Productivity effects of international outsourcing: Evidence from plant level data*

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Abstract

We investigate the impact of international outsourcing on productivity using plant level data for Irish manufacturing. Specifically, we distinguish the effect of outsourcing of materials from services inputs. Moreover, we examine whether the impact on productivity is different for plants being more embedded in international markets through exporting or being part of a multinational. Our results show robust evidence for positive effects from outsourcing of services inputs for exporters, either domestic- or foreign-owned. By contrast, we find no statistically significant evidence of an impact of international outsourcing of services on productivity for firms not operating on the export market.

Keywords: International outsourcing, productivity, exporting, multinational production

JEL classification: F14, F23, L23

1 Introduction

International outsourcing has become a growing phenomenon in world trade. Hummels et al. (2001), for example, provide evidence from data for 10 OECD and four emerging market countries that trade in outsourced components in the vertical chain accounts for 21 percent of these countries' exports.[1] Moreover, they find that international outsourcing grew approximately 30 percent between 1970 and 1990. More recently, the attention in many industrialised countries has shifted away from outsourcing of materials to services outsourcing (Amiti and Wei, 2005). For instance, much media coverage has been given to the outsourcing of services to developing countries such as India.

Given the considerable growth in outsourcing it is not surprising that a sizeable amount of research has now been devoted to attempting to understand the causes and consequences of this disintegration of production.[2] When investigating the impact of international outsourcing most research has focused on the implications for domestic labour markets, see, for example, Feenstra and Hanson (1999), Head and Ries (2002) and Hijzen et al. (2005). Another somewhat neglected, but potentially important, aspect of outsourcing is its impact on productivity.[3] In this regard, standard trade theory tells us that increased specialization following international outsourcing is beneficial for the economy as it allows reallocation of resources to their best use. A priori, one would also expect the individual plant to be able to benefit from international outsourcing as it allows the plant to purchase higher quality intermediates abroad and/or reorganize production to concentrate the most efficient stages in the home country.

The empirical evidence on such a link between international outsourcing and productivity is limited. A few papers that have investigated productivity effects of

outsourcing have used aggregate data. Specifically, Egger and Egger (2006) focus on the link between international outsourcing of materials and labour productivity of EU low skilled labour and conclude that short run productivity of low skilled workers is adversely affected by cross-border fragmentation while in the long run low-skill worker productivity rises. Amiti and Wei (2006) using US industry data find that, in particular, services outsourcing is positively associated with productivity.

A small number of papers have also looked at the outsourcing – productivity relationship using firm level data. Tomiura (2005) and Kurz (2006) using data for Japan and the US, respectively, model a firm's decision to outsource and find that more productive firms are more likely to outsource. Neither paper deals specifically with the possibility of endogeneity of the outsourcing decision, though Kurz (2006) concludes that outsourcers are "outstanding" in that they are larger, more capital intensive and more productive. The papers by Kasahara and Rodrigue (2005) and Yasar and Morrison Paul (2007) investigate the relationship between firm productivity and firm level imports of materials in a production function framework using data for Chile and Turkey, respectively. Specifically, Kasahara and Rodrigue find that firms who switch from non-importing to importing status can raise productivity by 3.4 to 22.5 percent depending on the estimation technique used.[4]

In the current paper we investigate whether international outsourcing (via imports of intermediate products) affects total factor productivity at the plant level. In contrast to much of the earlier literature focusing on outsourcing we do so using plant, rather than industry, level data. Furthermore, our work is distinct from Kasahara and Rodrigue (2005) and Yasar and Morrison Paul (2007) in that we look specifically at differences between outsourcing of materials and services inputs. To do so we use current data

which also allows us to capture recent growth in services outsourcing (see, e.g., Amiti and Wei, 2005). As far as the authors are aware, ours is the first paper to do this using plant level data. Recent empirical studies of firm and plant level productivity have established that there is large and persistent heterogeneity across firms even within narrowly defined industries (see, e.g., Bartelsman and Doms, 2000), hence accounting for this with the use of micro data is important. Another contribution of our paper is that we allow for potential productivity effects to be different for purely domestic plants, exporters, and foreign-owned affiliates in the host country. This aspect links our paper in with the recent theoretical and empirical work on plant/firm heterogeneity and international trade, such as Bernard et al. (2003), Helpman et al. (2004) and Yeaple (2005).

Our analysis, in distinguishing between services and materials outsourcing is in line with current thinking that recent innovations in communications technology should reduce the search costs for international service partners as evidenced in the growth of internationally traded services, albeit from a low baseline (Amiti and Wei, 2005). That such a categorisation may be important has been hinted at by Amiti and Wei (2006) who find stronger productivity benefits from international outsourcing of services than materials. Similar to the empirical literature using aggregate industry level data (e.g., Feenstra and Hanson, 1999), which defines international outsourcing generally as imported intermediate inputs we examine input sourcing behaviour at the plant level. Hence, we define international outsourcing as the value of imported intermediates at the level of the plant.

Our empirical analysis utilises plant level data for manufacturing industries in the Republic of Ireland. Ireland may be considered as an interesting case study given that

Hummels et al. (2001) argue that a small open economy is most likely to rely heavily on fragmentation of its production processes. Amiti and Wei (2005) point out that Ireland is ranked number one on the list of *industrialised* countries outsourcing business services, characterised by a staggering 15 percent of Irish GDP comprising internationally outsourced services.[5] Thus outsourced services are not a trivial component in the Irish economy. Furthermore, Ireland has over the last few decades been an important host country for affiliates of multinational companies, and many plants, both foreign and domestic owned, engage in exporting (see, for example, Barry and Bradley, 1997, and Ruane and Sutherland, 2002).

Our evidence from econometric estimations controlling for endogeneity of the outsourcing decisions suggests that there are potential positive effects from international outsourcing in particular of services inputs. However, we find that these benefits only accrue to exporters. This suggests that plant level heterogeneity, and in particular contacts in foreign markets, is important in evaluating the productivity effects of international outsourcing.

The structure of our paper is as follows. In the next section we discuss the theoretical background for our hypothesis that international outsourcing affects productivity. Section 3 sets out the empirical methodology for analysing the link between outsourcing and total factor productivity at the plant level. Then follows a description of the data along with some descriptive statistics in Section 4. We subsequently present the results of our estimations in Section 5 before concluding in the final section.

2 International outsourcing and productivity

The theoretical rationale for expecting an effect from international outsourcing on plant level productivity is fairly straightforward. Assume that goods are produced in a multistage production process, which for each good involves different stages from basic upstream production to the eventual completion of the final good in the downstream stages. In this set up, one may expect a number of different possible effects. In the short run, the plant engaging in international outsourcing has access to internationally traded inputs, which may be available at higher quality than those available domestically. Hence, increasing use of internationally traded inputs may result in a direct boost in productivity for the plant, shifting its production function outward. This may be particularly important for plants that are operating far away from the international technological frontier in their industry.[6]

The second type of effects concerns compositional changes induced by international outsourcing, which may have implications for productivity. For example, assuming that a plant carries out multiple production stages in-house it may be beneficial to relocate those parts in which it is relatively inefficient to another country where it can be carried out at lower cost. Home production could then concentrate on those activities that it does more efficiently, and import the intermediate good now produced abroad. Hence, it would be able to reallocate resources to the more efficient production stage, expand output and push its production function outward, thus improving measured total factor productivity.[7]

Given the substantial heterogeneity of units in our plant level data, it seems reasonable to expect the plant level productivity effects to differ depending on plant

characteristics. We distinguish purely domestic plants from domestic exporters and foreign-owned multinationals. In their theoretical models, Antrás and Helpman (2004) and Grossman and Helpman (2005) make the reasonable argument that international outsourcing involves substantial sunk costs. Firms have to search for foreign suppliers, assess their quality and write contracts. The business literature has also highlighted the fact that there are substantial costs of outsourcing which may potentially cancel out any anticipated costs savings that may to be had from outsourcing. These include, for example, cost of travel, transportation and communication costs, or cost of sending employees to be located in overseas plants (Rasheed and Gilley, 2005). One may arguably expect that these types of costs differ between the different types of firms. In particular, we would expect exporters and foreign-owned firms to face lower costs of outsourcing as they are embedded into international production networks with more foreign contacts than purely domestic firms (e.g., Sjöholm, 2003).

Our data provides us with other valuable information that we exploit in the empirical analysis. Namely, we can distinguish international outsourcing of tangible inputs, i.e., materials and components, from services inputs (the exact definition of which will be given in the data section below). It is not a priori obvious that we should expect similar productivity effects from the outsourcing of different types of inputs and, hence, it seems appropriate to investigate this issue in detail empirically. More specifically, we would expect larger productivity benefits from international outsourcing of services than of materials. For an average manufacturing plant it is likely that services inputs are an activity which it performs relatively inefficiently (compared to the other production stages) as the main concern of the plant is to produce manufacturing output. Hence, importing the service activity (for example back office accounting or computing

operations) may bring higher productivity benefits than outsourcing some tangible intermediate input. In a similar vein, Amiti and Wei (2006) argue that outsourcing of services may be more likely to allow plant restructuring in a way that pushes out the technology frontier than outsourcing of material inputs.

3 Empirical methodology

In order to investigate the effect of international outsourcing on plant level total factor productivity we estimate production functions that include the effect of international outsourcing. Specifically, we assume a general Cobb-Douglas production function

$$Y_{it} = A_{it}^{\phi}(K_{it}^{\alpha} L_{it}^{\beta} M_{it}^{\gamma} S_{it}^{\lambda}) \qquad (1)$$

where Y is total output, K is capital, L is labour, M and S are materials and services inputs, and A is a technology parameter (or total factor productivity, TFP). Taking logs yields

$$y_{it} = \phi a_{it} + \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \lambda s_{it} \qquad (2)$$

where lower case letters denote natural logs (i.e., $y = \ln Y$) of the variables.

We investigate whether the use of international outsourcing has any effect on total factor productivity by allowing the intensity of international outsourcing to shift the technology parameter a of the underlying production function, $a_{it} = a(outs_{it})$, i.e., we assume that international outsourcing leads to a shift of the plant's production function. This is, thus, an empirical analysis of the type of effect from international outsourcing on productivity, as discussed in Section 2.

The estimation equation, thus, is

$$y_{it} = \pi + \delta outs^{m,s}{}_{it} + \alpha k_{it} + \beta l_{it} + \gamma m_{it} + \lambda s_{it} + \gamma X_{it} + d_t + d_j + \varepsilon_{it} \qquad (3)$$

where $outs^{m,s}$ is the intensity of international outsourcing for either materials m or services s and X is a vector of other firm characteristics that may impact on TFP. The variables d_t and d_j are full sets of time and industry specific dummies. The remaining error term ε allows for unspecified heteroskedasticity and correlation of residuals within plants (clustering).

The vector X includes two sets of dummy variables indicating whether a firm is part of a foreign owned multinational and whether it is an exporter as it is frequently argued that both types of firms are more productive than purely domestic plants. While the international evidence generally supports this claim (see, for example, Bernard and Jensen, 1999 and Doms and Jensen, 1998 for the US), the evidence for Ireland is less clear-cut. Girma et al. (2004) show using plant level data that labour productivity in multinationals is higher than in domestic plants (either exporters or non-exporters) but that there is no significant difference in productivity levels between domestic exporters and non-exporters.[8]

While the standard explanations for these productivity advantages usually focus on firm specific assets for multinationals and self-selection or learning for exporters,[9] the possibility that outsourcing enhances productivity can also be advanced. Being part of an international production network, either as an affiliate of an MNE or an exporter, allows firms to reap the advantages of international specialisation of production activities. This arguably allows such establishments to lower the sunk costs of searching for new intermediate good suppliers from which to outsource inputs. Hence, due to the lower cost associated with establishing an outsourcing relationship, such firms may reap greater

gains from international outsourcing than firms with production facilities and sales only on the domestic market. In the empirical estimations, we relax the assumption that the effect of outsourcing on productivity is the same across different types of plants by allowing for differential productivity effects of international outsourcing by nationality and export status of the plants.

4 Description of the data

In order to investigate the relationship between international outsourcing and productivity we use plant level data for manufacturing industries in the Republic of Ireland. The data are taken from the *Irish Economy Expenditure Survey*, undertaken annually over the period 1983-1998 by Forfás, the government agency with responsibility for enterprise development, science and technology. This is an annual survey of larger 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 plant population.[10] Hence, while our data can be regarded as representative of the targeted population of plants it does generally not include plants with less than 20 employees.

The survey provides plant level information on, *inter alia*, output (measured in terms of sales), value added (sales minus intermediate inputs), exports, employment, capital employed, nationality of ownership, as well as details on plants' expenditure on labour, materials, and services inputs.[11] One should note, however, that information on the capital stock, is only available from 1990 onwards, and hence, since we focus on total

factor productivity, our sample period consists of the years 1990-1998. A plant is defined as foreign owned in the data if at least 50 percent of its shares are held by foreign owners.[12] Dropping observations with missing values for any of the variables included in equation (3) leaves us with an unbalanced panel consisting of 1,099 plants. Of these, 459 are foreign-owned, 534 are exporters and the remaining 106 are purely domestic.

The main variable of interest is international outsourcing which is defined as imported inputs at the plant level. This can arguably be seen as a substitute for in-house production and may therefore, at least in the short run, lead to a reduction in the total wage bill. In some sense, the cost of outsourcing is therefore equal to the opportunity wage that may have accrued to in-house employees if the service had not been contracted out. We hence, similar to Girma and Görg (2004), calculate an indicator of an establishment's propensity to outsource as the expenditure on outsourcing, i.e., on either imported services or material inputs, relative to the plant's total wage bill.[13]

An advantage of our data set is that we can break down intermediate inputs into two groups: raw materials and components (referred to as materials) and services inputs respectively. Additionally, we have information on the proportion of these factors sourced abroad.[14] We can therefore calculate two disaggregated measures of international outsourcing, namely, the ratio of imported materials over total wages, and the ratio of imported services inputs over total wages. With regard to the latter measure, services include inputs such as consultancy, maintenance, security, cleaning, catering etc. They do not include other indirect costs such as rent, interest payments and depreciation.

To illustrate the development of international outsourcing over the nine year time period studied, Figure 1 plots the aggregate totals for the materials and services outsourcing ratios by year. Two points are worthy of note. Firstly, international

outsourcing of materials has consistently been more important than outsourcing of services in terms of aggregate values. Secondly, both types of outsourcing increased, on average, between 1990 and 1998, reflecting the general notion that international outsourcing has become more important over the 1990s.

[Figure 1 here]

Table 1 presents some summary statistics on some of the variables of interest. We find that foreign-owned plants as well as domestic exporters are larger (in terms of employment) and more productive (in terms of value added per worker) than purely domestic oriented local plants. We also find that foreign-owned plants have the highest intensities of international outsourcing for both services and materials while there is no strong difference in the average outsourcing intensities between domestic exporters and non-exporters.

[Table 1 here]

In order to get a preliminary idea of the relationship between international outsourcing and productivity (in terms of value added per employee), we decompose the latter variable in two groups: low (below median) and high (above median) labour productivity respectively. Table 2 then describes average outsourcing intensities for these low and high productivity establishments. One can see that high productivity plants exhibit higher average outsourcing intensities of both materials and services. We also find that a greater proportion of foreign owned establishments are located in the higher productivity category.

[Table 2 here]

5 Econometric analysis

While the summary statistics give some insight into the potential relationship between productivity and outsourcing, they do not, of course, allow us to take adequately into account other covariates that may impact on plant level productivity and may be correlated with outsourcing, or say anything about directions of causality. In order to deal with these issues we now turn to estimating the production function described in equation (3). The results of the estimation of the baseline specification of equation (3) using OLS are reported in column (1) of Table 3.[15] Examining firstly the coefficients on the standard production factors *k*, *l*, *s* and *m* shows that these return coefficients that are statistically significant and positive as expected. The coefficient on capital is arguably lower than what is generally found in manufacturing industries – see, e.g., Hall and Mairesse (1995) or Wakelin (2001) who find capital coefficients around 0.15 to 0.20. In our case, this smaller coefficient is due to the inclusion of services inputs.[16] However, comparing our estimates with those of Amiti and Wei (2006) who also include *k, l, s* and *m* in the production function shows that our coefficient on *k* does not appear to be much out of line.

In terms of the other variables, we find that foreign owned plants are more productive than domestic ones, as is generally found in the literature. However, we do not find any statistically significant productivity premium for exporters.[17] As pointed out above, this is not unexpected as there is, as far as we are aware, no clear cut evidence for Ireland substantiating that exporters are more productive than non-exporters. We are, of course, mostly interested in the effect of international outsourcing. Examination of these

results shows that international outsourcing of services appears to have a negative effect on plant level productivity, while the impact of materials is positive.

There are a number of econometric problems with this estimation, however. First, factor inputs should be considered potentially endogenous in the estimation of the production function. This is the case because the contemporaneous level of TFP may affect the current choice of variable input factors, in which case inputs would be correlated with the error term (e.g., Levinsohn and Petrin, 2003). Secondly, the relationship between outsourcing and productivity may be endogenous if there are unobserved variables that are potentially correlated with outsourcing and the error term. For example, plants with high or low productivity levels may be more likely to engage in outsourcing than other plants. This may explain the negative coefficient on services outsourcing in column (1) if, for example, low productivity firms use outsourcing as a defensive strategy out of desperation.

There are various ways of dealing with these problems, and we employ a number of alternatives here. Our first approach is based on the assumption that the part of the error term that is correlated with either the input choices or the outsourcing variables is time invariant. This can either be the case if, for example, the simultaneity of input choice and TFP is due to a particular manager in a plant who was in charge over the whole time the plant spends in our sample, or if plants that are consistently of low productivity always make particular outsourcing decisions. Under this assumption of a time invariant plant specific effect the model can be estimated using a fixed effects (within transformation) estimator. The results are reported in column (2). It is notable that the point estimates change slightly, but all coefficients are similar to OLS in terms of

sign and statistical significance.[18] Of course, assuming the observed component to be a fixed effect is not a reasonable assumption in a long panel.

Before continuing with dealing with the simultaneity problem another potential issue with regressions thus far is that we do not allow coefficients on inputs to vary by sector, hence, we are assuming that sectors use the same technology. This is a very restrictive assumption. In order to deal with this we, in a first step, estimate a production function regressing output on only the factor inputs using a fixed effects estimator, and to take account of sectoral heterogeneity production functions are estimated separately for two digit industries. We, then retrieve total factor productivity as the residual. TFP is then regressed on the other explanatory variables included in the model, which are assumed to be exogenous, using OLS. The results of this are reported in column (3). We now unearth important differences to the previous estimates. In particular, we find that international outsourcing of services has a positive and statistically significant effect on productivity, while the coefficient on materials outsourcing is still positive and statistically significant. This indicates that taking account of sectoral heterogeneity in the estimation of the production function is important for our conclusions.

In column (4) we deal more appropriately with the endogeneity of inputs choices by implementing the approach of estimating TFP due to Levinsohn and Petrin (2003). They suggest overcoming the simultaneity problem in production function estimations by essentially using inputs as a proxy for the unobserved productivity component. We implement their methodology, using plant level energy consumption as proxy. Accordingly, we now estimate production functions separately for two-digit industries using their approach, and then generate total factor productivity as the residual from that regression. The second stage TFP is performed using OLS.

Results reported in column (4) still show that international services outsourcing has a positive and statistically significant effect on productivity, although the point estimate is much lower than in the regression in column (3). The coefficient on materials outsourcing, though still positive, is also much lower than previously estimated. This model, while improving on the earlier estimations, still has one major flaw, namely, the assumption that international outsourcing is exogenous to plant level productivity.[19]

In order to take account of this potential endogeneity problem we implement an instrumental variables (IV) regressor in column (5). This treats the two outsourcing variables as endogenous. We use services and materials outsourcing in period *t*-2 as instruments, as well as a plant's total expenditure on transport costs. The latter seems a reasonable instrument as it is likely to be correlated with international outsourcing but can be assumed orthogonal to the error term.

We are careful to assess the validity of the instruments using a Sargan type (Hansen) test, as well as the instrument relevance, examining the strength of the relationship between the instruments and the potentially endogenous regressors. It has been noted by, for example, Staiger and Stock (1997) that when the partial correlation between the instruments and the endogenous variable is low, instrumental variables regression is biased in the direction of the OLS estimator. Staiger and Stock (1997) recommend that the F-statistics (or equivalently the p-values) from the first-stage regression be routinely reported in applied work.[20] These tests, as reported in column (5) indicate that instruments are both valid and relevant.

Turning to the coefficients, and in particular the outsourcing variables, we find that the result for services outsourcing is qualitatively similar to the one reported in column (4) - services outsourcing positively affects plant level productivity. However,

we now find that there is no statistically significant relationship between productivity and international outsourcing of materials.

The last column in Table 3 reports results of an estimation using the Generalized Methods of Moments (GMM) estimator as implemented by Baum et al. (2003). This estimator is more efficient in the presence of heteroskedasticity than the standard IV estimator. We use the same instrument set as for the estimations in column (5). Results are, reassuringly, much in line with the IV results. Looking at the point estimate, our results suggest that a ten percentage point increase in the measure of international services outsourcing leads to an increase in plant level productivity by approximately 0.8 to 0.9 percent.[21]

[Table 3 here]

The estimations reported in Table (3) constrain the effect of international outsourcing to be the same across different types of plants. As hinted at in Section 3, this may not be a reasonable assumption. In particular, in line with the recent literature stressing firm level heterogeneity in international trade theory an important aspect of differences in plants is their level of international involvement – are plants part of a foreign multinational, are they domestic firms that export, or are they purely domestic firms? This distinction can have implications for their ability to benefit from international outsourcing. As highlighted in recent theoretical work (e.g., Antrás and Helpman, 2004) international outsourcing involves sunk costs of searching for partners overseas. The potentially high cost of international outsourcing have also been pointed out in the business literature (Rasheed and Gilley, 2005). Arguably, these costs of international outsourcing may be much higher for firms without any previous

international contacts, i.e., purely domestic firms, than for those with such contacts through either exporting or being a multinational.

In order to allow for these potential differences in the effects of international outsourcing we generate interaction terms of the two outsourcing variables with dummy variables for exporters and foreign-owned plants. Column (1) of Table 4 reports results for estimations including only the first set of interaction terms, i.e., allowing the effect of outsourcing to differ for exporters and non-exporters regardless of their nationality. The results show that we now find a negative yet statistically insignificant effect of international services outsourcing on the productivity of non-exporting plants. For exporters, the results turn positive, with a coefficient of 0.23. This suggests that the search for partners with which to outsource production indeed involves costs and that these may outweigh any benefits of this outsourcing at least in the short run for firms that are not already established on international markets through exporting.

Column (2) includes interaction terms for both exporters and foreign-owned plants. Results show statistically significantly positive effects of services outsourcing for exporters. However, there is no further advantage to exporters that are foreign-owned, as indicated by the statistically insignificant (though positive) interaction term. It is noteworthy also that even when including the interaction terms we do not find any strong evidence to suggest that there are significant benefits associated with the international outsourcing of materials inputs.[22]

One potential criticism with our results so far concerns the measurement of international outsourcing, which reflects the value of imported inputs (services or materials) relative to the total wage bill in the plant. While we have argued in Section 4 that this is potentially an appropriate measure of international outsourcing intensities,

alternative measures are of course possible. We therefore construct a different measure of international outsourcing as imported services (materials) relative to total services (materials) inputs and use this in the estimation of the model. The results of this exercise are reported in column (3) of Table 4. Note that the conclusions on the effects of international outsourcing on plant level productivity do not change. International outsourcing of services is associated with higher productivity in exporting plants, but not in domestic oriented plants. Also, we do not find any effects associated with increases in international outsourcing of materials.

[Table 4 here]

6 Conclusions

This paper analyses the effect of international outsourcing of services and materials inputs at the plant level on productivity of the plant. We use various techniques to account for potential endogeneity of international outsourcing in the productivity estimation. Our results show robust evidence for positive effects from outsourcing of services inputs. However, these results only hold for exporters, either domestic- or foreign-owned. By contrast, we find no statistically significant evidence of an impact of international outsourcing of services on productivity for firms not operating on the export market. A possible reason for this is that firms that are members of international production networks possess extensive knowledge on where to procure competitively priced inputs and, hence, face lower costs of outsourcing, in particular searching for potential suppliers abroad.

Overall, our results suggest that plant level heterogeneity is important in evaluating the productivity effects of international outsourcing. It also indicates that further research into this area, either theoretical or empirical, would be very fruitful.

Appendix

Table A1: Persistence of materials and services outsourcing

	Percentage
Services outsourcing	
Firms with services outsourcing (ever outsourcing)	84
Non-service outsourcing firms that switch to services outsourcing	11
Service outsourcing firms that discontinue to outsource	4
Materials outsourcing	
Firms with materials outsourcing (ever outsourcing)	94
Non-materials outsourcing firms that switch to materials outsourcing	8
Materials outsourcing firms that discontinue to outsource	0

Explanatory notes: Row one suggests that 84 percent of plants outsourcing services at some stage during the sampling period. Of those plants that initially do not outsource services, 11 percent start outsourcing in the sampling period. Of those plants that initially do outsource, 4 percent stop at some stage.

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Footnotes

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[1] In the international trade literature, international outsourcing is generally seen to be equivalent to vertical specialisation and is measured in terms of trade in intermediate goods.

[2] See, for example, recent special issues on international outsourcing of the *North American Journal of Economics and Finance* (Vol. 16, No. 1, 2005) and the *International Review of Economics and Finance* (Vol. 14, No. 2, 2005).

[3] The potential importance of this aspect is highlighted by some recent evidence which casts some doubt on the efficacy of outsourcing for boosting company performance. For example, 56 percent of survey respondents to an IT specialists' journal claimed that outsourced IT work was at least worse than that produced in-house. More worryingly, 11 percent reported that the outsourced work induced a setback in the firm's production; see Software Development Magazine, January 2004 issue.

[4] López (2006) also uses similar Chilean data but applies it to a survival analysis and finds that exporters have higher survival likelihoods but only on the proviso that they are also importers. There is also a somewhat related literature using plant level data to look

at the productivity effects of reductions in tariffs on inputs, e.g., Fernandes (2007) and Amiti and Konings (2005).

[5] Compare this with 1.03 percent for the UK and 0.39 percent for the US.

[6] Of course, international outsourcing may also give plants access to inputs of the same level of quality but at a lower price. However, if the only effect of outsourcing is to provide inputs at lower prices it is not clear that this should have any sustained effects on measured total factor productivity.

[7] Furthermore, there may also be general equilibrium effects associated with the plant level outsourcing activity which, through the reallocation of production in the home country may affect relative prices in the economy.

[8] Ruane and Sutherland (2005) use a different firm level dataset for Ireland and find some evidence that exporters have higher levels of value added per employee, but this is not robust in all econometric specifications they estimate. Greenaway et al. (2005) also find in a study using Swedish firm level data that there are no strong productivity differences between domestic exporters and non-exporters. One possible explanation is that due to the small domestic market a much larger percentage of firms are exporters than in, e.g., the US or the UK. Hence, not only "exceptional" firms become exporters, but also those that are "less exceptional".

[9] See, for example, Helpman, Melitz and Yeaple (2004) and Bernard, Eaton, Jensen and Kortum (2003).

[10] Note that the data set does not allow us to distinguish plant exits that are purely due to shut downs from those that are due simply to non-response. Hence we cannot correct for

the possible relationship between outsourcing and plant exit (López, 2006). Our conclusions are, hence, conditional on continuing plants.

[11] All nominal values are deflated using a standard consumer price index as there are no official sector level price deflators available for Ireland.

[12] While this may leave out plants with minority foreign ownership it has been the case in Ireland, certainly over the period covered, that most FDI was in the form of new fully foreign-owned greenfield investment (see, e.g., Barry and Bradley, 1997).

[13] Another option may be to calculate outsourcing relative to total inputs; we explore this alternative in a robustness check in the econometric analysis below.

[14] 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. Also, the data set does not provide information on the source country of the inputs.

[15] In order to have a comparable set of observations across the different econometric specifications we only use observations for those firms for which we also have data on instruments used in subsequent regressions. Hence, the number of observations is the same in all regressions.

[16] In fact, in unreported regressions excluding services inputs we find that the size of the capital coefficient is larger.

[17] While the focus of this paper is not on exporting per se, we digged a little deeper into the data in order to try to understand why we fail to find a productivity premium for exporters in this regression. In unreported regressions we find that if we do not include

services inputs in the production function (as commonly done in many studies), then we also find a productivity premium for exporters. However, as shown in column (2) and (3) once we use a fixed effects estimator we are able to find a positive productivity effect for exporters. As regards further regressions our experimentation indicated that once we use the TFP measure based on the Levinsohn and Petrin (2003) methodology, then the exporting premium again disappears.

[18] Note that the nationality dummy cannot be estimated as it is time invariant; the nationality status reported in the data refers to the last year at which the plant was in the sample. Arguably, this does not allow for changes in ownership due to, for example, acquisitions of domestic firms by foreign owners. However, this may not be a problem for our particular study as foreign acquisitions in Ireland were virtually zero in the 1980s and 90s and by far the vast majority of foreign firms were established through greenfield investment (Barry and Bradley, 1997).

[19] A potential concern is that our results are driven by outliers. While an inspection of the data does not show any obvious outliers we investigate this problem by re-estimating the equation reported in column (4) using outlier robust regression (e.g., Rousseeuw and Leroy, 1987) to mitigate the influence of the extreme observations. Results, which are not reported here to save space, produce very similar point estimates and standard errors to those produced in column (4), suggesting that outliers are not responsible for our results.

[20] The F-statistic tests the hypothesis that the instruments should be excluded from the first-stage regressions (i.e. the relevance of the instruments). The idea here is that when

the F-statistic is small (or the corresponding p-value is large), the instrumental variable estimates and the associated confidence interval are unreliable.

[21] A potential question is whether the effects of outsourcing are related to the intensity of outsourcing (as assumed in the estimations thus far) or just related to the outsourcing status of the plant. In order to investigate this we firstly checked the persistence of outsourcing activity at the plant level, see the appendix. Table A1 shows that only 11 percent of firms that do not outsource services switch into outsourcing, while the equivalent number for materials outsourcing is 8 percent. Hence, outsourcing appears a relatively persistent activity in our data. In a further analysis we also re-estimated our equation using two dummy variables for whether a plant outsources services or materials respectively. These estimations do not produce any statistically significant results, suggesting that it is indeed the intensity rather than the discrete status that matters (as would be expected from the results in Table A1). Results are not reported to save space.

[22] Using industry level data for the US, Amiti and Wei (2006) also find much stronger evidence for beneficial effects of international outsourcing of services than materials.

Table 1: Summary Statistics

	Domestic non-exporters	Domestic exporters	Foreign
Employment	64.7	102.74	184.14
	(127.94)	(227.51)	(244.92)
Labour productivity	0.202	0.214	0.530
	(0.193)	(0.178)	(1.366)
Services o/s intensity ($outs^s$)	0.255	0.238	0.332
	(0.443)	(0.450)	(2.188)
Materials o/s intensity ($outs^m$)	1.579	1.368	2.213
	(2.903)	(1.866)	(3.363)
Observations	2117	7358	6358

Notes:
Table reports means and standard deviations in parentheses
labour productivity is value added per employee
outsourcing intensities are imported services (materials) over total wage bill

Table 2: Summary Statistics for Low and High Productivity Plant

	Low labour Productivity		High labour Productivity	
	Mean	Std. Deviation	Mean	Std. Deviation
Materials o/s intensity ($outs^m$)	1.36	1.88	2.29	3.56
Services o/s intensity ($outs^s$)	0.26	1.79	0.30	3.56
Share of foreign plants	0.29	0.45	0.57	0.49

Notes:
"High labour productivity" is a plant with value added per employee > median plant

Table 3: Regression results for various specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	*log output*	*log output*	*log TFP (FE)*	*log TFP (LP)*	*log TFP (LP)*	*log TFP (LP)*
	OLS	FE	OLS	OLS - LP	IV - LP	GMM - LP
log capital	0.069	0.024				
	(0.014)*	(0.004)*				
log labour	0.190	0.265				
	(0.030)*	(0.011)*				
log services	0.478	0.501				
	(0.020)*	(0.007)*				
log materials	0.289	0.149				
	(0.020)*	(0.006)*				
export dummy	0.021	0.039	0.438	0.010	0.008	0.007
	(0.026)	(0.015)*	(0.107)*	(0.015)	(0.015)	(0.015)
foreign dummy	0.078		0.718	0.019	0.018	0.016
	(0.019)*		(0.072)*	(0.012)	(0.012)	(0.012)
services outsourcing	-0.051	-0.037	0.253	0.040	0.090	0.076
	(0.016)*	(0.007)*	(0.069)*	(0.009)*	(0.026)*	(0.022)*
materials outsourcing	0.013	0.008	0.090	0.004	0.002	0.003
	(0.004)*	(0.002)*	(0.013)*	(0.002)*	(0.003)	(0.003)
Observations	5337	5337	5337	5337	5337	5337
R-squared	0.96	0.84	0.34	0.64	0.63	0.64
F test (s2) p-value					0.00	0.00
F test (m2) p-value					0.00	0.00
Hansen J p-value					0.31	0.31

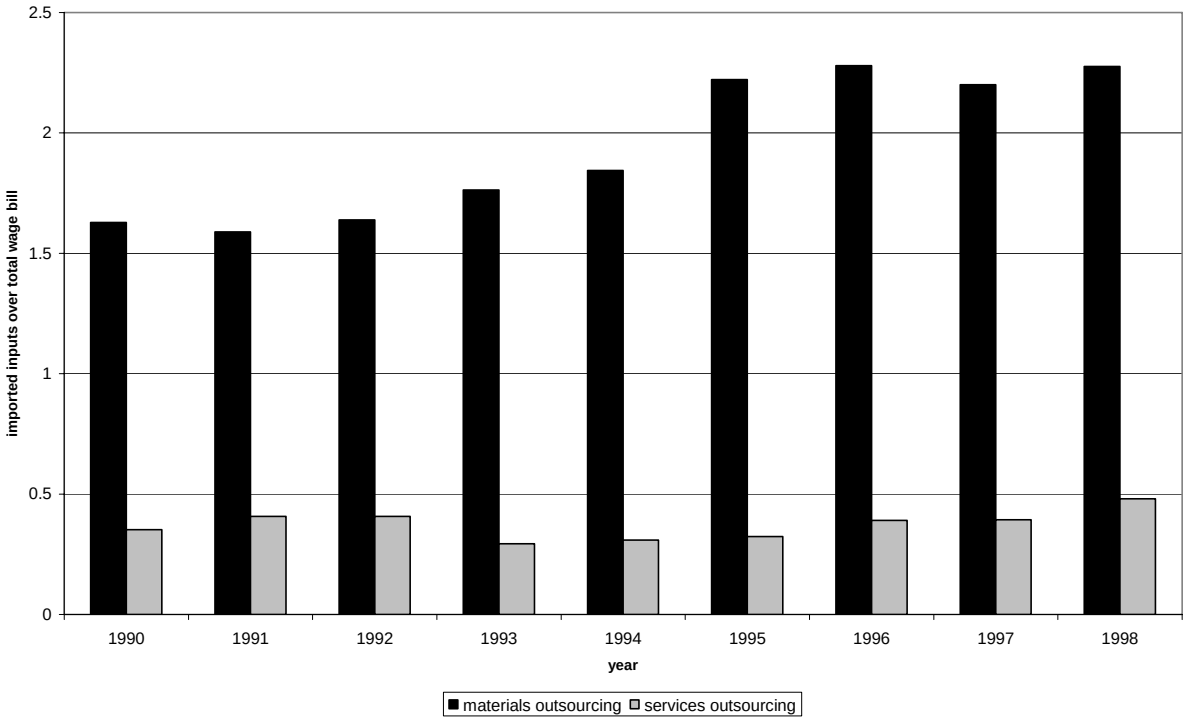
Notes:
Robust standard errors in parentheses
*significant at 5%
Constant term and full set of time and two-digit industry dummies included
TFP in (3) calculated from fixed effects regressions for each two digit industry
TFP in (4) to (6) calculated using the Levinsohn and Petrin (2003) technique for each two digit industry

Table 4: Regression results with heterogeneous outsourcing effects

	(1)	(2)	(3)
Dependent variable	*log TFP (LP)*	*log TFP (LP)*	*log TFP (LP)*
	GMM - LP	GMM - LP	GMM - LP
export dummy	-0.035	-0.023	0.005
	(0.025)	(0.023)	(0.032)
foreign ownership dummy	0.016	-0.008	0.065
	(0.012)	(0.017)	(0.031)*
services outsourcing	-0.146	-0.144	-0.125
	(0.090)	(0.082)	(0.080)
materials outsourcing	-0.001	-0.005	0.023
	(0.004)	(0.004)	(0.051)
services outsourcing * export dummy	0.230	0.180	0.187
	(0.094)*	(0.083)*	(0.086)*
materials outsourcing * export dummy	0.004	0.001	-0.061
	(0.005)	(0.004)	(0.054)
services outsourcing * foreign dummy		0.054	0.011
		(0.040)	(0.049)
materials outsourcing * foreign dummy		0.010	-0.069
		(0.004)*	(0.036)
Observations	5337	5337	5332
R-squared	0.63	0.64	0.64
F test (s2) p-value	0.00	0.00	0.00
F test (m2) p-value	0.00	0.00	0.00
F test (exp_s2) p-value	0.00	0.00	0.00
F test (exp_m2) p-value	0.00	0.00	0.00
F test (for_s2) p-value		0.00	0.00
F test (for_m2) p-value		0.00	0.00
Hansen J p-value	0.37	0.45	0.12

Notes:
Robust standard errors in parentheses
** significant at 5%; *** significant at 1%
Constant term and full set of time and two-digit industry dummies included
TFP calculated using the Levinsohn and Petrin (2003) technique for each two digit industry
Column (3) based on alternative outsourcing measures: outsourcing relative to total services or material inputs, respectively

Figure 1: Development of international outsourcing



Note: outsourcing is measured as imported services or material inputs over total wage bill