link based on the technology of the parent company technology in its home country	Variable capturing the indigenous firms' output in upstream industries available to foreign affiliates in industry *j* based on the technology of the parent company in its home country.	WIOD 2014 and CIP and ASI 2008-2014
$BAC_{jt}\_noimp\_Home$, backward supply chain link with no imported inputs based on the technology of the parent company in its home country	Variable capturing the indigenous firms' output in upstream industries available to foreign affiliates in industry *j,* net of imported inputs, based on the technology of the parent company in its home country.	WIOD 2014 and CIP and ASI 2008-2014
$\Delta Sales_{jt}$	Annual growth of sales in industry *j.*	CIP and ASI 2008-2014
Age	Firm age.	CIP and ASI 2008-2014
HHI_{jt}	Herfindahl-Hirschman Index in industry j at time t; the higher the index is increasing in market shares concentration (and decreases with the level of competition).	CIP and ASI 2008-2014
Exporter	Binary variable equal to one if firm i reports export sales and zero otherwise.	CIP and ASI 2008-2014
Importer	Binary variable equal to one if firm i reports imported inputs and zero otherwise.	CIP and ASI 2008-2014
Wage/Emp	Wage per employee in constant 2010 prices.	CIP and ASI 2008-2014
R&D (1/0)	Binary variable equal to one for firms with investment in R&D and zero otherwise.	CIP and ASI 2008-2014
R&D/Emp	Investment in R&D per employee in constant 2010 prices.	CIP and ASI 2008-2014

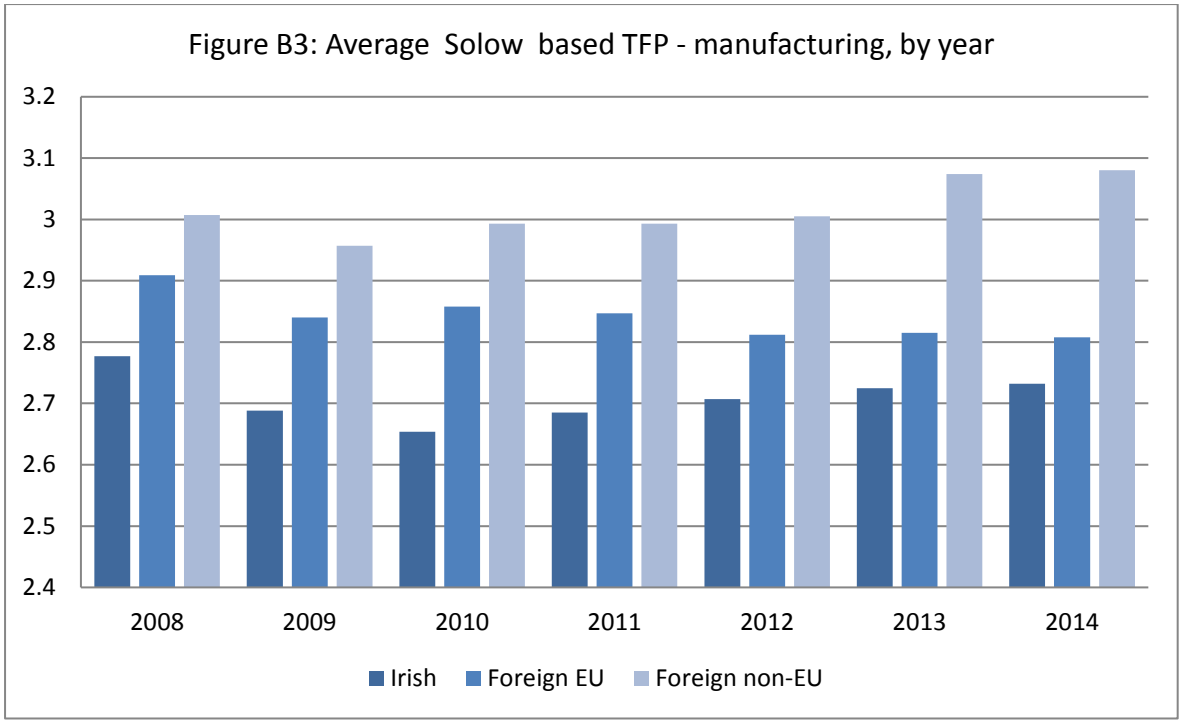
APPENDIX B: AVERAGE PRODUCTIVITY AND PRODUCTIVITY DISPERSION BY OWNERSHIP TYPE, SECTOR, AND YEAR



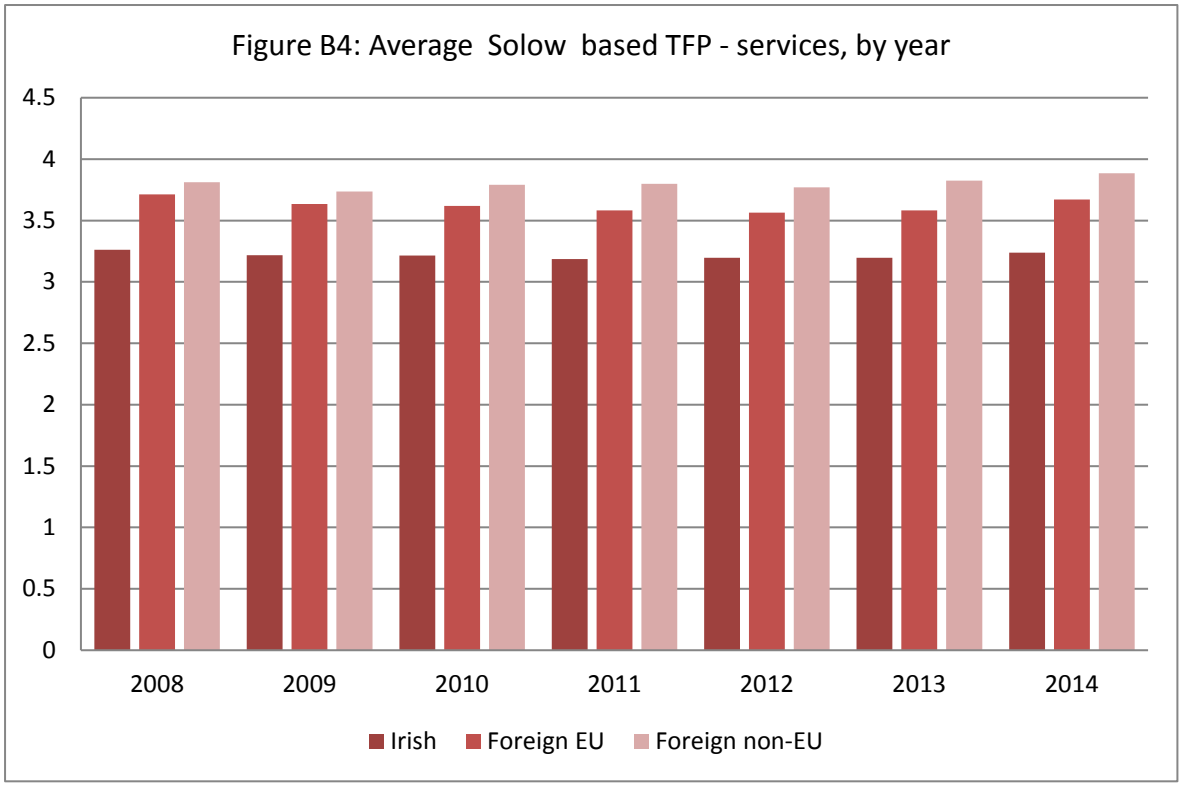
Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.

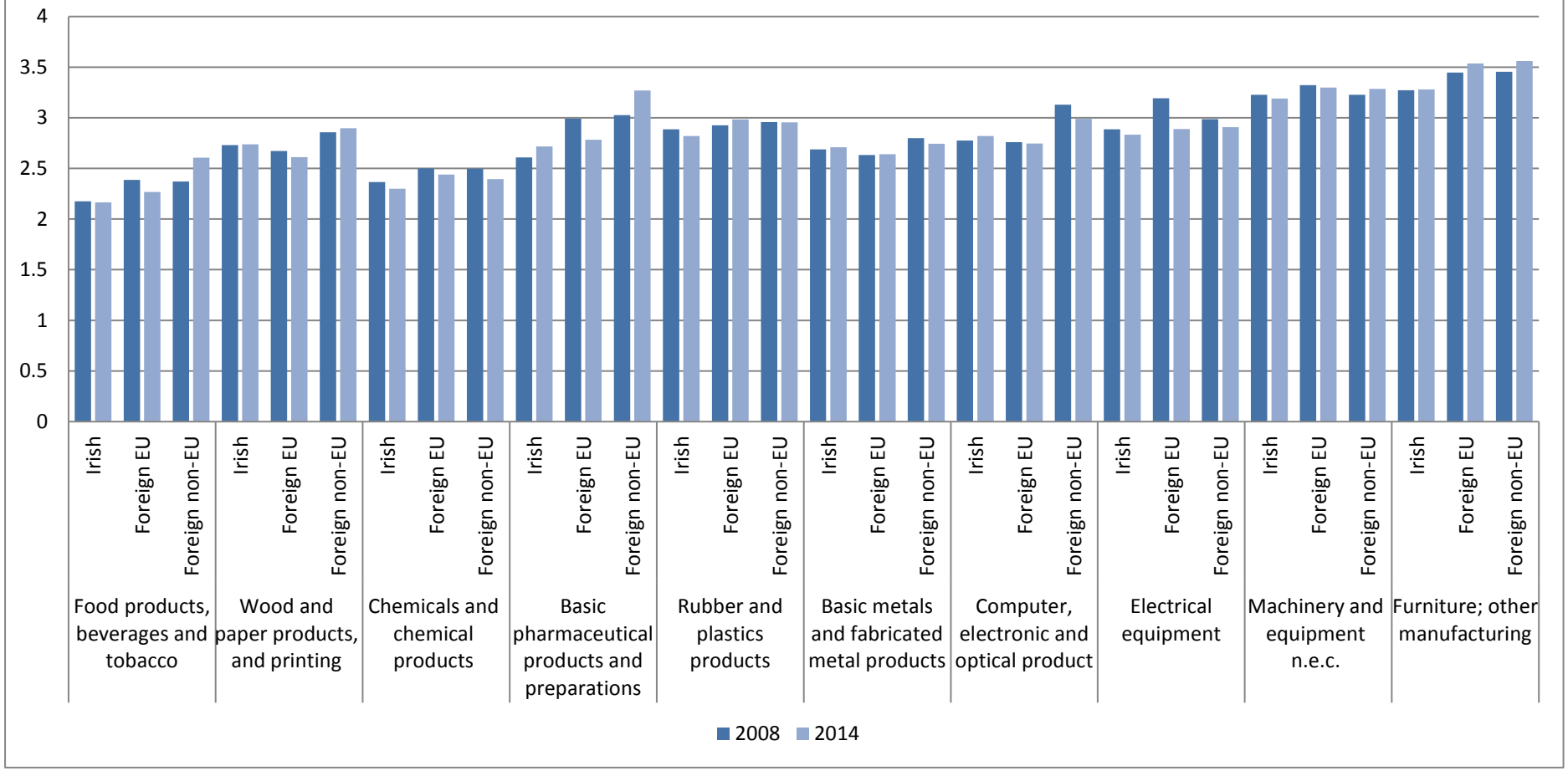


Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.

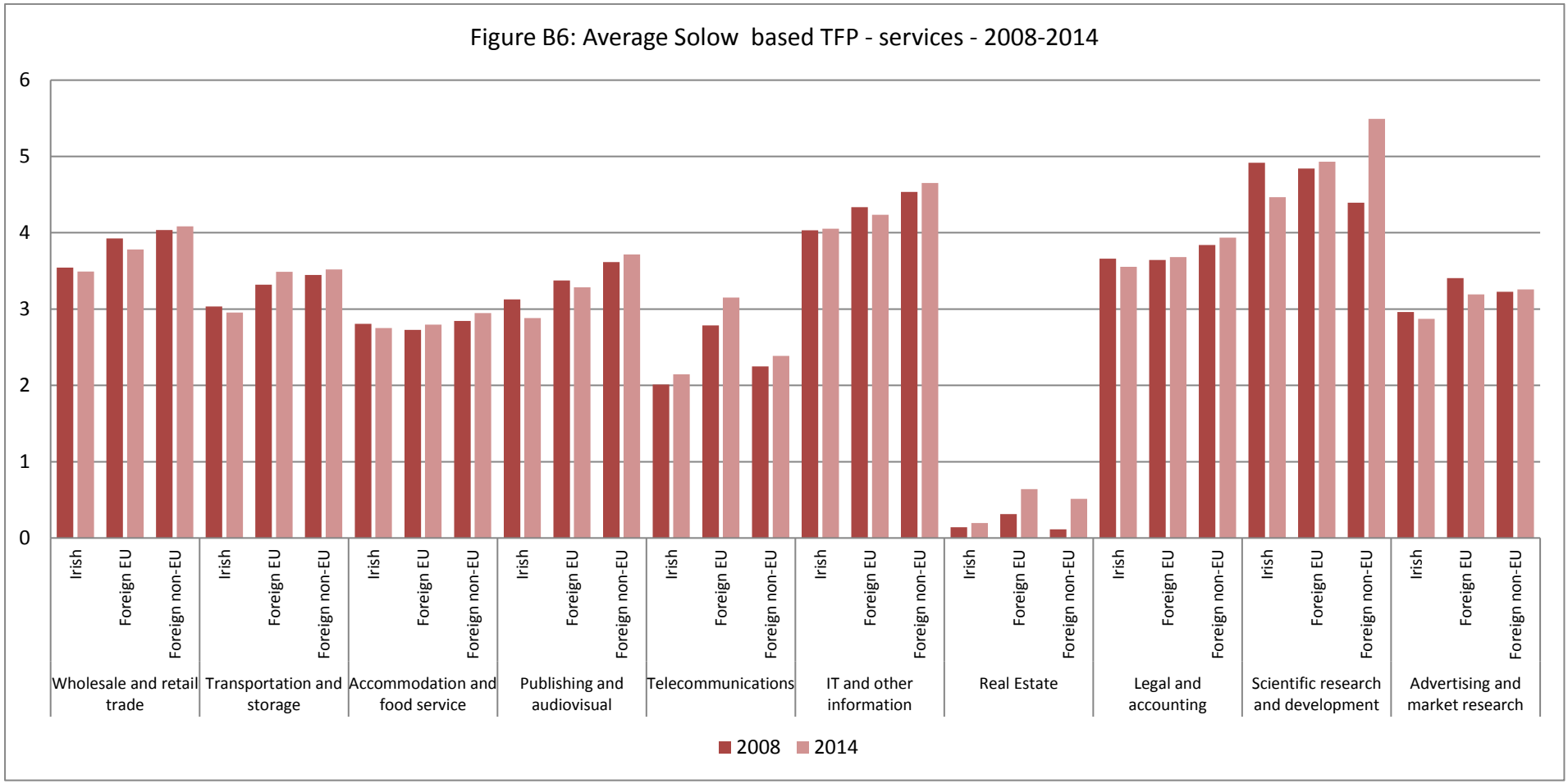


Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.

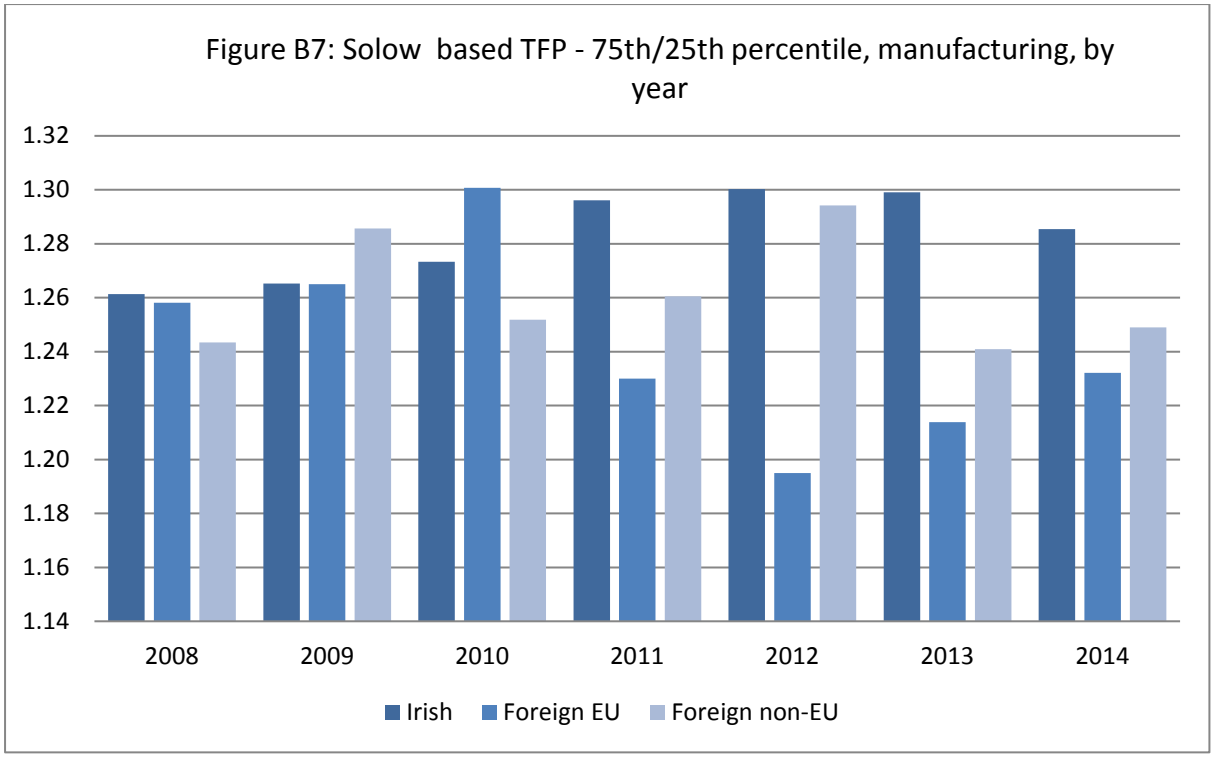
Figure B5: Average Solow based TFP - manufacturing - 2008-2014



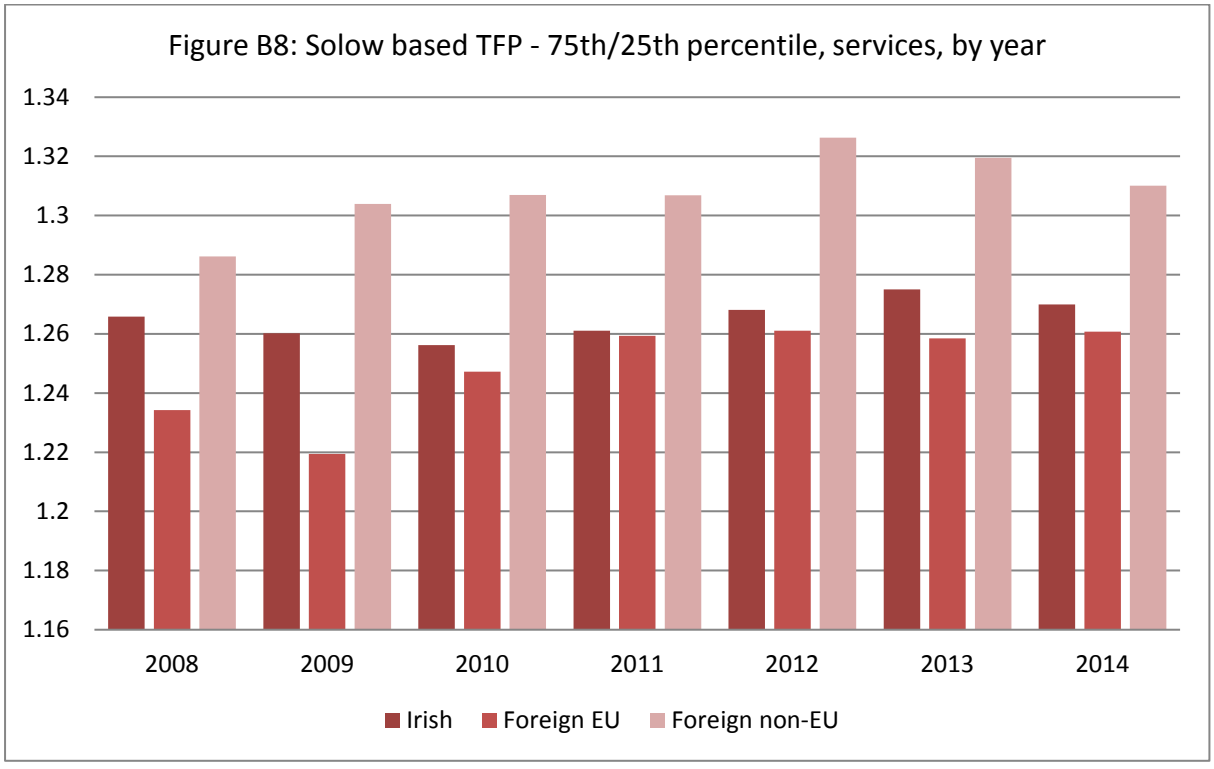
Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



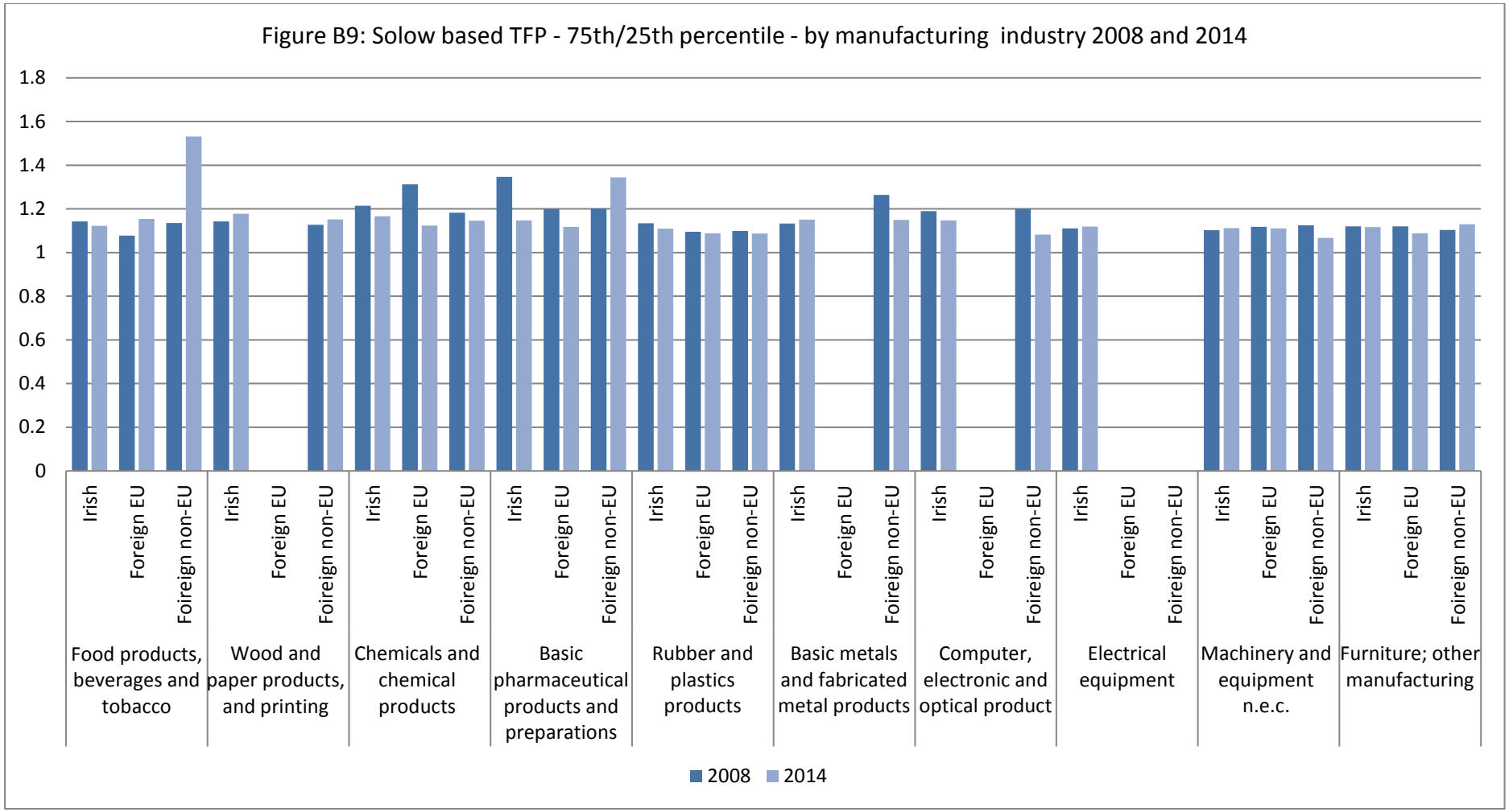
Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



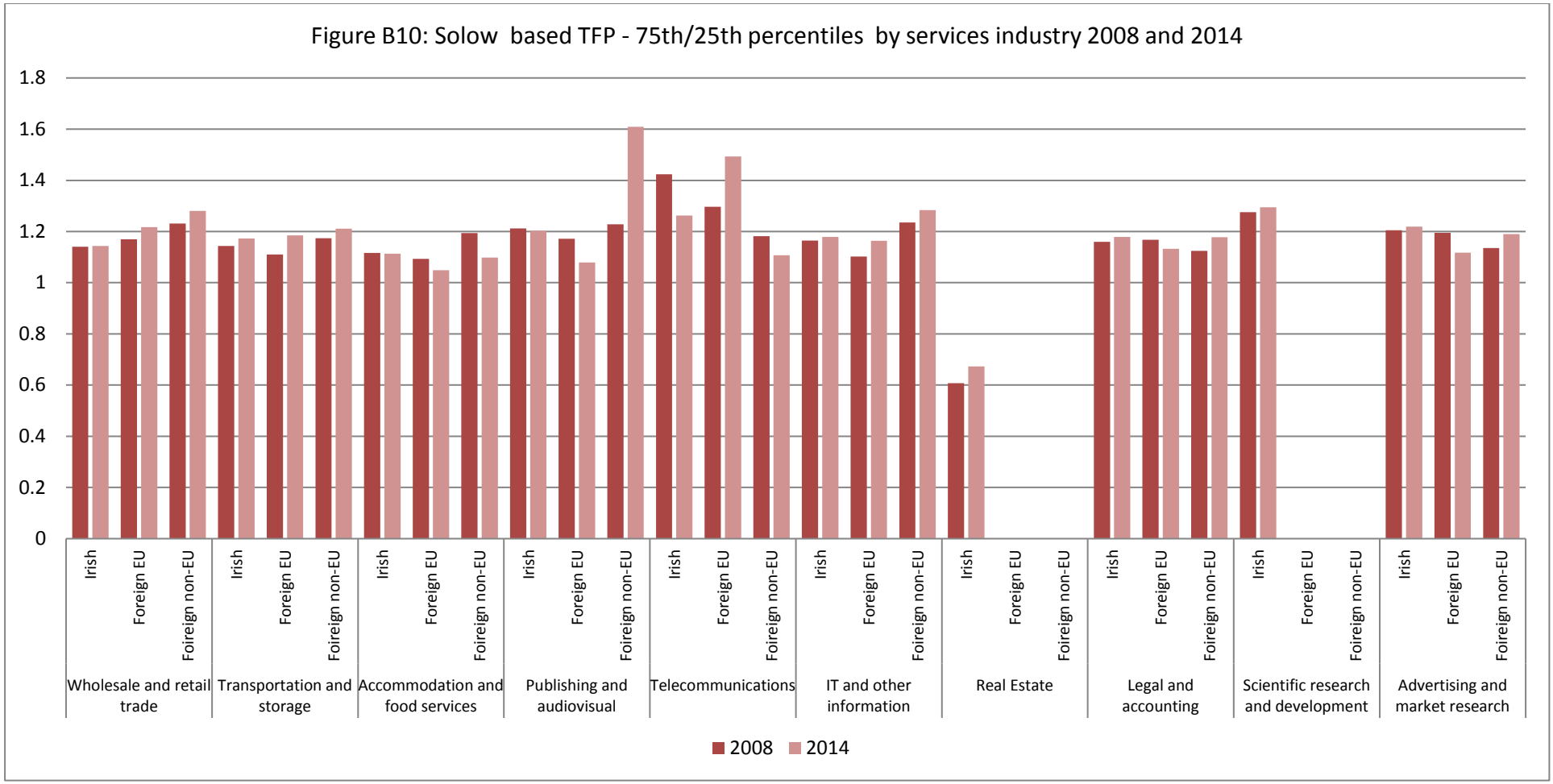
Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



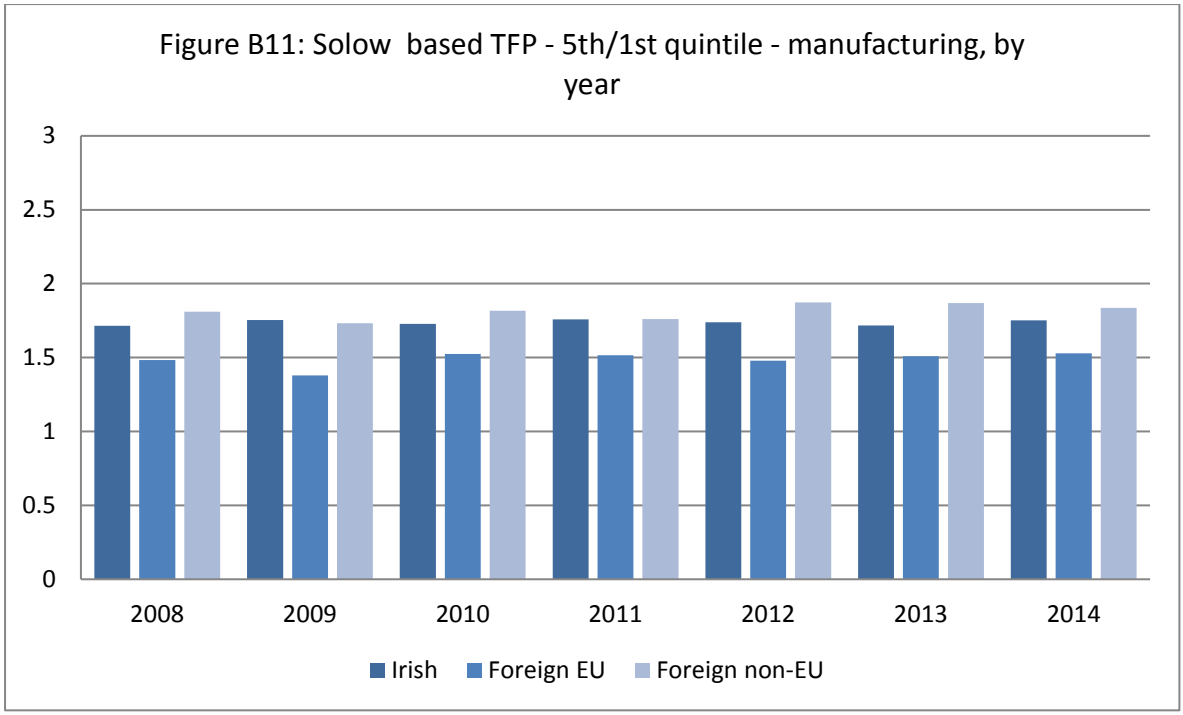
Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



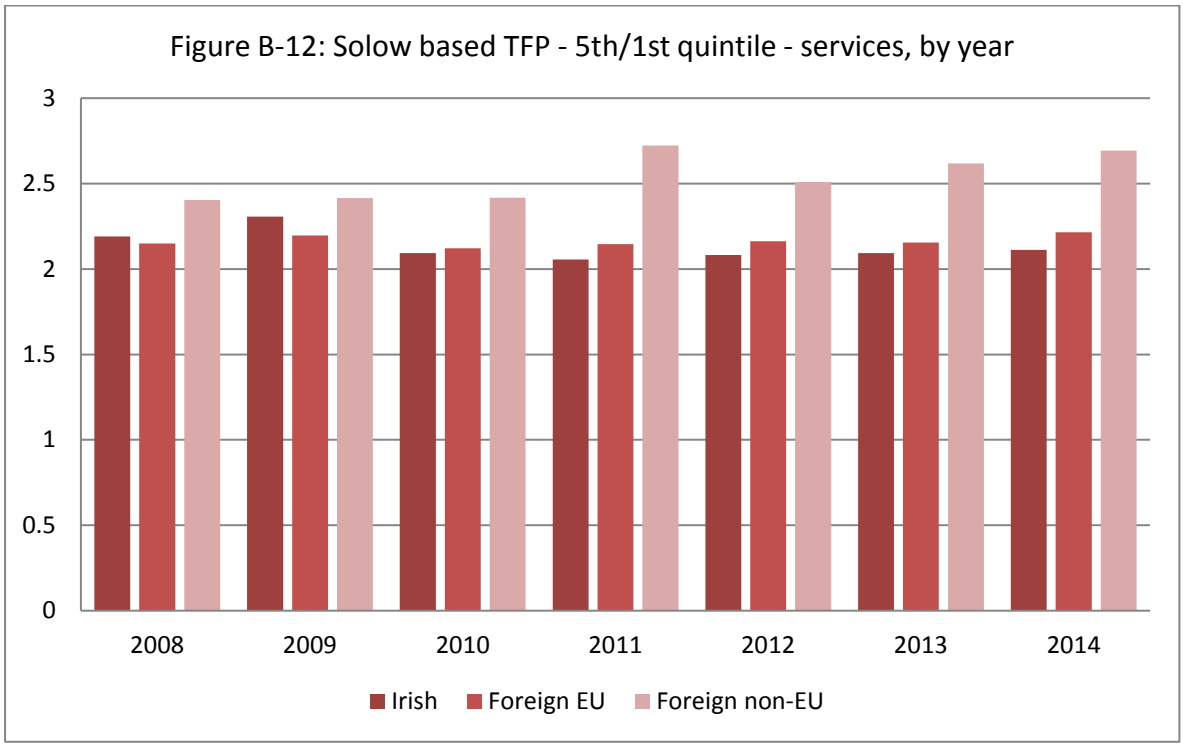
Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.



Source: Authors' analysis of estimates of TFP based on the Solow Index obtained as part of the *MultiProd* project and data from the CIP and ASI provided by Ireland' s Central Statistics Office.

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