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Multinational Companies, Backward Linkages and Labour Demand Elasticities

by

Holger Görg, Michael Henry, Eric Strobl and Frank Walsh

GEP
Leverhulme Centre
for Research on Globalisation and Economic Policy

The Authors

Holger Görg is a Reader in International Economics in the School of Economics at the University of Nottingham and an Internal Research Fellow in GEP. Michael Henry is a Research Fellow at Aston Business School, Aston University. Eric Strobl is Associate Professor at École Polytechnique Paris. Frank Walsh is Lecturer at University College Dublin.

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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 generally reduces the wage elasticity of labour demand. This result is economically important and holds for a number of different specifications.

Outline

1. *Introduction*
2. *Theoretical background*
3. *Description of the data*
4. *Estimating labour demand elasticities*
5. *Conclusions*

Non-Technical Summary

It has been well established in the empirical literature that workers in industrialised countries have experienced higher job insecurity over the last few decades, both in terms of higher volatility of employment spells and earnings. "Globalisation" has been made at least partly responsible for these trends, certainly in the popular debate as well as among academics. 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. 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.

It is important to note, however, that the potential "footloose" nature of FDI in terms of plan closures is only one possible response to changes in production costs. 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 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.

This paper examines the link between nationality of ownership and the wage elasticity of labour demand, and 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. 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 locally sourced inputs are to some degree "specific" due to, e.g., better quality and availability, or lower transport costs than imported inputs. 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 given that its manufacturing industry is heavily dependent on foreign multinationals. Moreover, Ireland has operated a number of explicit policy programmes to foster linkages between foreign multinationals and domestic suppliers.

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 and when taking account of exit. 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.

1 Introduction

It has been well established in the empirical literature that workers in industrialised countries have experienced higher job insecurity over the last few 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 (e.g., Lipsey and Sjöholm, 2004; Girma and Görg, 2007). 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 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,

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[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.

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 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).

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[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 (e.g., Driffield et al., 2002, Javorcik, 2004).

The remainder of the paper is structured as follows. Section 2 provides the theoretical background for our analysis. Section 3 describes the data sources. Section 4 outlines the empirical approach and discussed our results. Section 5 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 but will treat each plant as a profit maximising firm where the output price equals the marginal cost 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 wages on the output price, which is a function of the firm's global production costs, to be negligible. The plant is hence assumed to 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:

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

The price of each factor i is w_i and total costs are $c = F + w_1 x_1 + w_2 x_2 \ldots + w_n x_n$. The Lagrangian function for cost minimisation is:

$$\ell = w_1 x_1 + w_2 x_2 .. + w_n x_n + \lambda [y - f(x_1 .. x_n)] \qquad (2)$$

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 σ_{1j}.

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

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[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.

$$\eta_{11}^* = \frac{\partial x_1}{\partial w_1} \frac{w_1}{x_1} = \frac{\sum\limits_{j \neq 1}^{n} \sigma_{1j} f_j x_j}{\sum\limits_{i=1}^{n} f_i x_i} = \sum\limits_{j=1}^{n} \sigma_{1j} s_j \tag{3}$$

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 σ) 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 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.

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)

$$\eta_{11}^{*} = -\sigma s_2 (1 - \eta_{w_2 w_1}) \tag{4}$$

The two factor analogue of (3) is $\eta_{11}^{*} = -\sigma s_2$ and $\eta_{w_2 w_1}$ 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 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:

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

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[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.

where η_{ll}^{*1} is the conditional demand elasticity for employment of the final good and η_{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 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. A look at the data shows that total exits over this period in our data only account for 3.3 percent of total plants.

Nationality of ownership is covered as a dichotomous variable indicating whether a plant is foreign or domestic owned. In this context one should note that Forfás defines foreign plants as plants that are majority-owned by foreign shareholders, i.e., where there is at least 50 per cent foreign ownership. While, arguably, plants with lower foreign ownership should still possibly considered to be foreign owned, this is not necessarily a problem for the case of Ireland since almost all inward foreign direct investment has been

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[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 $\eta_{11} = -[\sigma s_2 + \dfrac{s_1}{(1-r)r}]$ while the two factor analogue of the conditional elasticity is $\eta_{11}^{*} = -\sigma s_2$. 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.

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

greenfield investment rather than acquisition of local firms (see Barry and Bradley, 1997). 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 Ruane, 2000; 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]

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*,

$$l_{it} = \alpha_1 l_{it-s} + \alpha_2 w_{it} + \alpha_3 y_{it}$$
$$+ \beta_1 foreign_{it} + \beta_2 (w * foreign)_{it} + \beta_3 (y * foreign)_{it} + d_t + d_i + e_{it} \quad (6)$$

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 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). *foreign* in (6) 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 (6) 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. Also, the wage variable may not only capture labour costs but may also be a measure of firms' skill intensities. This is because a firm that uses higher skilled workers must pay higher average wages due to a composition effect, leading to another potential source of endogeneity in the estimation.

If such endogeneity biases 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] One possible way of solving this problem would be to first difference equation (6) and apply a first differenced generalized methods of moments (GMM) estimator as developed by Arellano and Bond (1991). This estimator uses suitably lagged levels of the endogenous variables as instruments in the first differenced equation. However, this approach has been criticised recently since it has been argued that lagged levels of variables may only be weak instruments for the variables in first differences. In order to overcome this problem of weak instruments, while also controlling for plant specific fixed effects, Blundell and Bond (1998) suggest using a system GMM estimator which uses an additional set of moment

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[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 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. In a transformation from the mean, the difference between the lagged dependent variable and its mean ($l_{it-1} - \bar{l}_i$) is by construction correlated with $e_{it} - \bar{e}_i$, as the mean $\bar{e}_i$ contains e_{it-1}, which is correlated with l_{it-1}. See, for example, Baltagi (1995) for a discussion.

restrictions to improve estimation.[16] Accordingly, the estimator uses a stacked system of 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 Hansen J 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).

The results of estimating equation (6) are reported in Table 2. Column (1) provides the simplest model using only one lag of the dependent variable. As the Hansen statistic indicates, we reject the hypothesis of instrument validity. Also, we reject the hypothesis of no second order autocorrelation (AR(2)). Hence, this equation is clearly misspecified. Column (2) adds the second lag of the dependent variable which improves on autocorrelation, but still leaves us with an instrument set that is not valid. Only in column (3) have we got a specification that has valid instruments where we can also reject the hypothesis of no AR(2) and we hence use this as our benchmark specification.

Turning to the coefficients, we find from column (3) 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. Overall, the results thus far suggest that it is more reasonable to estimate the effect of linkages on elasticities separately for domestic and foreign plants.

[Table 2 here]

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[16] The appendix provides an illustration of the "weak instrument" problem in first differenced GMM. As far as we are aware there is no formal test for weak instruments in the context of dynamic panel GMM and we hence follow an approach used by Bond et al. (2001). Estimating a first differenced version of equation (7) using OLS would upward bias coefficients on the lagged dependent variable, while a fixed effects (FE) transformation would lead to a downward bias. As the table in the appendix shows, using first differenced GMM a la Arellano and Bond (1991) produces coefficients on l_{t-1} that are close to the FE model. This suggests that the first differenced GMM model is biased downwards which can be due to weak instruments (Bond et al., 2001). The estimates produced by the system GMM estimator lie comfortably between OLS and FE estimates suggesting that it is more reliable.

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

$$l_{it} = \gamma_1 l_{it-s} + \gamma_2 w_{it} + \gamma_3 y_{it} + \lambda_1 link_{it} + \lambda_2 (link * w)_{it} + \lambda_3 (link * y)_{it} + d_t + d_i + e_{it}$$

$$(7)$$

where *link* is the measure of local linkages which is interacted with *w* and *y*. Hence, $\gamma_2 + \lambda_2 (link)_{it}$ 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 λ_2 is statistically significantly different from zero, and whether it is different for multinationals and domestic firms. We check for the latter by including appropriate triple interaction terms.

Table 3 shows the results of estimating equation (7). Column (1) reports elasticities based on the full sample of plants, not distinguishing between foreign and domestic owned establishments. The results indicate that there is indeed a statistically significant impact of linkages on the wage elasticity of labour demand for all firms. However, allowing for different effects of linkages for domestic and foreign firms reveals some interesting differences across nationality of ownership. To do so we construct a triple interaction term of (*w * link * foreign*) while also including the interaction of (*w * foreign*) as in Table 2. The latter interaction term thus allows for differences in wage elasticities for foreign firms, while the former allows for a different effect of linkages on the wage elasticity for foreign firms.

The results in column (2) show that linkages have a statistically significant and positive effect on the wage elasticity for all firms (as apparent from the interaction of log wage * linkage). However, we also find from the triple interaction term (log wage * linkage * foreign) that the positive effect is higher for foreign firms at (0.058 + 0.023 =) 0.081 than for domestic firms at 0.058. The difference in results 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 less effect of increased linkages on the elasticity.[17]

Using the point estimates in column (2) implies that the wage elasticity of labour demand for a foreign owned plant with zero linkages is (0.217 + 0.107=) 0.324, whereas a foreign plant with a mean level of local linkages has a wage elasticity of 0.289. Increasing the degree of linkages by two standard deviations from the mean then implies a further reduction in the elasticity to 0.248. Hence, the estimated coefficients are not only statistically, but also economically, significant.[18] 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 0.243) than that of a domestic plant with zero linkages (at 0.217). 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.[19]

[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). We, therefore, provide a robustness check to deal with the issue of plant size. Specifically, we classify plants into three size categories according to their average size over the sample period: small (employment less than 33rd percentile of the size distribution), medium (employment between 33rd and 66th percentile of the size distribution), and large (employment greater than 66th percentile of the size distribution) and estimate equation (8) on these different samples separately.

Columns (4) to (6) in Table 3 present these results. Our findings on the effect of linkages for multinationals still hold. While we indeed find that wage elasticities differ by size class we also find that for all size groups, increased linkages are associated with

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

[18] 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.

[19] Column (3) presents an alternative regression which only uses one lag of the dependent variable. However, as in Table 2, this specification is mis-specified and we reject the hypothesis of no second order autocorrelation.

reductions in these elasticities for foreign firms, although the coefficient on the triple interaction term is, while still positive, statistically insignificant for large firms in column (6). 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.

Another robustness check considers the unbalanced nature of our panel data which contains exit, so that if the probability of exit were correlated with the 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, Column (1) of Table 4 reports a regression on the sample of surviving plants only, thus excluding exitors, while column (2) includes a dummy equal to 1 for the whole lifetime of a plant that exits the data, and interacts this dummy with all variables containing log wage and its interaction terms.

Note from column (1) that the results on the survivor sample is similar to that reported in column (2) of Table 3. Considering column (2), while we find that the dummy variable and interaction terms are all statistically significant (except the final four way interaction of wage, linkage, foreign and exit dummy), we also find that the positive and statistically significant coefficient on the triple interaction of linkage and wages for foreign-owned plants is robust to this specification. 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 4 here]

5 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, proposing the possibility 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 and when taking account of exit.

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:

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

The Lagrangian function for cost minimisation is:

$$\ell = w_1 x_1 + w_2 x_2 .. + w_n x_n + \lambda [y - f(x_1 .. x_n)] \quad \text{(A2)}$$

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

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

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

$$dy = f_1 dx_1 + f_2 dx_2 .. f_n dx_n = 0$$
$$f_1 d\lambda + \lambda f_{11} dx_1 .. \lambda f_{1n} dx_n = dw_1$$
$$\text{.......................................}$$
$$fn d\lambda + \lambda f_{n1} dx_1 ... \lambda f_{nn} dx_n = 0$$

This can be represented in matrix format as:

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

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

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

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

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

Using this definition of the elasticity of substitution[20] in (A5) along with the first order condition we get the labour demand elasticity conditional on output:

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

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:

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

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:

$$\begin{bmatrix} 0 & f_1 & f_2 \\ f_1 & f_{11} & f_{12} \\ f_2 & f_{21} & f_{22} \end{bmatrix}\begin{bmatrix} \dfrac{d\lambda}{dw_1\lambda} \\ \dfrac{dx_1}{dw_1} \\ \dfrac{dx_2}{dw_1} \end{bmatrix} = \begin{bmatrix} 0 \\ \dfrac{1}{\lambda} \\ \dfrac{dw_1}{dw_2\lambda} \end{bmatrix}$$

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

$$\frac{\partial x_1}{\partial w_1} = \frac{|B_{22}|}{\lambda |B|} = \frac{f_2 f_1 \left.dw_2\right/dw_1 - f_2^2}{\lambda |B|} \qquad (A8)$$

---

[20] Using this definition $\sigma_{11} = \dfrac{(f_1 x_n .. + f_2 x_n)}{x_1^2}\dfrac{|B_{22}|}{|B|}$ 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

$$-\sigma_{11}\frac{f_1 x_1}{\sum_{i=1}^n f_i x_i} = \sum_{i=2}^n \sigma_{1i}\frac{f_i x_i}{\sum_{i=1}^n f_i x_i}$$

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

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

From (A7) and (A8) we get:

$$\eta_{11}^* = -\sigma s_2 (1 - \eta_{w_2 w_1})$$

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:

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

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:

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

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

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

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

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

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

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

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:

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

Note (A14) can be rearranged as: $\dfrac{ryf_{12}}{f_1 f_2} = \dfrac{1}{\sigma_{12}} - (1-r)$. Using this in (A16) when

$s_i = \dfrac{f_i x_i}{y}$ we get:

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

Table 1: Development of backward linkages

(locally sourced inputs divided by total inputs)

NACE	Description	1983		1998	
		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)	(3)
log employment (t-1)	0.459	0.561	0.916
	(0.006)[a]	(0.007)[a]	(0.007)[a]
log employment (t-2)		-0.014	-0.073
		(0.003)[a]	(0.003)[a]
log wage	-0.518	-0.449	-0.435
	(0.015)[a]	(0.014)[a]	(0.010)[a]
log output	0.489	0.422	0.457
	(0.010)[a]	(0.008)[a]	(0.006)[a]
log wage (t-1)			0.334
			(0.007)[a]
log output (t-1)			-0.322
			(0.005)[a]
foreign dummy	0.957	0.604	0.214
	(0.071)[a]	(0.061)[a]	(0.038)[a]
log output * foreign dummy	-0.131	-0.056	-0.008
	(0.011)[a]	(0.009)[a]	(0.006)
log wage * foreign dummy	0.081	-0.039	-0.055
	(0.015)[a]	(0.015)[a]	(0.008)[a]
Hansen test (p-value)	0.00	0.00	0.10
AR(2) test (p-value)	0.00	0.08	0.69
Observations	12474	9717	9717

System GMM estimation

Dependent variable: log(employment)

Standard errors in parentheses

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%

Table 3: Conditional labour demand including backward linkages

	(1)	(2)	(3)	(4)	(5)	(6)
	all firms	all firms	all firms	small firms	medium firms	large firms
log employment (t-1)	0.843	0.836	0.683	0.769	0.828	0.875
	(0.009)[a]	(0.003)[a]	(0.002)[a]	(0.002)[a]	(0.001)[a]	(0.002)[a]
log employment (t-2)	-0.069	-0.074		-0.086	-0.111	-0.104
	(0.005)[a]	(0.001)[a]		(0.001)[a]	(0.001)[a]	(0.001)[a]
log wage	-0.240	-0.217	-0.268	-0.193	-0.208	-0.312
	(0.015)[a]	(0.008)[a]	(0.009)[a]	(0.003)[a]	(0.002)[a]	(0.004)[a]
log output	0.214	0.212	0.273	0.192	0.193	0.219
	(0.008)[a]	(0.004)[a]	(0.005)[a]	(0.002)[a]	(0.001)[a]	(0.002)[a]
linkage	0.342	0.336	0.372	0.345	0.446	0.398
	(0.077)[a]	(0.025)[a]	(0.025)[a]	(0.020)[a]	(0.007)[a]	(0.012)[a]
log wage * linkage	0.074	0.058	0.008	0.115	0.002	0.094
	(0.021)[a]	(0.012)[a]	(0.012)	(0.005)[a]	(0.003)	(0.005)[a]
log output * linkage	-0.069	-0.071	-0.064	-0.089	-0.071	-0.088
	(0.012)[a]	(0.005)[a]	(0.005)[a]	(0.003)[a]	(0.001)[a]	(0.002)[a]
foreign dummy		0.118	0.186	0.722	0.253	0.182
		(0.017)[a]	(0.025)[a]	(0.008)[a]	(0.005)[a]	(0.010)[a]
log wage * foreign		-0.107	-0.135	-0.403	-0.022	0.022
		(0.008)[a]	(0.009)[a]	(0.005)[a]	(0.003)[a]	(0.004)[a]
log output * foreign		0.009	0.010	0.037	-0.030	-0.038
		(0.004)[a]	(0.005)[b]	(0.002)[a]	(0.001)[a]	(0.002)[a]
log wage * linkage * foreign		0.023	0.069	0.518	0.014	0.007
		(0.014)*	(0.014)[a]	(0.010)[a]	(0.005)[a]	(0.006)
log output * linkage * foreign		0.018	0.006	-0.163	0.007	0.027
		(0.004)[a]	(0.005)	(0.003)[a]	(0.002)[a]	(0.002)[a]
Hansen test (p-	0.06	0.36	0.14	1.00	1.00	1.00

value)						
AR(2) test (p-value)	0.96	0.94	0.04	0.19	0.11	0.31
Observations	9716	9716	12472	2556	3399	3761

System GMM estimation

Dependent variable: log(employment)

Standard errors in parentheses

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%

Linkage defined as inputs sourced in Ireland divided by total inputs

Definition of size classes:

small: employment less than 33 percentile (43 employees)

medium: employment between 33 and 66 percentile

large: employment larger than 66 percentile (99 employees)

Table 4: Robustness checks: Considering exit in conditional labour demand

	Only survivors	all firms with exit dummy
log employment (t-1)	0.832	0.821
	$(0.001)^a$	$(0.002)^a$
log employment (t-2)	-0.069	-0.063
	$(0.001)^a$	$(0.001)^a$
log wage	-0.214	-0.201
	$(0.006)^a$	$(0.007)^a$
log output	0.217	0.202
	$(0.002)^a$	$(0.003)^a$
linkage	0.415	0.212
	$(0.013)^a$	$(0.023)^a$
log wage * linkage	0.049	0.052
	$(0.008)^a$	$(0.011)^a$
log output * linkage	-0.080	-0.056
	$(0.003)^a$	$(0.005)^a$
foreign dummy	0.118	0.214
	$(0.012)^a$	$(0.015)^a$
log wage * foreign	-0.120	-0.121
	$(0.005)^a$	$(0.007)^a$
log output * foreign	0.012	0.008
	$(0.002)^a$	$(0.003)^a$
log wage * linkage * foreign	0.038	0.036
	$(0.009)^a$	$(0.013)^a$
log output * linkage * foreign	0.017	0.012
	$(0.003)^a$	$(0.004)^a$
log wage * exit dummy		0.056
		$(0.018)^a$
log wage * linkage * exit dummy		-0.044
		$(0.012)^a$
log wage * foreign * exit dummy		-0.220
		$(0.012)^a$
log wage * linkage * foreign * exit dummy		0.019
		(0.013)
exit dummy		0.069
		$(0.035)^b$

Hansen test (p-value)	0.38	0.32
AR(2) test (p-value)	0.93	0.89
Observations	8924	9444

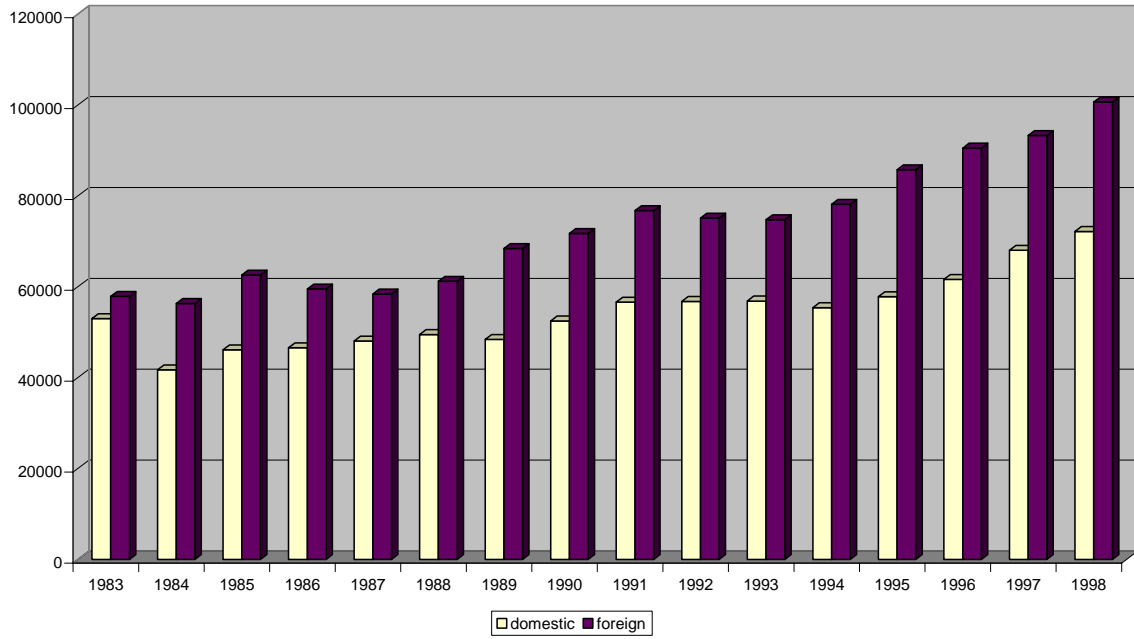System GMM estimation

Dependent variable: log(employment)

Standard errors in parentheses

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%

Linkage defined as inputs sourced in Ireland divided by total inputs

Figure 1:

Employment growth by nationality of ownership

Appendix II: Comparison of different estimators

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ols	fe	dif	sys	ols	fe	dif	sys
log employment (t-1)	0.865	0.488	0.481	0.631	1.040	0.647	0.612	0.975
	$(0.006)^a$	$(0.006)^a$	$(0.039)^a$	$(0.026)^a$	$(0.017)^a$	$(0.011)^a$	$(0.058)^a$	$(0.037)^a$
log employment (t-2)					-0.088	-0.016	-0.003	-0.113
					$(0.016)^a$	$(0.008)^b$	(0.023)	$(0.028)^a$
log wage	-0.143	-0.342	-0.272	-0.276	-0.449	-0.446	-0.501	-0.520
	$(0.009)^a$	$(0.008)^a$	$(0.091)^a$	$(0.046)^a$	$(0.033)^a$	$(0.009)^a$	$(0.099)^a$	$(0.071)^a$
log output	0.102	0.381	0.405	0.317	0.446	0.462	0.415	0.462
	$(0.005)^a$	$(0.005)^a$	$(0.048)^a$	$(0.027)^a$	$(0.023)^a$	$(0.006)^a$	$(0.061)^a$	$(0.069)^a$
log wage (t-1)					0.410	0.246	0.222	0.421
					$(0.034)^a$	$(0.010)^a$	$(0.064)^a$	$(0.062)^a$
log output (t-1)					-0.413	-0.186	-0.082	-0.343
					$(0.024)^a$	$(0.008)^a$	(0.065)	$(0.069)^a$
Hansen test (p-value)			0.01	0.01			0.05	0.14
AR(2) test (p-value)			0.02	0.05			0.06	0.90
Observations	12474	12474	9717	12474	9717	9717	7752	9717

Dependent variable: log(employment)

Standard errors in parentheses

[c] significant at 10%; [b] significant at 5%; [a] significant at 1%