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Görg, Holger; McHenry, Michael E.; Strobl, Eric; Walsh, Frank A.

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Multinational companies, backward linkages and labour demand elasticities

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Multinational Companies, Backward Linkages and Labour Demand Elasticities

Holger Görg, University of Nottingham,
Michael Henry, Aston Business School, Aston University,
Eric Strobl, Ecole Polytechnique Paris and SALISES
and Frank Walsh, University College Dublin

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Multinational companies, backward linkages and labour demand elasticities

Holger Görg
University of Nottingham

Michael Henry
Aston Business School, Aston University

Eric Strobl
Ecole Polytechnique Paris and *SALISES*

Frank Walsh
University College Dublin

Abstract

This paper investigates the link between nationality of ownership and wage elasticities of labour demand at the level of the plant. In particular, we examine whether labour demand in multinationals becomes less elastic with respect to the wage if the plant has backward linkages with the local economy. Our empirical evidence, based on a rich plant level dataset, shows that the extent of local linkages indeed reduces the wage elasticity of labour demand. This result is economically important and holds for a number of different specifications.

JEL Classification: F23, J23, L23

Keywords: labour demand, elasticities, linkages, multinational companies

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1 Introduction

It has been well established in the empirical literature that workers in industrialised countries have experienced higher job insecurity over the last decades, both in terms of higher volatility of employment spells and earnings (e.g., OECD 1997). "Globalisation" has been made at least partly responsible for these trends, certainly in the popular debate as well as among academics (e.g, Rodrik, 1997; Scheve and Slaughter, 2004). Of all the drivers of globalisation - trade, migration of workers, and foreign direct investment (FDI) - FDI is probably the most visible. It is also likely to be, at the margin, the most important aspect of globalisation in economic terms. For instance, over the last two decades global FDI flows have grown at least twice as fast as trade, now well exceeding $500 billion and resulting in a total stock of more than $8 billion (United Nations, 2004).

It is not surprising then, that the potential "footloose" nature of FDI in response to changes in production costs elsewhere has raised some concern about the jobs created through FDI, despite the generally higher wages associated with such employment (see Conyon et al., 2002). As a matter of fact, these fears have recently come to the fore in the wake of a number of plant closures by high profile multinationals in Europe, often attributed to lower wages elsewhere. For example, the Japanese multinational Sony announced the closure of one of its plants in Wales in June 2005, with the resulting loss of 650 jobs due to the availability of lower production costs elsewhere.[1]

It is important to note, however, that the potential "footloose" nature of FDI is only one possible response to changes in production costs.[2] Alternatively, multinationals may, rather than completely shutting down production, simply downsize their operations and shed labour in the light of the availability of cheaper labour elsewhere. Thus, if one is to

[1] http://www.personneltoday.co.uk/Articles/2005/06/30/30593/Sony+slashes+650+UK+jobs.htm
[2] Bernard and Sjöholm (2003) and Görg and Strobl (2003) find that multinationals have higher exit probabilities than comparable domestic plants, a finding in line with this argument.

capture the complete picture of lower job stability in multinationals then one arguably also needs to investigate differences in the wage elasticity of multinationals relative to the indigenous industry. In this regard, there are only a few studies which compare the wage elasticity of labour demand in multinationals and domestic firms. Fabbri et al. (2003) discuss the issue and illustrate the theory with a standard neo-classical labour demand framework. Their idea is quite straightforward: multinationals are part of global production networks and, within these networks, can more easily transfer production in response to changes in costs (in particular wages). Using industry level data they find an increase in wage elasticities of labour demand (conditional on output) over time for low skilled US and UK manufacturing workers and argue that increased activity of multinationals may be partially responsible for this. By contrast Barba-Navaretti et al (2003) in a cross country firm level study of a group of European countries find that, in most countries, multinationals adjust their labour demand more rapidly than domestic firms in response to shocks, but have a more inelastic demand curve with respect to wages. They argue that multinationals have a more rigid demand for labour due to differences in skill structure.[3]

The current paper re-examines the link between nationality of ownership and the wage elasticity of labour demand, but specifically investigates whether efforts at integrating multinationals in the local economy through backward linkages can reduce their volatile nature by affecting their elasticity of labour demand.[4,5] Our argument that this is likely to be the case rests on the idea that locally purchased inputs may be more difficult to substitute for labour than other inputs. This may be plausible under the assumption that

[3] The paper by Konings and Murphy (2001) is also somewhat related. They look at the extent to which multinationals substitute employment towards parent plants in response to wage changes. They find evidence of substitution between EU parent firms and their subsidiaries rather than towards low wage subsidiaries outside the EU. In addition, Slaughter (2001) looks at labour demand elasticities in the US to see whether increased openness to trade has increased the demand elasticity and found little support for this hypothesis.
[4] We do not consider plant exit in this paper.
[5] Our paper is, hence, also related to the recent literature on productivity spillovers from FDI, which argues that spillovers are most likely to occur through multinationals' backward linkages with domestic suppliers (Javorcik, 2004).

locally sourced inputs are to some degree "specific" due to, e.g., better quality and availability, or lower transport costs than imported inputs. To discuss these points in more detail we present a simple framework that highlights how such channels are likely to affect labour demand.

Using a rich plant level data set for manufacturing plants in the Republic of Ireland we then empirically investigate whether wage elasticities depend on the extent of local backward linkages and whether this is more important for foreign multinationals than for indigenous firms. Arguably, Ireland is a particularly interesting case study in this regard given that its manufacturing industry is heavily dependent on foreign multinationals, and also the fact that foreign plants account for about half of total employment. Moreover, Ireland has operated a number of explicit policy programmes to foster linkages between foreign multinationals and domestic suppliers (Ruane, 2001).

The remainder of the paper is structured as follows. Section 2 provides the theoretical background for our analysis. Section 3 outlines the empirical approach, and Section 4 describes the data sources. The empirical results are discussed in Section 5 while Section 6 concludes.

2 Theoretical background

We consider a foreign owned plant as a subsidiary of a multinational firm that has already decided to locate the plant, thereby incurring fixed costs, and also has an upward sloping marginal cost curve. Because the firm has several plants in different locations we assume the plant is a price taker and the multinational firm will minimise costs by equalising marginal costs across all plants. The head office may have market power and will equalise marginal costs across all plants. Thus the subsidiary will look like a textbook competitive firm where the plant manager has to maximise profits choosing output at a

price fixed by head office, where the price equals the marginal cost of plants in other locations. This means that for a foreign affiliate located in a host country we assume the impact of an increase in local wages on the firms output price, which is a function of the firm's global production costs, to be negligible. The plant is hence will have a fixed price, a u-shaped average cost curve due to fixed costs and increasing marginal costs.[6]

In order to illustrate our argument as to why backward linkages with domestic suppliers may impact on labour demand elasticities we summarise the well known neo-classical conditional labour demand model.[7] A price taking affiliate has a production function with *n* inputs:

$$y = f(x_1,...x_n) \qquad (1)$$

The price of each factor i is w_i and total costs are $c = F + w_1x_1 + w_2x_2... + w_nx_n$. The Lagrangian function for cost minimisation is:

$$\ell = w_1x_1 + w_2x_2.. + w_nx_n + l[y - f(x_1..x_n)] \qquad (2)$$

The share of any factor j in variable costs is s_j. The elasticity of substitution between labour (factor 1) and any other factor j is s_{1j}.

We show in the appendix that the labour demand elasticity conditional on output is:

$$h_{11}^* = \frac{\partial x_1}{\partial w_1}\frac{w_1}{x_1} = \frac{\sum_{j\neq 1}^{n} s_{1j} f_j x_j}{\sum_{i=1}^{n} f_i x_i} = \sum_{j=1}^{n} s_{1j} s_j \qquad (3)$$

[6] The plant may make profits in contrast to a competitive firm since we do not expect free entry to dissipate profits.

[7] See also Fabbri et al. al (2003) who use this framework to motivate differences in labour demand elasticities between foreign and domestic owned firms, or Hammermesh (1993) for a more general discussion.

Other things equal, equation (3) tells us that the labour demand elasticity is determined by two aspects, namely, the elasticity of substitution between labour and the other factor *j*, and the share of factor *j*.[8]

There are a number of issues with regard to (3) that are important to point out for our task at hand. First, with regard to labour's share in total cost, since theoretical frameworks outlining multinational firms suggest that such firms will have fixed costs (e.g. Markusen, 2002), one should be wary about looking at labour's share in output as a proxy for *s*, as it is labour's share in variable costs that is relevant to the demand elasticity. For example, affiliates whose parent has incurred significant advertising or R&D costs may have very high output per worker, so that labour costs may be a small share of output but a much larger share of variable costs.

Equation (3) also suggests that, if locally purchased inputs are more difficult to substitute for labour than other inputs (low s) firms that purchase more local inputs will have smaller elasticities. This may be plausible under the assumption that locally sourced inputs are to some degree "specific" due to, e.g., better quality and availability, or lower transport costs than imported inputs. As an example, a multinational firm switching sourcing from a supplier abroad to a local is then in a better position to obtain specific design or quality standards, perhaps with the help of providing assistance to the local supplier in the first instance.[9] Therefore, it may be less likely to substitute the locally sourced input for labour than the previously imported input.[10]

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[8] While equation (3) is well known we derive it explicitly in the Appendix to point out two important points that will be relevant to our analysis. First while much of the literature using equation (3) assumes constant returns to scale, this is not necessary. Secondly, s_l is labour's share of *variable* costs, not *total* costs. A firm may incur non-recoverable fixed costs, e.g., from advertising or R&D, or other start-up costs to enhance output per worker but these will not affect the calculation in equation (3).

[9] Moran (2001) provides plenty of case studies between foreign subsidiaries and domestic suppliers and provides evidence of such assistance.

[10] An additional possible explanation is that firms that locate close to an input source do so partly because local inputs are more difficult to substitute for, and that these may often be inputs such as agricultural commodities in food and drink production etc. Think of a foreign owned producer of a food or drink product who would find it difficult to substitute away from labour with a software firm who has skilled labour to some

One of Marshalls well known rules of labour demand is that it will be less elastic the more elastic is the supply of other inputs.[11] The intuition is that if the supply of another input (say capital) is steep, a rise in wages will increase the demand for capital as firms substitute from labour into capital, but this will drive up the price of capital limiting the degree to which firms will substitute. For the two factor case, Appendix 2 shows how an increase in the price of the other factor reduces the conditional demand elasticity, summarised in equation (4)

$$h_{11}^{*} = -s s_2 (1 - h_{w_2 w_1}) \qquad (4)$$

The two factor analogue of (3) is $h_{11}^{*} = -s s_2$ and $h_{w_2 w_1}$ is the percentage change in the price of factor 2 (w_2) associated with a percentage change in w_1. A rise in wages (price of factor 1) will induce firms to substitute from labour into other inputs. To the extent that these are purchased in the domestic economy firms will increase the demand for such inputs and drive up the price, hence limiting the extent of substitution away from labour. Firms who substitute from labour into inputs sourced abroad would not expect the same to be true if a small country has little impact on the world price of that factor. Hence, their labour demand should be more elastic with respect to the wage rate than that of firms using local inputs.

Fabbri et. al (2003) argue that multinationals may have more elastic demand than domestic firms because firms with global production networks may be able to more easily import intermediate goods that could alternatively be produced by domestic labour. They argue that this is especially likely if a firm is vertically integrated internationally and different plants engage in intra-firm trade. To see how this argument fits into our

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degree at a fixed output level. (Kennedy, 1991) provides evidence that backward linkages in the former industry are much higher than in most other manufacturing industries, including the computer industry.) However, in the econometric analysis below we focus on within firm changes, rather than differences across sectors, hence this explanation is less relevant to our analysis.

[11] See Hicks (1968) Appendix to chapter XI for a formal derivation in the constant returns to scale case, and Hamermesh (1993) for a more general discussion.

framework we assume that the multinational subsidiary produces two outputs y_1 and y_2 where y_2 is an intermediate input which can be produced in the subsidiary or imported at a fixed marginal cost from another branch of the company and y_1 is output of the final good. We assume the firm has two separate production functions for the two goods within the plant for simplicity where *a1* is the fraction of the workforce producing the final good and *a2* the fraction producing the intermediate good. If we estimate the demand elasticity for the plant holding final output fixed this does not condition on output of the intermediate input. The overall elasticity estimate conditional on final output will be:

$$h_{ll}^{*} = a_1 h_{ll}^{*1} + (1 - a_1) h_{ll}^{2} \qquad (5)$$

where h_{ll}^{*1} is the conditional demand elasticity for employment of the final good and h_{ll}^{2} is the unconditional demand for the intermediate good which for a given elasticity of substitution may be substantially larger than the conditional elasticity[12]. We might speculate that their conjecture that firms can easily transfer some stages of production to another subsidiary for a given final output would be less relevant for firms that purchase a large share of primary inputs locally.

3 Description of the data

The preceding discussion illustrates that there are plausible reasons why one might expect the source of inputs to matter for foreign firms' labour demand elasticities. We now turn to examining this issue empirically. The data for our analysis are taken from the *Irish Economy Expenditure Survey* (IEE), undertaken annually by Forfas, the government agency

[12] Appendix A3 derives the unconditional elasticity for the two factor case and a production function that is homogeneous of degree r. The unconditional elasticity is $h_{11} = -[s s_2 + \frac{s_1}{(1-r)r}]$ while the two factor analogue of the conditional elasticity is $h_{11}^{*} = -s s_2$. While s_i represents the share of variable costs in one case and output in the other clearly the unconditional elasticity may be much larger.

with responsibility for enterprise development, science and technology. This is an annual survey of plants in Irish manufacturing with at least 20 employees, although a plant, once it is included, is generally still surveyed even if its employment level falls below the 20 employee cut-off point. The survey provides plant level information on, *inter alia*, output, employment, nationality of ownership, as well as details on plants' expenditure on labour and other inputs.[13] The response rate to this survey is generally estimated to be between 60 and 80 per cent of the targeted plant population.

The data cover the period 1983-1998 and provide an unbalanced panel for 2,675 plants. Foreign-owned plants are defined in the data as those that are majority owned by foreign shareholders. A look at the data shows that total exits over this period in our data only account for 3.3 percent of total plants. By way of summary statistics, Figure 1 shows the development of total employment in foreign and domestic plants in Irish manufacturing over the sample period. One should note that employment in foreign-owned plants has increased more rapidly than domestic employment, with a growth from around 58,000 to almost 100,000 employees in 1998.

[Figure 1 here]

The IEE survey also includes information on plants' expenditure on intermediate inputs and breaks this down into domestically sourced and imported intermediates and we use this information to calculate our measure of local sourcing. More precisely, we calculate a linkage indicator as the percentage of inputs sourced locally (see, e.g., Görg and Strobl, 2002; Kennedy, 1991; Cohen, 1973). Table 1 shows the development of total backward linkages in 1983 and 1998 respectively by NACE 2 digit industry.

[Table 1 here]

[13] Note that the dataset does not allow us to distinguish skill groups for workers, thus we treat labour as homogeneous.

One should note, firstly, that foreign-owned plants on average have lower linkages than domestic plants, although there are some of exceptions (e.g., 19 - leather, in 1998). Moreover, the table highlights sectoral differences with the highest linkages occurring for domestic plants in sectors 30 (computers & office machinery) in 1983 and 15 (food & beverages) in 1998, and for foreign plants in sectors 27 (basic metals) in 1983 and 19 (leather) in 1998. As expected, there are significant differences in linkages between foreign and domestic plants, most noteworthy perhaps in sector 30 (office machinery) in 1983, although this difference has all but disappeared in 1998. The table also shows that for multinationals, backward linkages have generally increased over the 1983 to 1998 period. This may at least in part reflect the emphasis of the *National Linkage Programme* in Ireland on creating linkages between foreign multinationals and local suppliers (Ruane, 2001).

4 Estimating labour demand elasticities

4.1 Differences between foreign and domestic plants

The first step in our empirical analysis is to establish whether in our dataset there are differences in labour demand elasticities between domestic and foreign owned plants. In order to do so we specify the following dynamic conditional labour demand function for plant *i* in year *t*,

$$L_{it} = a_1 L_{it-s} + a_2 w_{it} + a_3 y_{it} + b_1 x_{it} + b_2 (xw)_{it} + b_3 (xy)_{it} + d_t + d_i + e_{it} \qquad (7)$$

where L, w, and y are logged values of employment, wages per head, and output, respectively. The variables d_t, d_i, and e are time specific effects, plant specific time invariant effects, and an i.i.d. error term, respectively; all unobservable to the econometrician.[14] Depending on observations per plant one may want to include up to t-s

[14] A static version of the equation including only w and y can be derived from a Cobb-Douglas production function using labour and capital as inputs. The cost of capital is difficult to measure at the plant level. We

lagged dependent variable in the equation, since, arguably, labour demand may be dynamic in nature because of a non-smooth adjustment process in plants' employment policy (see, for example, Hamermesh, 1993). One should note in this regard, that while we experimented with several lags these only proved to be significant up to t-2, and we thus report on results for specifications including lags t-1 and t-2 of the dependent variable. *x* in (7) is a dummy variable equal to one if a plant is foreign-owned and zero otherwise. This variable is interacted with *w* and *y* to allow for nationality of ownership differences in the wage and output elasticity.

In terms of estimation of equation (7) one should note that simply using OLS is likely to prove problematic. Specifically, employment is likely to be simultaneously determined with output and may also affect plant level wages if the plant is not a price taker in the local labour market. If such an endogeneity bias were time invariant then simply first differencing the data would provide a possible solution. However, given the length of the panel of individual plants (up to 15 years) this is unlikely to be the case.[15] In order to take account of this problem while also controlling for plant specific fixed effects, we thus resort to using the now popular GMM systems estimator developed by Blundell and Bond (1998). Accordingly, one simultaneously estimates first differenced and level versions of the estimating equation, where for the former appropriately lagged values and for the latter appropriately lagged differences of the endogenous variables can serve as valid instruments. The validity of these instruments can be tested using a Sargan-type test. The consistency of our estimates also rests on the assumption that there is no second order correlation of the residuals of the first-differenced equation. The standard procedure to verify this is to use an AR(2) test on the residuals developed by Arellano and Bond (1991).

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assume that the cost of capital is the same for all plants in the economy and is, hence, captured by time dummies.

[15] The inclusion of the lagged dependent variable would render a simple fixed estimator inappropriate in this context.

The results of estimating equation (7) are reported in Table 2. One should note, firstly, that the Sargan test provides some support for our instruments. As pointed out above, consistency of the estimates also relies on no second order autocorrelation. The AR(2) test indicates, reassuringly, that we cannot reject the hypothesis of no second order autocorrelation at conventional levels of statistical significance. Turning to the results, we find from column (1) that the wage and output elasticities look economically sensible – they are negative and positive, respectively, and statistically significant in both cases. The point estimates are also well within the range of those generally found in the literature (e.g., Barba Navaretti et al., 2003). More importantly, the significant coefficients on the interaction terms suggest that multinationals respond differently to wage changes in terms of their demand for labour. Specifically, the wage elasticity for multinationals is higher (in absolute terms) than for domestic plants; a result found by Barba Navaretti et al. (2003) for Finland and Sweden. We do not find any statistically significant differences in the output elasticities, however. Column (2) provides a robustness check, allowing for further lags in the wage and output variables. However, we still find statistically significantly higher wage elasticities for multinationals compared to domestic plants. Overall, the results thus far seem to suggest that it is more reasonable to estimate the effect of linkages on elasticities separately for domestic and foreign plants.

[Table 2 here]

4.2 Linkages and labour demand

If multinationals have higher labour demand elasticities than domestic firms it may indeed be the case that they are more likely to reduce labour demand than comparable domestic plants if labour costs increase. The issue now becomes whether further integration of multinationals through local linkages may provide a counter force to this, and

as discussed in Section 2, there may be reasons to think that it does. In order to investigate this issue we examine whether labour demand elasticities depend on the degree to which multinationals are integrated into the local economy. More specifically, we estimate a dynamic conditional labour demand function, similar to equation (7) as

$$L_{it} = g_1 L_{it-s} + g_2 w_{it} + g_3 y_{it} + l_1 link_{it} + l_2 (link * w)_{it} + l_3 (link * y)_{it} + d_t + d_i + e_{it} \tag{8}$$

where *link* is the measure of local linkages which is interacted with *w* and *y*. Hence, $g_2 + l_2 (link)_{it}$ represents the wage elasticity of labour demand, which by construction depends on the degree of local linkages. The crucial point of the analysis is, hence, whether l_2 is statistically significantly different from zero.

Table 3 shows the results of estimating equation (8) for different groups of plants. Column (1) reports elasticities based on the full sample of plants, including foreign and domestic owned establishments. The results indicate that there is no statistically significant impact of linkages on the wage elasticity of labour demand for the overall sample. However, breaking down the total sample into that of domestic and foreign plants reveals some interesting differences across nationality of ownership. Specifically, the estimates in column (2) show that for foreign owned multinationals the wage elasticity increases with the level of local linkages, in line with our expectations discussed in Section 2. By contrast, in column (3) one discovers for domestic plants that there are no statistically significant effects of local linkages on the wage elasticity. This could perhaps reflect the fact that domestic plants source different types of inputs locally, which may be easily substitutable for local labour, hence there may be no effect of increased linkages on the elasticity.[16]

[16] Unfortunately our dataset does not distinguish different types of inputs, hence we cannot follow up this conjecture with further analysis.

Using the point estimates in column (2) implies that the wage elasticity of labour demand for a foreign owned plant with zero linkages is 0.412, whereas a plant with a mean level of local linkages has a wage elasticity of 0.362. Increasing the degree of linkages by two standard deviations from the mean then implies a further reduction in the elasticity to 0.303. Hence, the estimated coefficients are not only statistically, but also economically, significant.[17] One may want to notice also that even if a foreign plant had a linkage coefficient of 1 its wage elasticity would still be substantially higher (at 0.294) than that of a domestic plant (at 0.223). Hence, while linkages may help to reduce the elasticity they are not enough to explain away the higher elasticities in foreign than in domestic plants.

[Table 3 here]

Robustness checks

One possible concern with the estimation above is that labour demand elasticities may depend on size of the plant (Hamermesh and Pfann, 1996) and our results may therefore just reflect the fact that multinationals are generally larger than domestic plants, and that larger firms have higher linkages (as found by Görg and Ruane, 2001 and Alfaro and Rodriguez-Clare, 2004). There are a number of arguments to counter this concern. Firstly, size is taken into account in the labour demand equation, although of course the standard specification does not allow the wage elasticity to depend on size. Secondly, the *link* variable as well as its interaction with output and wages is treated as endogenous in our system GMM estimations, to deal with the potential criticism of the effect of correlated unobserved characteristics that may affect the elasticity. Hence, we would argue that our results do not just reflect the impact of unobserved characteristics. However, we also provide a robustness check to deal more directly with the issue of plant size. We classify

[17] In 1998, the mean ratio of locally sourced inputs over total inputs for foreign owned plants is 0.42 (see Table 1), the standard deviation is 0.25.

plants into three size categories: small, medium and large (the exact definition is given below Table 4) and estimate equation (8) on these different samples separately. Table 4 presents these results for foreign multinationals and domestic plants.[18] Our findings on the effect of linkages for multinationals still hold. While we indeed find that wage elasticity differs by size class we also find that for all size groups, increased linkages are associated with reductions in these elasticities. Hence, our previous findings are not just reflections of the fact that we do not take into account size differences in the estimation of wage elasticities.

[Table 4 here]

Another robustness check concerns our measure of linkages. Rodriguez-Clare (1996) argues that the indicator of locally sourced inputs over total inputs may not be an appropriate indicator of local linkages for the purpose of gauging multinationals' effects on local development. Assuming that multinationals are likely to be more intensive users of intermediates than domestic firms he shows in his theoretical model that in order to measure the relative importance of multinationals' local linkages what matters is the ratio of domestically sourced inputs relative to employment in the plant.[19] However, his model is about the effect of linkages on output in the economy and the linkage index is derived for that purpose. Given that we are interested in labour demand it is not clear, therefore, whether this index should be considered superior to our linkage measure in our context. Nevertheless, in order to take this issue into account, we define an alternative measure of

[18] Note that the test statistics for AR(2) are problematic for samples of small foreign and domestic plants. Hence these results should be interpreted with caution. We did not search for different sets of instruments so that we can have the same set of instruments across all specifications in the paper.

[19] Alfaro and Rodriguez-Clare (2004) present empirical evidence using firm level data for a number of Latin American countries on this proposition. They show that multinationals indeed have higher intensities of intermediate inputs compared to domestic firms.

local linkages as a plant's inputs sourced in Ireland relative to its employment and use this in our labour demand estimation.[20]

Estimating equation (8) using this definition of linkages does not change our conclusion, as shown in Table 5.[21] We still find a statistically significant and positive coefficient on the wage interaction term in column (1), indicating that foreign owned plants reduce their wage elasticity of labour demand with increasing integration into the local economy. This is not the case for domestic plants, however. Again using the point estimates the results in column (1) suggest that the wage elasticity for a foreign plant with mean level of local linkage is 0.349, compared with an estimated elasticity of 0.362 for plants with zero linkages. Increasing the linkage coefficient by two standard deviations from the mean leads to a further reduction to 0.298.[22]

[Table 5 here]

Another issue stems from the unbalanced nature of our panel data which contains exit, so that if the probability of exit were correlated with degree of local linkages and employment then our results may be biased. For example, foreign multinationals may have more sunk costs the more integrated they are into the local economy and hence may be less likely to exit. However, exiting plants are also likely to adjust their employment differently prior to exit. As argued in Section 3, there is very little exit in our data and, hence, it may be considered negligible in our analysis. Regardless, we report some additional specifications to ensure that are our results are not biased due to plant exit. In this regard, Columns (1) to (3) of Table 6 report regressions on the sample of surviving plants only,

[20] In the data appendix we provide some summary statistics for this measure of linkages similar to Table 1.

[21] One interesting difference between the results in Tables 3 and 5 is the difference in the sign on the local linkages term on its own. It is statistically significant and positive in the former, yet negative in the latter set of regressions. This is likely to reflect the differences in measurement, where the second indicator takes into account that there may be differences in the intensity of input use between domestic and foreign-owned plants. However, it is reassuring to note that the impact of linkages on the wage elasticity of labour demand is unaffected by the choice of linkage coefficient.

[22] In 1998, the mean level of locally sourced inputs per employee in foreign owned plants is 64.7, the standard deviation is 126.5.

thus excluding exitors, Columns (4) to (6) include a dummy variable equal to 1 in the year prior to plant exit, and Columns (7) to (9) include a dummy equal to 1 for the whole lifetime of a plant that exits the data. While we find that the dummy variables are all statistically significant, we also find that the positive and statistically significant coefficient on the interaction of linkage and wages for foreign-owned plants is robust in all three estimations, with magnitudes similar to that found in Table 3. Moreover, once controlling for exit by including dummy variables there are statistically significant and positive interaction terms for domestic plants also. Hence, our result that higher local linkages decrease wage elasticities of labour demand is robust to the different ways of dealing with the potential bias introduced through plants exiting the dataset.

[Table 6 here]

Finally, Table 7 provides a further robustness check, estimating variants of equation (8) including additional lags for *w* and *y*. These estimations show that the result on wage elasticities remains for foreign owned plants. Furthermore, they suggest that labour demand in domestic plants also becomes less elastic with respect to the wage rate as linkages increase.

[Table 7 here]

6 Conclusions

This paper investigates the link between nationality of ownership and labour demand elasticities at the level of the plant. In particular, we examine whether labour demand in multinationals (or other domestic firms) becomes less elastic if a plant has backward linkages with the local economy. We have in mind the simple idea that locally purchased inputs may be more difficult to substitute for labour than other inputs, due to the very nature of the inputs. Our evidence shows that the extent of local linkages indeed

reduces the wage elasticity of labour demand for foreign owned plants. In robustness checks we find that the results hold when allowing for plant heterogeneity in terms of size, for alternative measures of local linkages (e.g. the level of locally sourced inputs per employee), when taking account of exit, and when allowing for different lag structures in the labour demand equation.

While our labour demand estimations show that increasing the level of linkages may lead to economically significant reductions in foreign plants' wage elasticities, it is also clear that even if a multinational sourced all of its inputs in Ireland it would still have a substantially higher elasticity than a comparable domestic plant. Hence, while linkages are important in explaining differences in elasticities they are not sufficient to explain away the fact that foreign plants have higher wage elasticities than domestic plants.

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Appendix I: Theory

A1: Deriving the conditional labour demand elasticity

A price taking firm firm has a production function with n inputs:

$$y = f(x_1,...x_n) \qquad \text{(A1)}$$

The Lagrangian function for cost minimisation is:

$$\ell = w_1x_1 + w_2x_2.. + w_nx_n + l[y - f(x_1..x_n)] \quad \text{(A2)}$$

For each of the n factors we get a first order condition:

$$w_i = lf_i(x_1,..x_n) \qquad \text{(A3)}$$

Differentiating the production function and the n first order conditions with respect to l , w_1 and all the inputs we get the following system of equations:

$$\begin{aligned}
&dy = f_1dx_1 + f_2dx_2..f_ndx_n = 0\\
&f_1dl + lf_{11}dx_1..lf_{1n}dx_n = dw_1\\
&.....\\
&fndl + lf_{n1}dx_1...lf_{nn}dx_n = 0
\end{aligned}$$

This can be represented in matrix format as:

$$\begin{bmatrix} 0 & f_1 & .. & f_n \\ f_1 & f_{11} & .. & f_{1n} \\ . & .. & .. & .. \\ f_n & f_{n1} & .. & f_{nn} \end{bmatrix} \begin{bmatrix} \dfrac{dl}{dw_1 l} \\ \dfrac{dx_1}{dw_1} \\ .. \\ \dfrac{dx_n}{dw_n} \end{bmatrix} = \begin{bmatrix} 0 \\ \dfrac{1}{l} \\ 0 \\ 0 \end{bmatrix}$$

Applying Cramers rule where B is the Bordered Hessian above and B_{22} replaces the second column with the solution vector, we get:

$$\frac{\partial x_1}{\partial w_1} = \frac{|B_{22}|}{l|B|} \qquad \text{(A4)}$$

Allen (1969) derives the following expression for the elasticity of substitution:

$$s_{ij} = \frac{(f_1 x_n .. + f_2 x_n)}{x_i x_j} \frac{|B_{ij}|}{|B|} \qquad \text{(A5)}$$

Using this definition of the elasticity of substitution[23] in (A5) along with the first order condition we get the labour demand elasticity conditional on output:

$$h_{11}^* = \frac{\partial x_1}{\partial w_1} \frac{w_1}{x_1} = \frac{\sum_{j \neq 1}^{n} s_{1j} f_j x_j}{\sum_{i=1}^{n} f_i x_i} = \sum_{j=1}^{n} s_{1j} s_j \qquad \text{(A6)}$$

A2: Upward sloping supply for other factors

We will assume there are only two factor in this case. The elasticity of substitution in this case can is:

$$s_{12} = \frac{-f_1 f_2 (x_1 f_1 + x_2 f_2)}{x_1 x_2 (f_1^2 f_{22} + f_2^2 f_{11} - 2 f_1 f_2 f_{21})} \qquad \text{(A7)}$$

The cost minimisation problem can be represented as above in matrix format except that we allow w_2 to vary as well as w_1. That is we assume an exogenous change in the wage leads to an increase in demand and the wage of the other factor if its supply curve slopes upwards:

$$\begin{bmatrix} 0 & f_1 & f_2 \\ f_1 & f_{11} & f_{12} \\ f_2 & f_{21} & f_{22} \end{bmatrix} \begin{bmatrix} \frac{dl}{dw_1 l} \\ \frac{dx_1}{dw_1} \\ \frac{dx_2}{dw_1} \end{bmatrix} = \begin{bmatrix} 0 \\ \frac{1}{l} \\ \frac{dw_1}{dw_2 l} \end{bmatrix}$$

Using (A4) to get the solution and noting from (A7) that:

$$\frac{\partial x_1}{\partial w_1} = \frac{|B_{22}|}{l|B|} = \frac{f_2 f_1 \, dw_2 / dw_1 - f_2^2}{l|B|} \qquad \text{(A8)}$$

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[23] Using this definition $s_{11} = \frac{(f_1 x_n .. + f_2 x_n)}{x_1^2} \frac{|B_{22}|}{|B|}$ where B_{22} is the determinant of the cofactor of the bordered Hessian for the second of the n+1 rows and columns. Also note from Allen (1969) p504 that $-s_{11} \frac{f_1 x_1}{\sum_{i=1}^{n} f_i x_i} = \sum_{i=2}^{n} s_{1i} \frac{f_i x_i}{\sum_{i=1}^{n} f_i x_i}$

Also note in the two factor case from (A7) that:

$$|B| = \frac{s_{12} x_1 x_2}{f_1 f_2 (f_1 x_1 + f_2 x_2)} \qquad \text{(A8)}$$

From (A7) and (A8) we get:

$$h_{11}^* = -s s_2 (1 - h_{w_2 w_1})$$

A3: The unconditionat elasticity

Next we look for the labour demand elasticity when output varies after an increase in the price of labour. We assume that the price of output is fixed. Mosak (1938) analyses the impact of a change in prices on factor and output demands for price taking firms. Mosaks approach is more detailed and would allow us to calculate the substitution and scale effects separately. For simplicity we assume that the production function is homogeneous of degree r where r is less than unity. We will assume that fixed costs ensure an optimal size at a positive level of output for the firm. The firm will maximise profits:

$$pf(x_1, x_2) - w_1 x_1 - w_2 x_2 - F \quad \text{(A9)}$$

The first order conditions are as in (A3) except lambda is now the output price p.
Differentiating the first order conditions with respect to x_1, x_2 and w_1 and solving we get the change in labour from a change in the wage:

$$\frac{dx_1}{dw_1} = \frac{f_{22}}{p(f_{11} f_{22} - f_{12}^2)} \qquad \text{(A10)}$$

Our assumption that the production function is homogeneous of degree r implies the following:

$$ry = f_1 x_1 + f_1 x_2 \qquad \text{(A11)}$$

$$f_{11} = (r-1)\frac{f_1}{x_1} - f_{12}\frac{x_2}{x_1} \qquad \text{(A12)}$$

$$f_{22} = (r-1)\frac{f_2}{x_2} - f_{12}\frac{x_1}{x_2} \qquad \text{(A13)}$$

Substituting A9-11 into (A5) the elasticity of substitution simplifies to to:

$$s_{12} = \frac{f_1 f_2}{(1-r) f_1 f_2 + r f_{12} y} \qquad \text{(A14)}$$

Substituting A9-11 into (A10) we get:

$$\frac{dx_1}{dw_1} = -\frac{x_1[(1-r)f_2 + f_{12}x_1]}{p(1-r)[(1-r)f_1 f_2 + f_{12}ry]} \qquad \text{(A15)}$$

Using (A.14) in the denominator and again applying the first order condition, the own price elasticity of demand for factor 1 at fixed output price is:

$$h_{11} = \frac{dx_1}{dw_1}\frac{w_1}{x_1} = -s\ (1 + f_{21}\frac{x_1}{f_2(1-r)}) \qquad \text{(A16)}$$

Note (A14) can be rearranged as: $\frac{ryf_{12}}{f_1 f_2} = \frac{1}{s_{12}} - (1-r)$. Using this in (A16) when $s_i = \frac{f_i x_i}{y}$ we get:

$$h_{11} = -[s\,s_2 + \frac{s_1}{(1-r)r}] \qquad \text{(A17)}$$

Appendix II: Data

Table A1: Linkages defined as locally sourced inputs per employee, in thousand £

	1983		1998	
NACE	domestic	foreign	domestic	foreign
15	185.9	113.7	178.1	202.9
16	34.6	20.0	49.5	91.3
17	11.5	18.4	14.8	20.5
18	4.7	5.3	11.4	7.7
19	18.5	7.4	86.3	196.4
20	50.8		52.8	83.9
21	27.5	29.1	36.3	51.4
22	9.2	6.1	24.7	32.6
23	34.7		131.5	29.6
24	34.8	31.3	56.8	77.2
25	14.0	13.0	34.2	32.9
26	25.7	21.0	52.0	71.7
27	43.2	87.6	28.8	90.8
28	13.5	13.5	27.6	31.9
29	16.5	20.6	36.2	26.1
30	105.9	46.5	42.8	129.9
31	8.1	17.7	21.6	30.6
32	8.6	13.0	25.6	38.3
33	8.7	23.9	31.6	36.0
34	24.9	16.1	31.1	28.4
35	21.2	10.3	10.7	27.7
36	14.7	22.8	25.6	85.7
Total	72.0	32.5	61.7	64.7

Source: own calculations from Irish Expenditure Survey

Table 1: Development of backward linkages

(locally sourced inputs divided by total inputs)

		1983		1998	
NACE	Description	domestic	foreign	domestic	foreign
15	Food & beverages	0.77	0.67	0.80	0.69
16	Tobacco	0.47	0.32	0.38	0.64
17	Textiles	0.26	0.33	0.37	0.30
18	Wearing apparel	0.21	0.27	0.40	0.41
19	Leather	0.51	0.34	0.56	0.72
20	Wood & wood products	0.47		0.53	0.61
21	Pulp & paper	0.42	0.29	0.50	0.33
22	Publishing & printing	0.25	0.32	0.55	0.48
23	Petroleum	0.48		0.31	0.22
24	Chemicals	0.44	0.35	0.57	0.39
25	Rubber & plastics	0.33	0.27	0.46	0.37
26	Non metallic minerals	0.48	0.38	0.69	0.51
27	Basic metals	0.63	0.90	0.57	0.30
28	Fabricated metals	0.31	0.27	0.49	0.38
29	Machinery & equipment	0.46	0.33	0.48	0.37
30	Computers & Office machinery	0.92	0.23	0.46	0.39
31	Electrical machinery	0.31	0.35	0.49	0.34
32	TV and telephone	0.26	0.19	0.47	0.34
33	Medical & optical instruments	0.33	0.33	0.59	0.41
34	Motor vehicles	0.27	0.31	0.40	0.46
35	Other transport equipment	0.24	0.09	0.28	0.45
36	Not elsewhere classified	0.40	0.60	0.51	0.53
	Total	0.48	0.36	0.56	0.42

Source: own calculations from Irish Expenditure Survey

Table 2: Labour demand elasticities, foreign vs domestic

	(1)	(2)
l_l(t-1)	0.812	0.914
	(0.009)***	(0.008)***
l_l(t-2)	-0.028	-0.024
	(0.005)***	(0.005)***
l_w	-0.317	-0.532
	(0.015)***	(0.015)***
l_y	0.185	0.369
	(0.010)***	(0.011)***
l_w(t-1)		0.353
		(0.012)***
l_y(t-1)		-0.237
		(0.010)***
l_w(t-2)		0.007
		(0.005)
l_y(t-2)		-0.046
		(0.004)***
own	0.202	0.053
	(0.065)***	(0.053)
l_y * own	-0.007	0.011
	(0.010)	(0.008)
l_w * own	-0.037	-0.046
	(0.013)***	(0.010)***
Sargan test (p-value)	0.18	0.12
AR(2) test (p-value)	0.32	0.19
Observations	9717	9717
Number of plants	1691	1691

System GMM estimation
Standard errors in parentheses
** significant at 5%; *** significant at 1%

Table 3: Conditional labour demand including backward linkages

	(1)	(2)	(3)
	all firms	all MNEs	domestic
l_l(t-1)	0.817	0.825	0.796
	(0.010)***	(0.001)***	(0.005)***
l_l(t-2)	-0.038	-0.047	-0.049
	(0.005)***	(0.000)***	(0.003)***
l_w	-0.281	-0.412	-0.223
	(0.015)***	(0.002)***	(0.009)***
l_y	0.175	0.187	0.220
	(0.009)***	(0.000)***	(0.007)***
local_link	-0.058	0.139	0.360
	(0.088)	(0.005)***	(0.052)***
l_y * local_link	0.009	-0.041	-0.057
	(0.014)	(0.001)***	(0.009)***
l_w * local_link	-0.020	0.118	0.008
	(0.022)	(0.003)***	(0.012)
Sargan test (p-value)	0.16	0.61	0.35
AR(2) test (p-value)	0.49	0.18	0.11
Observations	9716	4320	5396
Number of plants	1691	612	1079

System GMM estimation
Linkage defined as inputs sourced in Ireland divided by total inputs
Standard errors in parentheses
** significant at 5%; *** significant at 1%

Table 4: Robustness checks: Estimations by size classes

	(1)	(2)	(3)	(4)	(5)	(6)
	small MNEs	medium MNEs	large MNEs	small domestic	medium domestic	large domestic
l_l(t-1)	0.620	0.579	0.755	0.695	0.413	0.728
	(0.001)***	(0.004)***	(0.005)***	(0.002)***	(0.000)***	(0.001)***
l_l(t-2)	-0.034	-0.036	-0.037	-0.117	0.012	-0.010
	(0.001)***	(0.002)***	(0.004)***	(0.001)***	(0.000)***	(0.001)***
l_w	-0.674	-0.441	-0.336	-0.152	-0.249	-0.262
	(0.003)***	(0.006)***	(0.007)***	(0.004)***	(0.001)***	(0.001)***
l_y	0.264	0.207	0.191	0.183	0.273	0.215
	(0.002)***	(0.003)***	(0.003)***	(0.003)***	(0.001)***	(0.001)***
local_link	0.680	0.677	0.252	0.057	0.786	0.584
	(0.022)***	(0.049)***	(0.050)***	(0.030)*	(0.002)***	(0.007)***
l_y * local_link	-0.181	-0.186	-0.054	0.001	-0.137	-0.086
	(0.004)***	(0.006)***	(0.006)***	(0.005)	(0.001)***	(0.001)***
l_w * local_link	0.320	0.382	0.120	-0.057	0.073	0.048
	(0.007)***	(0.008)***	(0.012)***	(0.006)***	(0.001)***	(0.003)***
Sargan test (p-value)	1.00	1.00	1.00	1.00	1.00	1.00
AR(2) test (p-value)	0.05	0.91	0.21	0.02	0.40	0.33
Observations	1177	1459	1684	1375	1850	2171
Number of plants	283	308	236	505	521	420

System GMM estimation
Linkages defined linkage as inputs sourced in Ireland divided by total inputs
Standard errors in parentheses
** significant at 5%; *** significant at 1%

Definition of size classes:
small: employment less than 33 percentile (65 respectively 35 for foreign and domestic)
medium: employment between 33 and 66 percentile
large: employment larger than 66 percentile (162 respectively 65 for foreign and domestic)

Table 5: Robustness checks: Alternative linkage definition

	(1)	(2)
	all MNEs	domestic
l_l(t-1)	0.805	0.733
	(0.000)***	(0.001)***
l_l(t-2)	-0.042	-0.037
	(0.000)***	(0.001)***
l_w	-0.362	-0.219
	(0.001)***	(0.002)***
l_y	0.192	0.229
	(0.000)***	(0.001)***
local_link	-0.002	-0.003
	(0.000)***	(0.000)***
l_y * local_link	0.000	0.000
	(0.000)***	(0.000)***
l_w * local_link	0.0002	0.0001
	(0.000)***	(0.000)
Sargan test (p-value)	0.70	0.24
AR(2) test (p-value)	0.19	0.18
Observations	4320	5397
Number of plants	612	1079

System GMM estimation
Linkage defined as inputs sourced in Ireland divided by total employment
Standard errors in parentheses
** significant at 5%; *** significant at 1%

Table 6: Robustness checks: Considering exit in conditional labour demand

	(1)	(2)	(3)	(4)	(5)	(6)
	all MNEs	domestic	all MNEs	domestic	all MNEs	domestic
L.	0.823	0.802	0.826	0.778	0.812	0.776
	(0.001)***	(0.004)***	(0.001)***	(0.004)***	(0.001)***	(0.004)***
L2.	-0.046	-0.042	-0.051	-0.040	-0.032	-0.044
	(0.000)***	(0.002)***	(0.000)***	(0.002)***	(0.001)***	(0.002)***
l_w	-0.409	-0.214	-0.400	-0.284	-0.415	-0.235
	(0.002)***	(0.006)***	(0.001)***	(0.007)***	(0.001)***	(0.008)***
l_y	0.192	0.217	0.191	0.249	0.180	0.244
	(0.001)***	(0.004)***	(0.001)***	(0.005)***	(0.001)***	(0.005)***
local_link	0.305	0.425	0.209	0.424	-0.024	0.482
	(0.007)***	(0.033)***	(0.008)***	(0.039)***	(0.008)***	(0.039)***
l_y * local_link	-0.052	-0.064	-0.042	-0.087	-0.034	-0.084
	(0.001)***	(0.006)***	(0.001)***	(0.007)***	(0.001)***	(0.007)***
l_w * local_link	0.101	0.002	0.103	0.073	0.148	0.037
	(0.003)***	(0.009)	(0.002)***	(0.010)***	(0.003)***	(0.010)***
exit			-0.191	-0.036		
			(0.002)***	(0.009)***		
exitors					-0.308	0.167
					(0.003)***	(0.022)***
Sargan test (p-value)	0.98	0.28	0.69	0.34	0.67	0.39
AR(2) test (p-value)	0.19	0.18	0.19	0.14	0.14	0.15
Observations	3953	4971	4258	5108	4301	5143
Number of plants	552	981	604	1015	607	1018

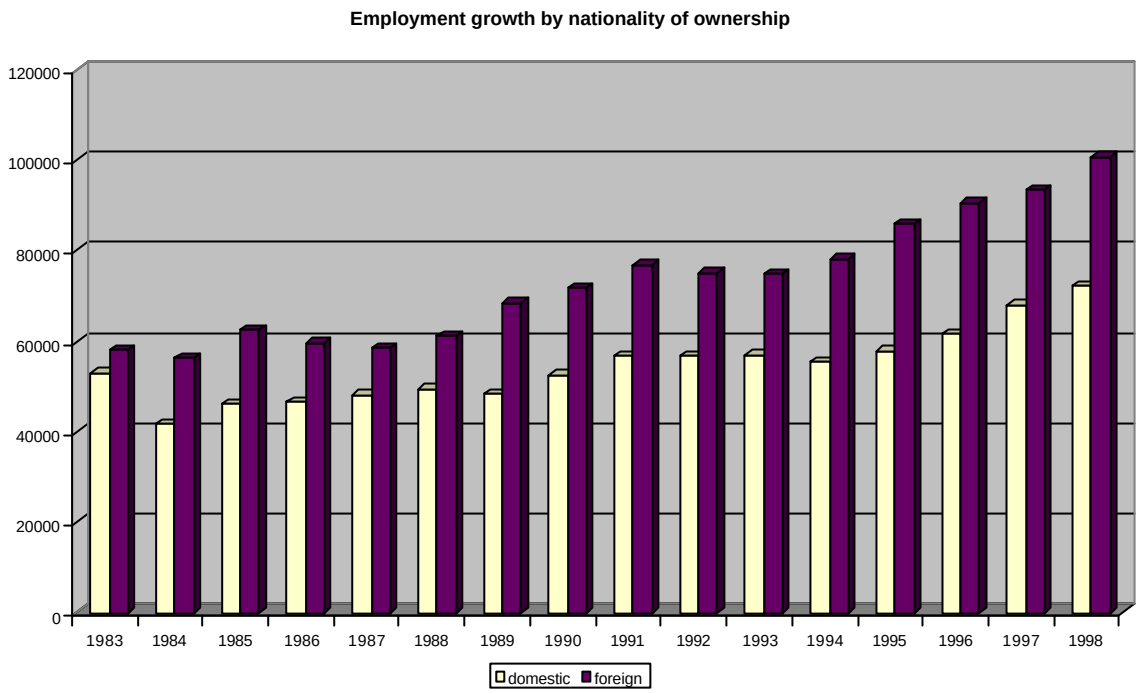
System GMM estimation
Linkages defined linkage as inputs sourced in Ireland divided by total inputs
Standard errors in parentheses
** significant at 5%; *** significant at 1%

Table 7: Robustness checks: alternative lag structure

	(1)	(2)
	all MNEs	domestic
l_l(t-1)	0.922	-0.216
	(0.001)***	(0.005)***
l_l(t-2)	-0.025	-0.028
	(0.000)***	(0.003)***
l_w	-0.629	-0.445
	(0.001)***	(0.011)***
l_y	0.419	0.392
	(0.001)***	(0.008)***
l_w(t-1)	0.386	0.310
	(0.001)***	(0.006)***
l_y(t-1)	-0.272	0.891
	(0.001)***	(0.005)***
l_w(t-2)	0.004	-0.057
	(0.001)***	(0.004)***
l_y(t-2)	-0.049	0.015
	(0.001)***	(0.003)***
local_link	0.025	0.268
	(0.007)***	(0.046)***
l_y * local_link	-0.022	-0.048
	(0.001)***	(0.009)***
l_w * local_link	0.082	0.031
	(0.002)***	(0.013)**
Sargan test (p-value)	0.76	0.26
AR(2) test (p-value)	0.08	0.20
Observations	4320	5396
Number of plants	612	1079

System GMM estimation
Linkage defined as inputs sourced in Ireland divided by total employment
Standard errors in parentheses
** significant at 5%; *** significant at 1%

Figure 1:


Employment growth by nationality of ownership
120000
100000
80000
60000
40000
20000
0
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
domestic
foreign