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Labour demand effects of international outsourcing: Evidence from plant-level data

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Abstract

We examine empirically the effect of international outsourcing on labour demand at the level of the individual plant. We do so by estimating a dynamic model of plant-level labour demand, using a Generalised Method of Moments estimator. We use plant-level data for the Irish Electronics sector, an industry that has expanded rapidly over the last decade and that has witnessed significant offshoring activity. Our results suggest that, in the short-run, there are significant reductions in plant-level labour demand, which we attribute to the use of international outsourcing. There appears to be stronger negative effects from outsourcing of materials than from services outsourcing.

JEL classification: F14; J23; L23
Keywords: International outsourcing; Offshoring; Labour demand; Electronics industry

1. Introduction

The term international outsourcing, or more specifically the location of production processes abroad and the subsequent imports of intermediates, has been a widely discussed topic in the U.S. and European

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media recently.[1] It appears to arouse either concern with unions that home jobs will be lost to workers abroad without commensurate job gains in other sectors, resulting in net job losses. Alternatively, employers can argue that productivity gains outweigh job losses especially in the lower skilled sectors and may be accompanied by increases in high skilled jobs. Kohler (2001) appropriately summarises the argument as "the perennial tension between efficiency and distributional concerns" (p. 49).

The media in the Republic of Ireland, the country for which we analyse data in this paper, fears employment losses as a consequence of offshoring, particularly with respect to financial services being relocated to India. This, it is argued, contributes to the growing competitiveness of these developing countries, despite Ireland's traditional strength in financial service provision. However, it is acknowledged that there may also be opportunities to be garnered from relocating the production of certain more routine inputs to partner countries, on condition that Ireland retains certain other high value added activities.[2] Ireland's island neighbour, Britain has recently highlighted the effects of outsourcing on competitiveness and employment in a recent UK Government White paper.[3] A recent Financial Times article reports findings from an independent consultant that a 'two-speed Europe is emerging', with the UK and Ireland reporting the highest levels of worker replacement.[4] The article estimates, for example, that 100,000 UK jobs will have relocated abroad by 2005 as a direct consequence of international outsourcing. The corresponding estimates for Germany and France are 11,000 and 7000, respectively. Accordingly, offshoring is a particularly burning issue in the island economies of Ireland and the UK.

The purpose of this paper is to examine empirically the effect of international outsourcing on demand for labour at the level of the individual plant. As pointed out above, workers' concerns about possible job losses are often countered with the argument that offshoring can increase employment in the country. It is, however, usually not made clear whether these new jobs occur in the same plant in the short-run, or whether jobs are lost in one plant and at some stage in the future other jobs are created in a completely separate plant.

In this paper, we focus on short-run employment effects in the outsourcing plants. We do so by estimating a dynamic model of plant-level labour demand, using a generalised method of moments estimator. We use plant-level data for the Irish Electronics sector, an industry that has expanded rapidly over the last decade and that has witnessed significant offshoring activity (Ruane & Görg, 2001). Our results suggest that, in the short-run, there are significant reductions in plant-level labour demand, which we attribute to the use of international outsourcing. There appear to be stronger negative effects from outsourcing of materials than from services outsourcing.

Our paper contributes to an existing and growing literature on the employment effects of international outsourcing. The issue that has attracted most attention thus far is whether offshoring has contributed to a shift in labour demand for different types of workers and consequently a change in the wage differential between high and low skill wages (e.g., Egger & Egger, 2003; Feenstra & Hanson, 1999; Hijzen, Görg, & Hine, in press). These analyses use industry-level data for their empirical estimations. However, there appears to be a lack of micro-level analyses in this area. An extension of this research is provided by Head and Ries (2002) who use Japanese firm-level data to look at the effect of international outsourcing

[1] Much of the media and policy-making community now refers to this as "offshoring", partly in order to distinguish it from domestic as opposed to international outsourcing. In the trade theoretic literature it is usually referred to as "fragmentation".

[2] Irish Times, "Outsourcing may see services sector 'decline'", 30/12/2003. "'Offshoring' to boost financial services—report", 09/12/2003.

[3] UK Government White Paper on Trade and Investment, "Making Globalisation a Force for Good", July 2004, CM6278, DTI.

[4] Financial Times, Monday 16th August, "Europe set to move 1 m jobs abroad in a decade" (World News).

on relative labour demand at the level of the plant.[5] Furthermore, some researchers have also used individual-level data to focus on intra-sectoral worker flows that arise as a consequence of outsourcing domestic production (Egger, Pfaffermayr, & Weber, 2003; Kletzer, 2000). However, no paper that we are aware of has looked specifically at the net effects of international outsourcing on labour demand using plant-level data.[6]

Our analysis adopts the following format. Section 2 outlines the relevant literature and our hypotheses. Section 3 presents the model used and outlines the estimation technique. Section 4 describes the data which relate to a 6-year micro-level panel of Irish electronics plants. Section 5 reports and discusses our results, while Section 6 concludes.

2. Background

The existing literature investigating labour responses to outsourcing contains several strands. One common theme running through the standard trade theoretic models based on Heckscher–Ohlin or specific factors assumptions, is an investigation of how international outsourcing (fragmentation) is predicted to change the composition of skilled and unskilled labour in a country (Arndt, 1997; Deardoff, 2001; Egger & Egger, 2003; Jones & Kierkowski, 2001; Kohler, 2001). In these models, international outsourcing mainly emerges in order to exploit differences in factor costs across countries. Since most models, to our knowledge, work on the premise that the home country is more developed than the country to which production is outsourced, broadly speaking the consensus is that fragmentation of production should induce a developed country to focus on higher skilled activities. This shift in skill configuration has implications for relative demand and wages for high and low skilled workers. In fact, the fragmentation of production and trade in intermediates is expected to affect employment and wages far more profoundly than the trade in final goods (Krugman, 1995).

Feenstra and Hanson (1996, 1999) provide probably the most prominent examples of empirical work on this issue. They investigate the impact of international outsourcing on relative demand and wage differentials between workers of different skill levels using industry-level data for the United States. They note that the two most widely cited explanations for rises in wage inequalities are skill-biased change and trade with low-wage countries. The latter is conductive to outsourcing in the vertical chain of production. They conclude that their results give credence to these two explanations for wage inequalities, where technical change in the form of capital expenditures is responsible for the lion's share of the wage premium enjoyed by non-production workers. Nevertheless, outsourcing remains a major and significant driver of the wage differential. Following Feenstra and Hanson's work, similar evidence has been produced for a number of European countries, e.g., Hijzen et al. (in press) for the United

[5] Geishecker and Görg (2004) look at the wage effects of international outsourcing, using individual worker data.

[6] Greenaway, Hine, and Wright (1999) and Konings and Vandenbussche (1995) provide somewhat related papers where they look at the effects of total trade on labour demand. Apart from using overall trade rather than focussing on outsourcing, the analyses are different in other ways. Greenaway et al. use industry level data for the UK, while Konings and Vandenbussche use UK firm-level data. The latter also do only specify a static model of labour demand. Another strand of related literature looks at the employment effects of outward foreign direct investment (e.g., Konings & Murphy, 2001). However, those papers do not distinguish horizontal from vertical FDI (with the latter being more akin to offshoring).

Kingdom, Geishecker (2002) for Germany, Strauss-Kahn (2003) for France and Egger and Egger (2003) for Austria.

This literature that sticks closely to standard trade theoretic models is, however, silent on whether the reallocation of resources due to international outsourcing takes place within a given firm or between firms in the same or different sectors. This is not a trivial question, as one may assume that the adjustment costs for workers increase if they have to move to another firm or even another sector (cf., Davidson & Matusz, 2001). In other words, the implications of outsourcing for the individual worker may be easiest if it just means that the individual has to perform a different sort of task within the same firm. It becomes more complicated if the worker is made redundant in the initial firm and then has to move to a different firm in the same or another sector to find alternative employment. In order to address questions like this, micro-level data are necessary.

An example of the use of firm-level data in looking at the impact of offshoring on the relative demand for skilled labour, is provided by Head and Ries (2002). They find that Japanese firms increasing employment in foreign affiliates in low-income countries raise the skill intensity of employment in their headquarters. No such effect is apparent for offshore production in high-income countries, however.

Egger et al. (2003) use individual-level panel data from Austria to examine in more detail the consequences for workers of increased international outsourcing. As they point out, complete labour adjustment in response to outsourcing may be a long-run aspiration but the immediate effects of outsourcing may bring unemployment in its wake because people who are laid off by their current employer, cannot immediately switch into alternative employment. This persistence of unemployment makes it more appropriate to investigate short-run transition probabilities where individuals can move into and out of unemployment and between different sectors.

Accordingly, they examine the impact of trade on employment using a worker flow framework similar to that pioneered by Kletzer (2000) which takes on board short-run employment changes. They explore the impact of several drivers on individual transition probabilities between size and different states of employment and unemployment. These drivers include growth changes in imported goods, exports, outsourcing, and technical change. They are able to model transition probabilities between different employment stages owing to the longitudinal and highly disaggregated nature of the data. They find that outsourcing reduces worker flow to the sectors in which the economy has a comparative disadvantage (CDA). However, net changes to the comparative advantage sectors (CA) of the economy remain unchanged. This overall finding suggests net unemployment increases, on the basis that a reduction in the likelihood that workers switch to the CDA sector is not matched by a proportionate inflow of workers to the CA sector. To put this result in context, Kletzer (2000) also finds that US outsourcing leads to net job losses.

We can see from our brief review of the literature, that while there is broad agreement from theory and aggregate empirical work on the direction of movement between sectors, lack of available micro-level data has made it difficult to capture the net employment effect of outsourcing at the level of the individual or the plant/firm. This is what we set out to provide in this paper—a detailed analysis of the short-run impact of international outsourcing on labour demand at the level of the plant. As far as we are aware, this is the first study to do so.

Of course, we would expect net employment effects to be relatively country specific. This expectation is shaped by country specific factors such as relative factor endowments and comparative advantage. Given the need to isolate overall effects of outsourcing, we set out to quantify how

outsourcing affects net employment within the Irish Electronics sector. Within this sector are grouped activities as diverse or inter-related as software and chip production (see Appendix for a list of subsectors).

Moreover, existing research has not differentiated between outsourced services and materials, thereby creating a gap in our understanding of how the nature of outsourced inputs affects the overall labour situation. The evolution of the banking and health sectors shows increasingly high volumes of service intermediates being offshored to locations such as India. More specifically in the Electronics sector, 'high abstraction' or intellectual activities once integral to production in a developed country, are being offshored.[7] This highlights the growing centrality of outsourced services in the production chain where they perform less of an ancillary and increasingly more of a core role. Accordingly, we distinguish between outsourced materials and service inputs in our empirical work.

3. Modelling and estimating labour demand

In modelling the net employment impact of international outsourcing we consider a plant-level dynamic employment equation of the form

$$n_{it} = \alpha_1 n_{it-1} + \alpha_2 w_{it-s} + \alpha_3 y_{jt-s} + \alpha_4 o_{jt-s} + \lambda_t + \mu_i + v_{it} \quad (1)$$

where n is log employment in plant i at time t and w is the log of the average wage in plant i. The log of total output in sector j is included to control for industry demand shocks (see, e.g., Arellano & Bond, 1991; Nickell, 1986) while common demand shocks are controlled for using a time trend (λ_t). The error term is made up of a plant specific component (μ_i) as well as a remaining white noise term (v_{it}).[8] The lagged dependent variable allows for the presence of adjustment costs, which imply that the level of employment may deviate from its steady state as adjustment to equilibrium takes place.

In this dynamic employment equation, we include a measure of (the log of) an industry's propensity to utilise internationally outsourced components (o_j). The coefficient α_4 captures the short-run effect of international outsourcing on labour demand in this specification. This approach, which is similar to the modelling of the effects of total trade on employment by Greenaway et al., (1999) and Konings and Vandenbussche (1995) implicitly assumes that international outsourcing increases technical efficiency in the underlying production function.[9] These changes in technical efficiency or total factor productivity can have implications for use of factors of production, which is what we examine in this equation.

For estimation purposes, we first-difference Eq. (1) in order to purge the plant specific component μ_i. As is by now well known, first differencing this dynamic panel equation induces bias in the coefficient on the lagged dependent variable due to correlation between this variable and the error term. Hence, an instrumental variable approach has to be adopted for the estimation. Specifically, we apply the

[7] See http://www.manpower.co.uk/news/OutsourcingSurvey.pdf for a discussion of this recent phenomenon.

[8] Note that we do not include a plant specific measure of the cost of capital in this equation. We assume that the effect of cost of capital is controlled for by either or both of these two variables: the time trend (assuming that cost of capital varies over time but not over plants in the electronics industry) or the plant-specific effect (assuming that cost of capital does not vary over time).

[9] Görg, Hanley and Strobl (2004) examine in more detail the effect of international outsourcing on plant level total factor productivity.

generalised method of moments (GMM) technique introduced by Arellano and Bond (1991), which essentially uses lagged levels of the endogenous variables dated $t-2$ and earlier as instruments. This estimation technique also allows to treat some of the covariates as endogenous, again using lagged levels of the variables as instruments.

The first-differenced version of Eq. (1) produces unbiased and consistent estimates under the assumption that there is no second order serial correlation of the error term. We test for this, as well as for instrument validity in all estimations. In the estimation we furthermore allow for unspecified heteroskedasticity of the error term.

4. Data and descriptive statistics

Eq. (1) is estimated using plant-level data for the Irish Electronics industry for the period 1990 to 1995. The data derive from the *Irish Economy Expenditure Survey*, undertaken annually by *Forfás*, the government agency responsible for Enterprise Development, Science and Technology in Ireland. This comprises 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 response rate to this survey is generally estimated to be between 60 and 80 per cent of the targeted population of plants. The data provided include plant-level information on, inter alia, output, employment, total wage bill, as well as details on plants' expenditure on materials and services inputs. Quite uniquely, we are able to distinguish materials and services purchased abroad from those bought at home. Unfortunately, however, the data set does not provide information on different skill categories of labour, hence we are forced to consider labour as homogeneous.

Our variable of interest, o_j, represents international outsourcing in terms of imported intermediates. Such measures of outsourcing have been predominant in the literature using aggregate industry-level data to examine the implications of outsourcing for workers (e.g., Feenstra & Hanson, 1999; Hijzen et al., in press). We expect outsourced intermediates, at least in the short-run, to reduce a plant's wage bill by eliminating potentially inefficient in-house production on products or services requiring otherwise longer production runs or a broader market. It follows that the cost of outsourcing is analogous to the opportunity wage that may have accrued to in-house employees, had the service not been contracted out. Accordingly, in line with Girma and Görg (2004) and Görg et al., (2004), we calculate an indicator of an establishment's propensity to outsource as the expenditure on outsourcing, i.e., on either services or material inputs, relative to the plant's total wage bill.

As alluded to earlier, an advantage of our data set is that we can break down intermediate inputs into raw materials and components (referred to as materials) and services inputs, and the proportion of these factors offshored.[10] We can therefore calculate two disaggregated outsourcing variables, namely, the ratio of imported materials and the ratio of imported services inputs over total wages, respectively. With regard to the latter measure, services inputs are defined as other direct and indirect costs, excluding

[10] One should note that materials and services not sourced abroad may have been purchased from foreign affiliates of multinationals located in Ireland rather than just from purely domestic firms. Unfortunately, the data set does not allow us to distinguish these two sources for domestically purchased inputs.

materials, wages, rent, interest payments, and depreciation. This includes contracted out services, such as consultancy, maintenance, security, cleaning, catering, etc.

Table 1 contains some descriptive statistics for the main variables of interest. We see that the first year of the study, 1990, only around half the plants were captured but the data set includes a higher number of

Table 1
Descriptive statistics

	1990	1991	1992	1993	1994	1995
Average number of employees						
Mean	174	136	124	137	153	180
Median	106	61	61	76	73	78
S.D.	183	170	149	160	233	308
N	54	109	120	121	123	125
Average annual wage (IRP 000)						
Mean	14.0	15.58	16.69	18.03	18.49	19.00
Median	13.79	15.49	16.40	16.54	16.76	17.00
S.D.	4.59	5.71	6.05	7.25	8.46	8.25
N	54	109	120	121	123	125
Average total outsourcing ratio (o_j)						
Mean	3.1	2.9	3.1	2.9	4	3.9
Median	2	1.3	1.4	1.3	1.2	1.4
S.D.	3.1	4.8	5	6	10.9	8.3
N	54	109	120	121	123	125
Average total inputs (inputs)						
Mean	17,718	15,195	14,812	16,678	20,291	38,316
Median	6473	2635	2790	3613	3419	4236
S.D.	49,432	43,412	39,905	48,757	55,099	122,381
N	54	109	120	121	123	125
Average outsourced inputs (for1)						
Mean	12,970	9716	9160	11,962	13,154	23,761
Median	3840	1286	1333	1782	1640	1718
S.D.	40,135	31,756	26,060	36,010	39,586	76,623
N	54	109	120	121	123	125
Average outsourced material inputs (for2)						
Mean	11,976	9238	8658	12,384	12,031	23,463
Median	3250	1409	1180	1926	1661	1731
S.D.	38,312	30,950	24,769	33,385	37,709	78,161
N	53	99	110	106	108	108
Average outsourced service inputs (for3)						
Mean	1077	1257	1224	1113	2590	3488
Median	112	38	57	70	61	60
S.D.	2921	5130	6209	5783	11,399	19,050
N	53	108	120	121	123	125

All wages and input prices inflation adjusted (consumer price index base year 1990=100).

firms over the 5 years that follow. As such, the 1990 values occasionally appear at variance with those of the following 5 years. This anomaly is most likely due to sample composition.[11]

The most noticeable change across the years, arises between 1994 and 1995, when average total inputs increased from 20.3 K to 38.3 K (35 percent), total outsourced inputs rising by 13.2 K to 23.8 K (36 percent). Service inputs experience the highest proportional rise, albeit from a low initial level. They increase from an average of 2.6 K to 3.5 K, an increase of 43 percent. Interestingly, the outsourcing ratio (i.e., total outsourced inputs over the wage bill) increased substantially between 1993 and 1994 but does not rise further with the increasing use of intermediates in the year that follows. This is due to a simultaneous increase in the average wage and the average total wage bill between 1994 and 1995, which implies that our outsourcing measure remains constant. However, it should be noted that the average wage also increased significantly in the earlier years since 1990. Has the increased use of international outsourcing been a reaction at the plant level to the rising wage bill? While we do not address this question directly in this paper, our analysis goes into that direction as it allows us to determine whether outsourcing leads to reductions in labour demand.

5. Analysis

In the estimation of Eq. (1) we can opt to treat our covariates as fully exogenous, in which case we employ a standard GMM specification comprising a fully exogenous dynamic panel model with appropriate tests for autocorrelation. Alternatively, it can be argued that the interrelationships among the determinants of employment (in particular wages and international outsourcing) are more complex and accordingly pre-determined. This assumption is reasonable because we can argue that errors in predicting employment at time t+1, based on values of outsourcing and wages at time t, are themselves predictive of employment at time t+2. In this latter instance, the GMM framework is modified to allow this relaxation of strict exogeneity. The predetermined variables (outsourcing and wages) are now instrumented, using lagged levels as instruments as described in Arellano and Bond (1991).

We first estimate the changes to employment levels when outsourcing and wages are treated as fully exogenous, see column (1) of Table 2.[12] As expected, there is a strong element of persistence in employment, where higher employment levels in the previous year are associated with higher contemporaneous employment levels. As we would expect, higher contemporaneous as well as lagged industry demand, induce higher employment levels. Moreover, increases in a firm's average wage, lead to staff reductions. Most interesting from our point of view, higher levels of outsourcing are associated with reduced employment, as evidenced by a negative coefficient for the variable o_j, ceteris paribus, although the coefficient is not statistically significant in this specification.

In the second estimation in column (2), wages and outsourcing are formulated as pre-determined variables; an arguably reasonable assumption in the estimation of labour demand equations (see Arellano & Bond, 1991). On this occasion, the main difference between equations in columns (1) and (2) is that in the latter, international outsourcing is statistically significant and negative. The point estimate (i.e., the

[11] Note that this should not cause a problem in the econometric analysis below, where we follow each individual plant over the time period, hence the composition of the total sector does not matter.

[12] Nickell (1986) argues that additional lags beyond $t-1$ may be necessary to capture adequately adjustment costs. We experimented with including higher order lags in the estimations, the coefficients on these higher lags beyond lag two are generally, however, statistically insignificant.

Table 2
Impact of total outsourcing (O/S) on employment

	(1)	(2)	(3)	(4)
n_{it-1}	0.616 (2.62)***	0.548 (2.63)***	0.648 (2.73)***	0.454 (2.48)***
n_{it-2}	0.074 (0.59)	0.136 (1.17)	0.058 (0.45)	0.123 (1.11)
y_{it}	0.089 (1.88)*	0.092 (2.18)**	0.089 (1.88)*	0.106 (2.56)***
y_{it-1}	0.036 (0.76)	0.064 (1.25)	0.031 (0.65)	0.080 (1.91)*
w_{it}	−0.520 (3.32)***	−0.621 (3.11)***	−0.537 (3.33)***	−0.766 (2.57)***
w_{it-1}	0.029 (0.16)	−0.078 (0.47)	0.055 (0.31)	−0.080 (0.41)
Total outsourcing (o_j)	−0.048 (0.76)	−0.277 (1.93)**		
ΔTotal outsourcing (Δo_j)			−0.046 (1.03)	−0.093 (2.22)**
Time trend	0.020 (0.99)	0.032 (1.50)	0.018 (0.87)	0.028 (1.49)
Wald χ^2	135.25	127.67	144.77	117.59
Arellano-Bond (order 2)[a]	0.15	0.12	0.15	0.11
Sargan test[b]	0.82	0.69	0.80	0.78
Observations	173	173	172	172
Number of plants	80	80	79	79

Dynamic panel equation with robust standard errors, t-statistics in parentheses.
*, **, *** signify statistical significance at 10, 5 and 1 percent, respectively.
[a] H_0: no autocorrelation ($P>z$).
[b] Overidentifying restrictions where H_0: overidentified ($P>\chi^2$). χ^2 from 2-step estimates columns (1) and (3): apart from lagged employment, all covariates treated as exogenous columns (2) and (4): outsourcing and wages treated as pre-determined.

elasticity of labour with respect to outsourcing) suggests that a 1 percent increase in the outsourcing ratio reduces employment by 0.27 percent.

As a consequence of estimating our model with robust standard errors (i.e., allowing for heteroskedasticity), we are obliged to use the Sargan test statistic as calculated for the two-step model in line with guidance issued by Arellano and Bond (1991). We apply the second-step estimates because the one-step Sargan test over-rejects in the presence of heteroskedasticity. We cannot reject the null in the Sargan test in either specification. This null tests the overall validity of the instruments by analysing the sample analog of the moment conditions used during estimation. Failure to reject the hypothesis, i.e. lower χ^2 test values or higher p-values, lend support to the model. The other diagnostic examined is the null hypothesis of no second-order serial autocorrelation. If the test rejects the null, we must conclude that the original error term is serially correlated. Fortunately, we are unable to reject the null of no second order serial autocorrelation in both specifications at conventional levels of statistical significance.

Having looked at how the levels of bought in intermediates change the demand for labour, it is also reasonable to argue that changes in demand for these intermediates could also influence labour demand. Accordingly, we estimate the effects of changes in offshoring (i.e., Δo_j) on labour demand. Again, we distinguish estimations, which treat outsourcing and wages as exogenous (column 3) or pre-determined (column 4). From column (4) we find that international outsourcing negatively affects labour demand, although the elasticity is somewhat lower than in the "levels estimation" in column (2).

As noted earlier, no analysis to our knowledge has yet examined the potential effect of materials and service intermediates on labour demand despite the prima facie case for treating service intermediates separately. We therefore document the individual effects of materials and

Table 3
Impact of material and service O/S on employment

	(1)	(2)
n_{it-1}	0.474 (2.54)**	0.176 (1.03)
n_{it-2}	0.159 (1.40)	0.224 (2.55)**
y_{it}	0.107 (2.47)**	0.045 (1.31)
y_{it-1}	0.075 (1.58)	0.040 (0.82)
w_{it}	−0.558 (2.26)**	−1.157 (4.49)***
w_{it-1}	−0.074 (0.43)	−0.249 (1.40)
Materials outsourcing (o_j)	−0.192 (2.22)**	
Services outsourcing (o_j)		−0.149 (2.31)**
Time trend	0.025 (1.06)	0.066 (2.52)**
Wald χ^2	115.96	59.30
Arellano-Bond (order 2)[a]	0.13	0.22
Sargan test[b]	0.54	0.92
Observations	170	143
Number of plants	78	70

Dynamic panel equation with robust standard errors, *t*-statistics in parentheses.
*, **, *** signify statistical significance at 10, 5 and 1 percent, respectively.
[a] H_0: no autocorrelation ($P>z$).
[b] Overidentifying restrictions where H_0: overidentified ($P>\chi^2$). χ^2 from 2-step estimates outsourcing and wages treated as pre-determined.

services outsourcing (in terms of levels) on employment in Table 3. We only report estimations treating outsourcing and wages as pre-determined.

The elasticity of employment with respect to materials outsourcing is negative, indicating that higher levels of the latter are associated with lower employment levels. A similarly negatively signed coefficient is registered for services offshoring, although the point estimate is somewhat smaller than for materials outsourcing. Hence, negative employment effects appear to be due to both types of international outsourcing, with somewhat stronger effects from materials outsourcing. As in the case of all analyses thus far, we find that second order serial autocorrelation does not appear to be a problem. Also, the failure to reject the Sargan test indicates instrument validity.

6. Conclusions

In this, to our knowledge, first analysis on the net or overall effects of international fragmentation of production on labour demand at the plant level, we find that outsourcing in the Irish Electronics sector, significantly decreases labour demand in the short-run. This finding is robust to changes in different specifications of wages and the outsourcing ratio to accommodate possible pre-determination of these variables.

We should qualify our findings by emphasising that they pertain to offshoring for the Electronics sector. Nevertheless, our data captures firms from many subsectors within Electronics, including manufacturing and services activities, which are potentially upstream or downstream processes in the production chain. Accordingly, the negative relationship between offshoring and

employment evidenced in our data, is arrived at despite arguably some potential for employment switching among subsectors. If every offshored input occasioned an intra-sectoral employment switch, the net impact of offshoring on employment would be zero. Of course, our analysis fails to pick up overall economy-wide employment gains because it merely captures employment losses *within* this one sector. Accordingly, there may be extra-sectoral employment leakages, e.g. between Electronics and Pharmaceuticals, occasioned by offshoring and hence our results may over-exaggerate net employment losses.

In addition, we are cautious to point out that our estimations merely capture the short-run effects of international outsourcing in the plant. In the medium or longer run, plants may increase labour demand due to increased competitiveness following international outsourcing. Unfortunately, our relatively short panel does not allow us to examine long-run effects in any detail.

Our findings appear largely in line with the conclusions of Egger et al. (2003) that unemployment arises as a short-run consequence of offshoring. Intuitively, we argue that the movement into a new job is a medium or even long-run phenomenon and that offshoring shocks are expected to induce net job losses at the level of the plant in the short-run. However, in order to judge the overall economy-wide net employment effects as well as the long-run implications of outsourcing at the level of the plant, further research is needed using micro and macro-level data.

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Appendix A. Number of firms by sub-sector

Electronics sector (Republic of Ireland)	Frequency	%
Components	112	17
Computers	23	4
Consumer Electronics	67	10
Instrumentation	66	10
Networking/Data Communications	18	3
Peripherals and Media	72	11
Printed Circuit board Assembly (PCBA)	53	8
Semiconductors	23	4
Services	39	6
Software Development	96	15
Software Production	33	5
Telecommunications	50	8
Total	652	100

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