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## Local linkages: The interdependence of foreign and domestic firms

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# Local linkages: The interdependence of foreign and domestic firms

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**Abstract:** This paper investigates the interdependence of foreign and domestic firms' local linkage decisions and the extent to which they respond differently to variations in export intensity and productivity originating from each of the two groups of firms. Our empirical analysis, based on Irish data, uncovers an interesting asymmetric pattern in the local linkage dynamics of foreign and domestic firms. We find that local linkages of domestic firms tend to evolve independently of their foreign counterpart, and that they react almost instantaneously to exogenous events such as increases in export intensity or productivity. Local linkages of foreign firms, by contrast, react gradually to exogenous events and the impact works through the reverberating dynamics of the lagged linkages of both foreign and domestic firms. The Irish experience is instructive to policymakers in emerging markets who are naturally interested in the best way to maximize the value of FDI, in terms of benefits the latter brings about for sustainable economic development.

Keywords: Local linkages; Multinationals; Foreign direct investment; Emerging markets.

JEL Classification: F23, L22

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## 1. Introduction

Multinational enterprises (MNEs) are prominent players in the increasingly integrated global economy. In 2015 foreign affiliates of MNEs account for nearly one-third of the world's total exports with employment reaching 79.5 million.<sup>1</sup> For developing host countries, foreign affiliates of MNEs often bring much needed managerial know-how, new technologies, international networks and financial resources, in addition to contributing directly as producers and employers.<sup>2</sup> An important channel through which the host country benefits from MNEs is the purchase of domestically sourced raw materials and other inputs by foreign affiliates (backward linkages) and sales of intermediate goods to domestic firms (forward linkages), a topic that has been the subject of intensive research. It has been established theoretically that linkages can induce increased demand for inputs creating employment and growth among domestic firms (Markusen and Venables, 1999). Domestic suppliers may also be motivated or helped by their foreign partners to upgrade their technology base in view of the more sophisticated product mix of foreign firms (Rodríguez-Clare, 1996; Moran, 2001). Indeed, there is almost consensus in the empirical literature that there exists positive and significant productivity spillovers effect from foreign affiliates to domestic firms, although the estimated size varies considerably across different studies.<sup>3</sup>

However, despite the ongoing interest in this topic, questions remain. Specifically under-researched is the nature and the extent to which domestic and foreign local linkages influence each other, the focus of this paper. Why would the local linkages of the two groups of firms influence each other? Here is one example. Foreign and domestic firms procure their local inputs in the same domestic market and do not operate in isolation. As such, there will be interactions and spillovers between the two groups of firms. For instance, it is conceivable that increasing demand for local inputs from domestic firms could lead to scale economies in the suppliers industry, which in turn would increase demand from *both* domestic and foreign final good

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<sup>1</sup> UNCTAD (2016) Table I.4.

<sup>2</sup> Navaretti and Venables (2004) provide an overview of the benefits MNEs can bring to a host country.

<sup>3</sup> See, for example, Amendolagine et al. (2013) for a recent survey of the empirical literature and a large scale UN-sponsored empirical study of manufacturing firms in 19 Sub-Saharan African countries. Havranek and Irsova (2011) provide a meta-analysis of 3626 studies of vertical productivity spillovers from foreign to domestic firms.

producers downstream, and a second round backward linkage effect follows. The same argument of course applies equally to increasing demand for local inputs from foreign firms, and therefore we should expect the local linkages of domestic and foreign firms are interdependent and they influence each other in a dynamic manner, with multiplier effect reverberating back and forth between the two groups of firms.<sup>4</sup> The existing literature, however, only focuses on local linkages of foreign firms, and the central question is whether these linkages lead to technology transfer between foreign firms and their domestic suppliers. Moreover, in most empirical studies the model setup is static in nature which simply assumes away any potential dynamic impact. Therefore, it should be of interest to examine issues such as whether foreign and domestic firms have the same linkage potential, whether they have similar implications for domestic suppliers, and how their local linkages might influence each other.<sup>5</sup>

The aim of this paper is to fill this literature gap. We treat local linkages of foreign and domestic firms symmetrically, examine their interdependence and spillover effects in a dynamic panel vector autoregression framework, and investigate to what extent they respond differently to variations in export orientation and productivity originating from each of the two groups of firms. Applied to MNEs' foreign affiliates located in Ireland and indigenous Irish firms, among other findings our empirical model uncovers an interesting asymmetry in the pattern of the local linkage dynamics of foreign and domestic firms. We find that local linkages of domestic firms tend to evolve independently of their foreign counterpart, and that they react almost instantaneously to exogenous events such as increases in domestic firms' export intensity or productivity. Local linkages of foreign firms, by contrast, react gradually to exogenous events and the impact works through the reverberating dynamics of the lagged linkages of both foreign and domestic firms. Our empirical results also suggest that domestic firms' export intensity and productivity variations generate an instantaneous cross-impact on foreign firms' local linkage status, but similar exogenous shocks originating from foreign firms generate relatively little instantaneous cross-impact on domestic firms' local linkage status.

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<sup>4</sup> It is also possible that the local linkages of the two groups of firms might crowd out each other rather than mutually reinforcing if, for instance, the suppliers industry is under severe capacity constraint or decreasing return to scale. The theoretical study by Barry and Hannan (1995) demonstrates such a possibility in the Irish context by means of a Dutch-disease model.

<sup>5</sup> Görg et al. (2009) is an attempt along this research direction. They investigate the link between nationality of ownership and wage elasticities of labor demand. We are indebted to Holger Görg for inspiring many of the ideas in this paragraph.

Policymakers in developing countries are naturally interested in the best way to maximize the value of FDI, in terms of benefits the latter brings about for sustainable economic development. Cultivating linkages between foreign affiliates and domestic firms is arguably the most important way to tap the benefits of FDI, as linkages can be powerful channels for diffusing knowledge and technology—the ultimate engine of growth. In order to achieve this goal, policymakers need to understand why and how firms choose to purchase inputs domestically or from abroad, in the specific context of the developing country involved. The key message from this paper is that foreign and domestic firms’ local linkage formation decisions are interdependent and they can potentially influence each other in a dynamic manner. Even if the local linkages of foreign firms are of primary interest, it is still necessary to consider the linkages decision of domestic firms.

The remainder of the paper is structured as follows. In Section 2 we describe the dataset used in our empirical analysis, present a graphical overview of the key variables, and briefly review previous work on local linkages in Ireland. Section 3 reports our econometric analysis and findings. Concluding remarks are provided in the final section.

## **2. Multinationals in Ireland, local linkages and data**

### **2.1. Multinationals in Ireland and local linkages**

Ireland is a particularly suitable case study when considering FDI as it has attracted vast amounts of FDI over the past several decades, which has contributed greatly towards its economic growth. Ireland has received vast amounts of FDI from leading MNEs engaged in export-oriented production activities, and is the European headquarters for a number of core technology companies. Ireland is host to the European headquarters for Google, Apple, Facebook, LinkedIn, Dell, Intel and Hewlett Packard are among other companies from the ICT sector located in Ireland. There are over 187,000 people employed in foreign-owned enterprises in Ireland, representing almost one in ten workers in the economy.<sup>6</sup>

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<sup>6</sup> Reported by IDA Ireland 2016 <http://www.idaireland.com/newsroom/fdi-employment/>.

The important role of local linkages to the Irish economy was recognized in the early 1980s, when policymakers became aware that domestic suppliers were failing to reap the potential benefits associated with supplying inputs to foreign firms. The government implemented the National Linkage Programme (NLP) in order to make the most of the presence of foreign firms. This programme was sponsored by the Industrial Development Agency (IDA). The NLP focused on the purchase of raw materials and other inputs (backward linkages) and on the sales of intermediate goods (forward linkages) between domestic firms and foreign firms. The NLP aimed to identify potential purchasers and sub-suppliers in the core export-oriented sectors. This programme resulted in an environment more conducive to Irish suppliers and also helping them in upgrading technology. Nevertheless, some studies show that the level of local linkage developed by foreign firms has remained very low (Kennedy, 1991; Barry and Bradley, 1997; Barry, Bradley and O'Malley, 1999). These studies found that local linkages were significantly higher among domestic firms than foreign firms. Görg and Ruane (2000, 2001), Girma et al (2008), and Görg et al (2011) used data from 1983-1999, and we are not aware of any more recent studies examining local linkages in Ireland, even though the Irish economy is becoming increasingly dependent on foreign investment.<sup>7</sup> Our paper uses data from 2000-2013, examining the interdependence between foreign and domestic firms' local linkages, investigating if they have a similar linkage pattern, and if they have the same implications for domestic suppliers.

## **2.2 Data description**

The data for our analysis is taken from the Annual Business Survey, undertaken over the period 2000-2013 by the Irish Department of Jobs, Enterprise and Innovation. This is a survey of approximately 4,000 client companies of Enterprise Ireland, IDA Ireland and Údarás na Gaeltachta. Only companies employing ten or more employees in Ireland are covered and the sample comprises all Manufacturing and Information, Communication and Other Services sectors.<sup>8</sup> We make use of the fact that the Irish data includes information on the total amount of

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<sup>7</sup> Reported in the Irish Times (2016) <http://www.irishtimes.com/news/social-affairs/ireland-warned-about-overdependence-on-foreign-investment-1.2688148>

<sup>8</sup> The population of the ABSEI survey also includes a small number of High-Potential Start-Up companies with employment of less than 10 where there is an expectation that their employee numbers will exceed 10 in the following survey. To allow for 'non responses' aggregated results are developed by sector using a combined weighting and imputation system. Weighting are used to account for non-respondents and are based on NACE sector, ownership, size and region. Imputations are made where a large company has not responded and are usually based on their responses to previous surveys.

inputs foreign and domestic firms' source from the domestic economy. Our data distinguishes between imported and domestically sourced inputs. However, it is possible that materials and services sourced domestically may have been purchased from foreign affiliates of multinationals located in Ireland rather than domestic firms. Unfortunately the dataset does not separate these two types of domestically purchased inputs. Furthermore, the dataset does not identify the source country or industry of the inputs.

The time series plots in Figures 1a, 2a and 2b indicate that most foreign firms in Ireland are export oriented. We measure export intensity as exports-to-sales ratio. Over the years, the export intensity has remained constant for foreign firms. In early 2000's, Irish firms exported low amounts but following the financial crisis 2007, there has been a surge in exports. Not surprisingly, foreign firms tend to be more productive than Irish firms, as evident by comparing their labour productivity (value-added per employee) or real unit labour cost (payroll to value-added ratio) in Figures 1b, 1f, 2c, 2d, 2e and 2f. Moreover, over time, the pace of productivity improvement is also higher for foreign firms.

We measure local linkages by Irish-sourced inputs (materials, services, and local purchases (material plus service)) per unit output, computed by the ratio of the relevant input costs to value-added.<sup>9</sup> Figure 1 includes time series plots of the three measures of local linkages for the Irish economy. All three linkages of Irish firms - local purchases (Figure 1c), local materials (Figure 1d) and local services (Figure 1e) - exceed substantially those of foreign firms, echoing the findings of the literature cited in Section 2.1.

Figure 3 compares local linkages across the 'Manufacturing and other industry' sector (Figures 3a, 3c, 3e) with the 'Information, communication and other services' sector (Figures 3b, 3d, 3f). It is clear from the time series plots that Irish firms rely more on local inputs than foreign firms in the 'Manufacturing and other industry sector', and that there is not significant changes in their

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<sup>9</sup> Linkages may be measured in many ways; see UNCTAD (2001, p.192) for an overview of various linkages measures and their usage in the literature. Another measurement issue which arises for Ireland is the possibility of profit switching transfer pricing and other accounting behavior resulting in an inflated measure of MNE value added or gross sales and an underestimate of local purchases to increase the country located profits. These factors could potentially reduce the measured linkages level from what it should be on world or market prices. See Foley (1991) for a detail discussion of various measurement issues in the context of Irish data.

behaviour over time. On the other hand, local linkages for the information and communication sector exhibit more volatility over time. The time series suggests that in early 2000 Irish firms started to diversify by purchasing more inputs from abroad per unit output. This trend was followed rapidly by foreign firms until the gap between their local linkages stabilized around 2007.

It is clear from Figures 1 to 3 that the local input usage decisions of Irish and foreign firms are not independent and that they may influence each other. To ascertain their relationship we need a more rigorous empirical framework to which we now turn.

[Insert Figures 1 - 3 approximately here]

### 3. Empirical analysis

#### 3.1 Model specification

Our study examines the extent to which domestic and foreign local linkages influence each other and the dynamics of the impact of exogenous variables on local linkages. We adopt the following bivariate panel-vector autoregressive (VAR) system as our empirical platform, treating domestic and foreign variables symmetrically:

$$Y_{it} = A_1 Y_{i,t-1} + A_2 Y_{i,t-2} + \dots + A_k Y_{i,t-k} + B_1 X_{i,t}^1 + B_2 X_{i,t}^2 + \dots + B_m X_{i,t}^m + \alpha_i + u_{it} \quad (1)$$

$$i = 1, 2, \dots, N; t = 1, 2, \dots, T.$$

where  $Y_{it} = (\textit{linkage\_foreign}_{it} \quad \textit{linkage\_Irish}_{it})'$  is a 2 x 1 vector that contains the local linkage variable of foreign firms and domestic firms in sector  $i$  at time  $t$ ; The 2 x 1 vector  $X_{i,t}^j = (\textit{exogenous\_foreign}_{it}^j \quad \textit{exogenous\_Irish}_{it}^j)$ ,  $j = 1, 2, \dots, m$ , contains explanatory variables originating from foreign and domestic firms that potentially influence local linkages;  $\alpha_i$  a 2 x 1 vector of unobserved, cross-sectional fixed effects; and  $u_{it}$  a 2 x 1 vector of iid random disturbances. The sector-specific fixed effect  $\alpha_i$  controls for unmeasured but time-invariant factors that explain the variations in local linkages across different sectors. The coefficient



matrices  $A_1, A_2, \dots, A_k; B_1, B_2, \dots, B_m$  are all  $2 \times 2$ , with the first (second) row measuring the direct impact of the relevant variable on foreign (domestic) firms. Finally, the regression coefficients can be conveniently interpreted as elasticities as we enter all variables in natural logarithm in estimating the model.

The bivariate autoregressive specification allows the estimation of many interesting interdependence pattern of the local linkages of the two types of firms. In particular, the coefficient matrix  $B_j$  measures the *direct*, instantaneous impact of  $X_{i,t}^j$  on local linkages, whereas the matrix product

$$(I - A_1 - A_2 - \dots - A_k)^{-1} B_j \equiv B_j + C_1 B_j + C_2 B_j + \dots \quad (2)$$

encapsulates also the *indirect*, lingering impacts  $C_1 B_j, C_2 B_j, \dots$ . Of special interest is the cross-impact of an exogenous shock originating from the foreign (domestic) sector on the local linkages of the domestic (foreign) sector. The direct cross-impact will be captured by a non-diagonal  $B_j$  coefficient matrix. Notice that as long as the autoregressive coefficient matrices  $A_1, A_2, \dots, A_k$  are non-diagonal, there will be non-zero indirect cross-impact, even though  $B_j$  may be diagonal. As we shall report below, such indirect cross-impact channel does play an important role in explaining the local linkages of foreign and domestic firms in Ireland.

We include export-intensity, labour productivity and real unit labour cost, for both domestic and foreign firms, as exogenous driving variables. Labour productivity and real unit labour cost are alternative indicators of firm productivity. The choice is motivated by the existing literature. It is well established in previous empirical studies (Görg and Ruane, 2000, 2001; Moran, 2001; Görg et al, 2011) that local linkages are negatively related to the export orientation of firms. One potential explanation is that export-oriented firms may be more aware of foreign sources of supply and more likely to belong to an international network. They therefore may be more likely to diversify their input sources, enjoying the cost advantage of their more extensive supply network. Melitz (2003) theoretically proves that exporting firms have higher productivity levels

than non-exporting firms. His results have been empirically validated by Arkolakis et al. (2012), Harrigan et al (2015) and Görg et al (2016), among others. As such, we would expect that more productive firms in our sample will be exporters and therefore have a lower local linkage.

Each of the two equations in (1) is a dynamic panel regression with lagged dependent variables on the right-hand side. The treatment of the cross-sectional fixed effects requires extra care. It is known (Anderson and Hsiao, 1982) that, in a dynamic panel regression, the conventional fixed effects or random effects estimator are both biased and inconsistent. Further, it is important to ascertain the serial correlation property of the disturbances in the context of our dynamic model, as that is crucial for formulating an appropriate estimation procedure. Following Holtz-Eakin et al. (1988), Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998), we address these econometric issues under a Generalized Method of Moments (GMM) framework. In particular, we adopt the Blundell-Bond system-GMM approach which exploits moment conditions constructed out of (1) and its first-differenced version. The computation is done in STATA Version 12 with Roodman's (2009a, b) xtabond2 package.

[Insert Tables 1 - 3 approximately here]

### **3.2 Empirical results**

Table 1 reports GMM estimation results for the panel-VAR system for local linkages in total purchases--materials plus services--for alternative specifications of the exogenous driving variables. Column (1) includes all 6 available exogenous variables (real unit labour cost, labour productivity and export intensity, for both foreign and domestic firms), whereas the next two columns drop either real unit labour cost or labour productivity from the system to ascertain the individual impact of the two negatively correlated productivity measures. The following findings emerge from the estimation results.

First, the estimated autoregressive coefficients exhibit an interesting asymmetric pattern of the local linkage dynamics of foreign and domestic firms. The impact of lagged linkage levels by either domestic or foreign firms on domestic firms' linkage status are quantitatively small and statistically insignificant, whereas such impact on foreign firms' linkage status are both relatively

large and significant. This suggests that local linkages of domestic firms tend to evolve independently of that of foreign firms and there is not much dynamic lingering impact from exogenous variables. The local linkages of foreign firms, in contrast, would react gradually to exogenous events emanating from *both* foreign and domestic firms, and the impact works through the repercussion effects of lagged linkages of both foreign and domestic firms.

Second, domestic firms' export intensity and productivity are statistically significant in their own linkage equation but not in the foreign firms' equation. Similarly, foreign firms' productivity is significant only in their own linkage equation but not in the domestic firms' equation. The sign of the estimated coefficients is also consistent with prior expectation—export-oriented or highly productive firms should have lower local linkage. Together with the asymmetric local linkage dynamics discussed in the last paragraph, the empirical results imply that (1) domestic firms' export intensity and productivity generate a *direct, instantaneous* impact on their own local linkage status, and also an *indirect, lingering* cross-impact on foreign firms' local linkage status; (2) in contrast, foreign firms' productivity generates *direct, lingering* impact on their own local linkage status, but relatively little cross-impact on domestic firms' local linkage status.

Third, the estimated coefficients of foreign firms' export intensity do not follow a consistent pattern—with both the sign and magnitude vary substantially across the equations—and carry large standard errors. In conjunction with the findings reported in the last paragraph, this suggests that, at least in the context of Ireland, it is the export intensity of domestic firms, rather than that of foreign firms, together with the productivities of both groups of firms that are shaping local linkages in the economy.

Table 2 reports the estimation results for materials linkage which is broadly consistent with that of total purchases linkage discussed above, except that domestic firms' export intensity now generates a sizable direct, instantaneous impact on foreign firms' materials linkage, in addition to the indirect, lingering cross-impact that works through the repercussion effects of lagged linkages of both groups of firms. In summary, the empirical results suggest that the materials linkage of domestic firms appears to be insulated from changes in foreign firms' productivity and

export intensity, whereas the materials linkage of foreign firms is influenced, both directly and indirectly, by domestic firms' export intensity and the productivities of both groups of firms.

The estimation results for services linkage in Table 3 reveal an interdependence pattern that is different from the last two tables. The autoregressive coefficients of the VAR system now exhibit a more symmetrical pattern, indicating that services linkage of domestic (resp. foreign) firms depends on lagged linkages of both domestic and foreign firms. In particular, unlike the cases of total purchases and materials linkage, domestic firms' services linkage is no longer insulated from changes in foreign firms' productivity. Rather, shocks in foreign firms' productivity will generate both direct and indirect lingering impact on domestic firms' services linkage.

### **3.3 Discussion**

The dynamic interdependence between the local linkages of domestic and foreign firms uncovered by our empirical analysis is a reduced form result—it is purely statistical and it says nothing about the economic mechanism through which the observed interdependence emerges. While it is beyond the scope of this paper to uncover the exact mechanism, it is not difficult to imagine a plausible one which may be useful for interpreting our empirical results. Since both foreign and domestic firms procure their local inputs in the same domestic market, it is not implausible that there are interactions or competition between the two groups of firms. Suppose the domestic suppliers' industry is operating on the downward sloping portion of their average cost curves. If domestic firms purchase more inputs, these domestic suppliers will benefit from scale economies, which in turn motivates *both* foreign and domestic firms to purchase more local inputs as domestic suppliers become more efficient. The same argument of course applies equally to increasing demand for local inputs from foreign firms, and it is not hard to imagine, in a dynamic setting, there should also be a second round, third round, ... multiplier effect reverberating back and forth between the two groups of firms. It is this sort of interdependence mechanism that motivates our symmetrical treatment of the local linkages of foreign and domestic firms, exploring how their export orientation, productivity, and local linkages might influence each other over time.

We have also examined the role of export intensity and productivity in determining linkage patterns and performance. There are different interpretations of the causal link. One is that in the case of domestic firms export and productivity performance is an indicator of excellence as opposed to non-exporters and low productivity firms. The former would be relatively strong firms with a particular focus on core activities which often require proprietary and specialized inputs. The weak firms, on the other hand, would undertake more outsourcing to other domestic firms because their activities require only basic services and goods inputs. This explains the statistically significant negative relationship between Irish firms' export intensity/productivity and Irish firms' local linkages found in our empirical analysis. Alternatively, as supported by the literature, export firms are essentially more globalised with higher levels of knowledge about international supply possibilities and hence a lower disposition to source inputs domestically. The same export vs. non-export argument does not apply to foreign firms in our sample because the population of MNEs covered are the "IDA type firms", that is those which use Ireland as an export platform to serve external markets. This may partially explain the insignificant role of foreign firms' export intensity in explaining local linkages in our empirical analysis.

#### **4. Conclusion**

This study shows that local linkages of foreign and domestic firms are interdependent. Estimation results based on Irish data from the years 2000-2013 display an interesting asymmetric pattern in the local linkage dynamics of foreign and domestic firms. We find that local linkages of domestic firms influence local linkages of foreign firms, but domestic local linkages appear to be insulated from the influence of foreign firms. An explanation may be through the supply mechanism in that a higher propensity of domestic firms to source locally reflects an increased local supply capability which in turn increases the willingness of MNEs to source locally. The reverse argument does not apply to domestic firms because they are already predisposed to source locally; it is the MNEs which have to be persuaded because of their global networks and expectations.

Due to data constraints, we can only provide a primary investigation of the extent to which domestic and foreign local linkages influence each other. Further work adopting different

countries' data would provide more evidence. Further, the panel-VAR system that we employ in this paper can only provide reduced-form estimates that confirm the existence of dynamic interdependence between domestic and foreign local linkages. More disaggregated data, perhaps at the plant level, may help identify more clearly the transmission channels and the driving forces behind firms when they are choosing to purchase inputs domestically or from abroad.

In 2015, 46 countries and economies adopted 96 policy measures affecting foreign investment. Of these measures, 71 related to liberalization, promotion and facilitation of investment, while 13 introduced new restrictions or regulations on investment. The share of liberalization and promotion reached 85 percent, which is above the average between 2010 and 2014 (76 percent).<sup>10</sup> Apparently attracting FDI has become a top agenda in the policy goals of policymakers around the world. In host developing countries where domestic firms are lagging behind international best practice frontier, vertical linkages between foreign affiliates and domestic firms is arguably the most important channel for transferring managerial know-how, technology and other competitiveness-related knowledge, all of which are crucial for strengthening the domestic enterprise sector – the bedrock of sustainable economic development. For policymakers who are interested in the creation and deepening of local linkages of foreign affiliates, our analysis suggests that they should take into account the interdependence of foreign and domestic firms' local linkages formation decisions and their potential cross-impact on each other.

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<sup>10</sup> UNCTAD (2016).

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Figure 1

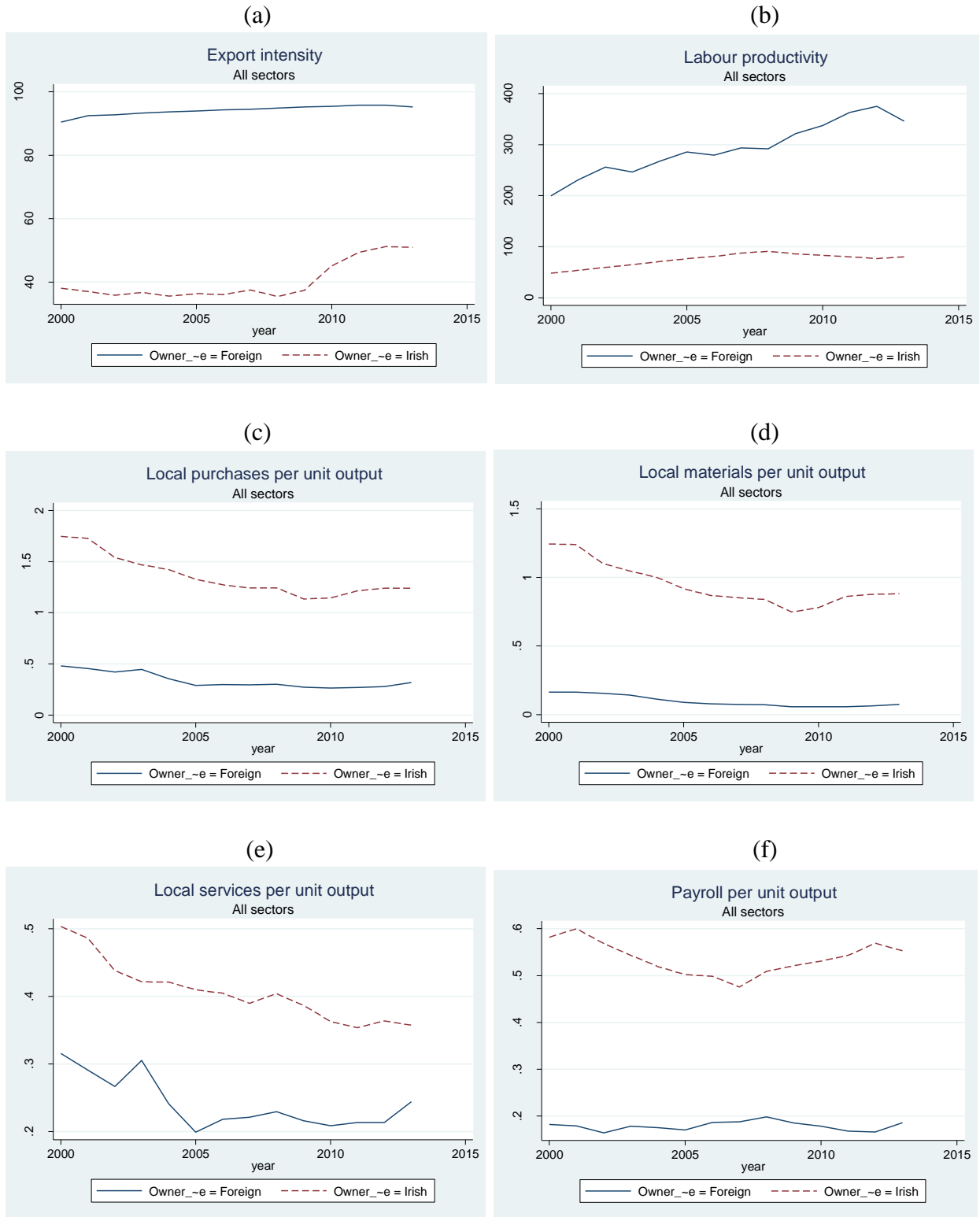


Figure 2

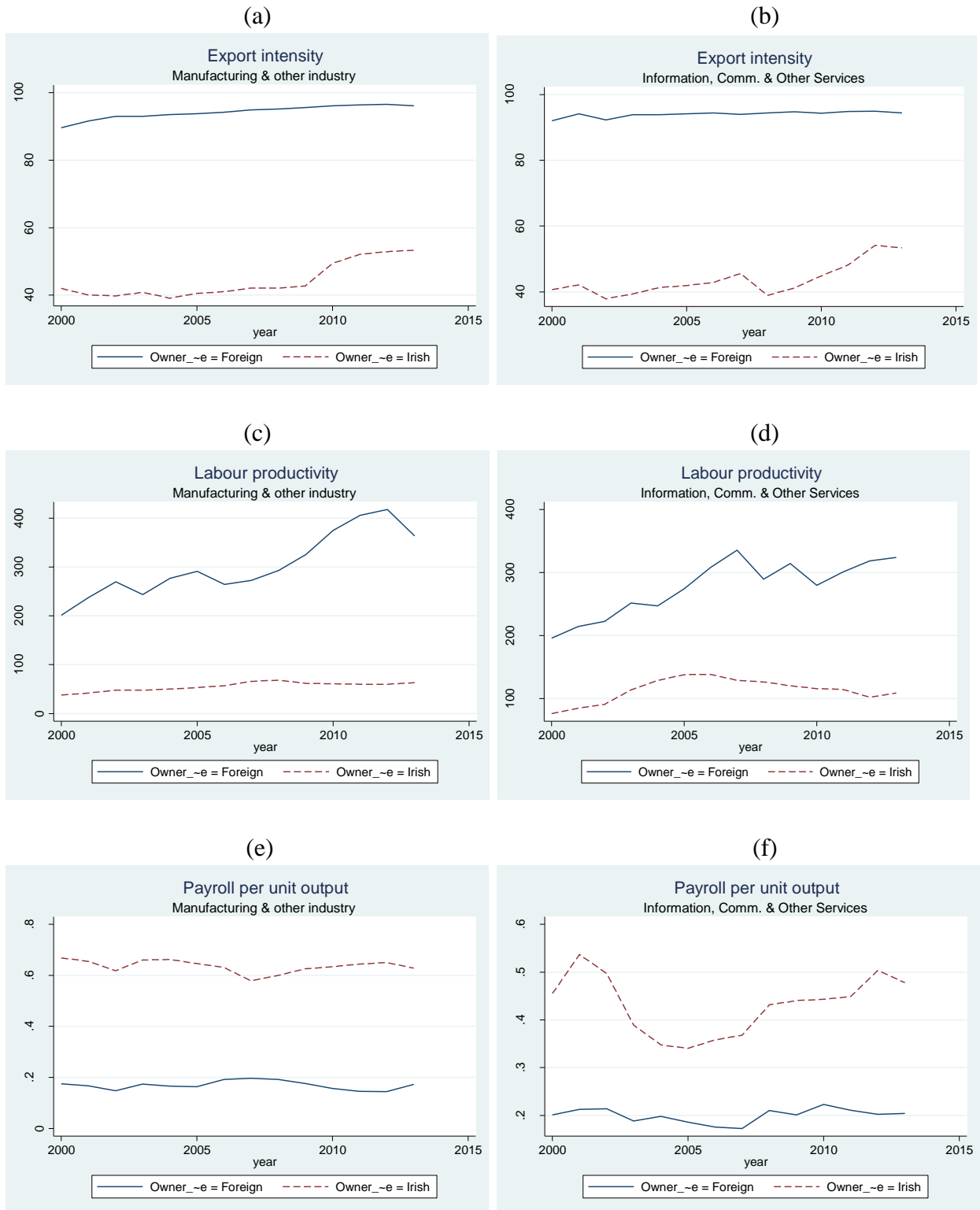


Figure 3

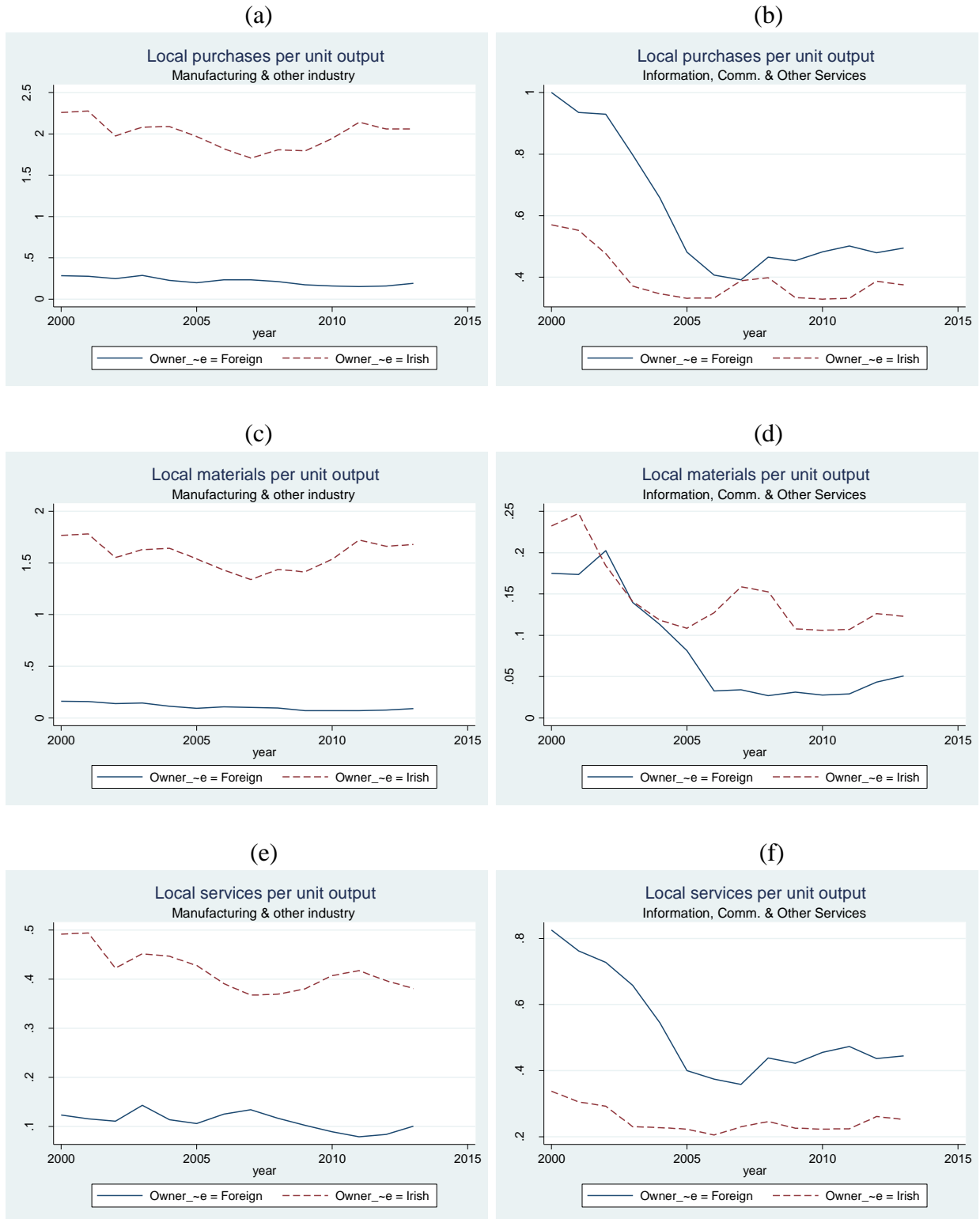


Table 1: GMM estimation of panel-VAR system (materials and services)

Linkage in materials & Services	(1)		(2)		(3)	
	Foreign	Irish	Foreign	Irish	Foreign	Irish
Linkage_foreign (t-1)	.4247 (.2315)**	-.1169 (.2580)	.5710 (.1967)***	-.2259 (.2332)	.4764 (.2536)**	-.0179 (.2498)
Linkage_Irish (t-1)	.1613 (.0797)**	-.0503 (.0685)	.1245 (.0812)*	-.0465 (.0733)	.1169 (.0675)**	-.0329 (.0598)
Unit labour cost_Irish	-.0083 (.0844)	.3677 (.3599)			.0591 (.0425)	.9953 (.0717)***
Labour productivity_Irish	-.0820 (.0926)	-.7049 (.3635)***	-.0493 (.0457)	-1.0526 (.0846)***		
Export intensity_Irish	-.0423 (.0445)	-.4389 (.1210)***	-.0291 (.0314)	-.5048 (.0762)***	-.0050 (.0426)	-.3884 (.0716)***
Unit labour cost_Foreign	1.0615 (.3604)***	.0203 (.6982)			.6041 (.2919)***	.1438 (.2376)
Labour productivity_Foreign	.4406 (.3474)	-.1411 (.5566)	-.3735 (.2449)*	-.2430 (.1357)**		
Export intensity_Foreign	.0429 (.2424)	.2394 (.6374)	-.0451 (.1916)	-.0457 (.6150)	.2918 (.3089)	.4797 (.8934)
Hansen J-statistic (df) [p-value]	13.94 (22) [.903]	18.41 (22) [.682]	17.42 (22) [.740]	20.41 (22) [.557]	18.02 (22) [.705]	20.73 (22) [.537]
Arellano-Bond m1 statistic [p-value]	-1.94 [.052]	-3.12 [.002]	-2.26 [.024]	-3.15 [.002]	-1.78 [.074]	-2.965 [.003]
Arellano-Bond m2 statistic [p-value]	-0.08 [.934]	-1.08 [.282]	-0.05 [.958]	-1.05 [.294]	-0.30 [.762]	-0.83 [.405]
Sector-specific effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: (a) Windmeijer (2005) bias-corrected standard errors in parentheses. Statistically significant estimates are highlighted by asterisks: 10-15% (\*), 5-10% (\*\*), below 5% (\*\*\*). (b) Sample size = 247 for all regressions. (c) The instrument count is 31 for all regressions. Roodman's (2009a,b) collapsed instrument matrix technique has been invoked to reduce the instrument count. (d) The Hansen J-statistic tests for over-identifying restrictions arising from the availability of more instruments than unknown parameters to be estimated. An insignificant J-statistic indicates that the model has been correctly specified. (e) The Arellano-Bond (1991) m1 and m2 statistics test for the presence of AR(1) and AR(2) in the first-differenced residuals. A correctly specified model should exhibit statistically significant m1 but insignificant m2. (f) The lag length of the VAR system is chosen by the Andrew-Lu (2001) model selection procedure for GMM estimation.

Table 2: GMM estimation of panel-VAR system (materials)

Linkage in materials	(1)		(2)		(3)	
	Foreign	Irish	Foreign	Irish	Foreign	Irish
Linkage_foreign (t-1)	.7537 (.0909)***	.0444 (.1578)	.7430 (.0878)***	.0576 (.1316)	.7916 (.0646)***	.2489 (.0955)***
Linkage_Irish (t-1)	.1026 (.0694)*	-.0342 (.0412)	.0963 (.0940)	-.0222 (.0392)	.0724 (.0815)	-.0372 (.0348)
Unit labour cost_Irish	.0478 (.1358)	-.0581 (.9829)			.0744 (.0472)*	1.3564 (.1849)***
Labour productivity_Irish	-.0579 (.1597)	-1.6178 (1.0448)*	-.0821 (.0646)	-1.6996 (.1644)***		
Export intensity_Irish	-.1090 (.0504)***	-.7978 (.1908)***	-.1221 (.0505)***	-.8847 (.1023)***	-.0907 (.0459)***	-.7185 (.0899)***
Unit labour cost_Foreign	.3830 (.3487)	.5456 (.9501)			.4718 (.1510)***	-.1547 (.1905)
Labour productivity_Foreign	-.1040 (.3816)	.5201 (.6212)	-.4833 (.2018)***	-.2031 (.2005)		
Export intensity_Foreign	-.2491 (.2518)	-.1812 (1.6161)	-.1313 (.2076)	-.5146 (.7087)	-.1800 (.2677)	-.5763 (.8934)
Hansen J-statistic (df) [p-value]	16.94 (22) [.767]	14.87 (22) [.868]	21.51 (22) [.489]	17.20 (22) [.752]	18.81 (22) [.657]	17.96 (22) [.709]
Arellano-Bond m1 statistic [p-value]	-2.31 [.021]	-2.67 [.008]	-2.34 [.019]	-2.80 [.005]	-2.31 [.021]	-2.81 [.005]
Arellano-Bond m2 statistic [p-value]	-0.47 [.636]	-0.08 [.935]	-0.28 [.777]	0.01 [.990]	-0.22 [.830]	-0.23 [.820]
Sector-specific effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: See table 1.

Table 3: GMM estimation of panel-VAR system (services)

Linkage in services	(1)		(2)		(3)	
	Foreign	Irish	Foreign	Irish	Foreign	Irish
Linkage_foreign (t-1)	.3494 (.2205)*	-.3449 (.1397)***	.4879 (.1929)***	-.3794 (.1504)***	.3442 (.2444)	-.2917 (.1683)**
Linkage_Irish (t-1)	-.0946 (.0771)	-.0944 (.0357)***	-.2180 (.0704)***	-.0907 (.0495)**	-.1366 (.0921)*	-.0894 (.0380)**
Unit labour cost_Irish	-.1386 (.1382)	.6569 (.1349)***			-.0375 (.0327)	.7756 (.0874)***
Labour productivity_Irish	-.1145 (.1320)	-.1012 (.1189)	.0465 (.0291)*	-.7142 (.1266)***		
Export intensity_Irish	-.0363 (.0377)	-.3673 (.0853)***	.0062 (.0302)	-.4398 (.0876)***	-.0074 (.0429)	-.3513 (.0939)***
Unit labour cost_Foreign	.7736 (.3850)***	-.1492 (.3564)			.5462 (.2204)***	.1653 (.0797)***
Labour productivity_Foreign	.2360 (.3928)	-.3254 (.2839)	-.3488 (.1334)***	-.2035 (.0512)***		
Export intensity_Foreign	-.1169 (.2898)	.0636 (.1413)	.1376 (.2128)	-.1619 (.8537)	.0943 (.4606)	-.1858 (.7923)
Hansen J-statistic (df) [p-value]	13.27 (22) [.925]	14.25 (22) [.892]	11.35 (22) [.969]	19.23 (22) [.631]	13.41 (22) [.921]	18.96 (22) [.648]
Arellano-Bond m1 statistic [p-value]	-1.66 [.096]	-3.82 [.000]	-1.92 [.055]	-3.67 [.000]	-1.46 [.142]	-3.82 [.000]
Arellano-Bond m2 statistic [p-value]	1.09 [.278]	-1.96 [.050]	0.73 [.466]	-1.63 [.104]	0.77 [.440]	-1.75 [.081]
Sector-specific effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: See table 1.