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*International Services Outsourcing and Innovation:*

*An Empirical Investigation*

**by**

Holger Görg and Aoife Hanley

**The Authors**

Holger Görg is a Professor in Kiel Institute for the World Economy, University of Kiel and CEPR, Germany and an External Research Fellow in GEP. Aoife Hanley is Associate Professor in Kiel Institute for the World Economy, University of Kiel.

# Services outsourcing and innovation:
# An empirical investigation

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**Abstract**

We provide a comprehensive empirical analysis of the links between international services outsourcing, wages and innovation using plant level data covering the period 2000 to 2004. Somewhat consistent with the predictions of recent theory, we observe a positive relationship between international outsourcing of services and innovative activity, measured in terms of R&D, at the plant level. However, we only find evidence for such positive effects for plants in manufacturing, not in services sectors. Furthermore, this positive effect of international services outsourcing on innovation does not appear to be mediated through wages as proposed by theory.

**Outline**

## Non-Technical Summary

Firms outsourcing service activities abroad frequently make media headlines. This is mainly due to the fear that such outsourcing, or offshoring, leads to job losses in the domestic economy. Following this media attention, advances in theoretical modelling and data availability have increasingly allowed academic economists to also concern themselves with this phenomenon.

A standard reply by academic economists to the public "fear" of international outsourcing is of course that outsourcing of some, usually relatively skill intensive industries, allows for a restructuring in the economy towards more skilled and technology intensive production. The economy will also be able to specialise more on innovation activities. However, whether outsourcing indeed leads to such positive restructuring towards innovation and technology is empirically largely unchecked.

This paper contributes to this debate in the literature by analysing empirically the link between international outsourcing and innovative activity at the level of the individual establishment. We ask the specific question of whether a firm that outsources some of its service activities abroad, consequently increases its rate of innovation – which is what the theoretical argument would suggest. For the empirical analysis we use plant level data for the Republic of Ireland, an economy where international services outsourcing appears to be much more important than in the US. Our data comprise plants in both manufacturing and services sectors, and we exploit this dimension in the data to check whether there are differences across these two broad sectoral categories. The time period for our analysis is 2000 to 2004, which captures much of the very recent activity in international outsourcing. In our analysis we also pay particular attention to the possible endogeneity of the outsourcing decision using instrumental variables and 3 stage least squares (3SLS) techniques.

As far as we are aware, this paper is the first to address explicitly the link between international outsourcing and innovative activity. While a number of papers have established that outsourcers are more productive than non-outsourcers, in line with theory, only a small number of papers has investigated whether international outsourcing increases subsequently productivity at the industry or firm level. Our paper looks specifically at one particular channel identified in the theoretical literature that may explain such outsourcing-induced productivity benefits.

Our empirical results agree in part with the stylised facts of the effects of internationally outsourced inputs on innovation. Somewhat consistent with the predictions of theory, we observe a positive relationship between international outsourcing of services and innovative activity, measured in terms of R&D, at the plant level, but only for plants operating in the manufacturing sector. We do not find any such effect for plants in services industries. Furthermore, our analysis also shows that the positive R&D effect does not appear to work through the wage channel, as posited by theory.

# Services outsourcing and innovation:
# An empirical investigation

Holger Görg

*Kiel Institute of the World Economy, University of Kiel and CEPR*

Aoife Hanley

*Kiel Institute of the World Economy and University of Kiel*

**Abstract**

We provide a comprehensive empirical analysis of the links between international services outsourcing, domestic outsourcing, profits and innovation using plant level data. We find a positive effect of international outsourcing of services on innovative activity at the plant level. Such a positive effect can also be observed for domestic outsourcing of services, but the magnitude is smaller. This makes intuitive sense, as international outsourcing allows more scope for exploiting international factor price differentials, therefore giving the establishment higher profits and more scope to restructure production activities towards innovation. We also find that international outsourcing has a positive effect on profitability, as predicted by theory, while this is not true for domestic sourcing. The results are robust to various specifications and an instrumental variables analysis.

JEL classification: F14, O31

Keywords: international services outsourcing, innovation, R&D

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Corresponding author: Holger Görg, Kiel Institute for the World Economy, Düsternbrooker Weg 120, D – 24105 Kiel, Germany. Email holger.goerg@ifw-kiel.de

**1 Introduction**

The practice of sourcing services inputs from abroad has increased substantially over the last decades. For example, Amiti and Wei (2006) document that in the US international outsourcing of services by manufacturing firms has grown at an annual rate of around 6 per cent over the period 1992 to 2000. If anything, this growth is likely to have accelerated in more recent years. This trend has given rise to public debates and policy concerns about the possible impact of this increasingly global division of labour. Trade economists have also got involved in this debate, generally using a response based on intuition derived from simple trade theory: international outsourcing of production allows firms to access cheaper inputs abroad, foster gains from international specialisation and will hence lead to the restructuring of production in the industrialised countries towards more "skill intensive" or "innovative" activities.[1,2]

In a standard Heckscher-Ohlin model this is an argument made at the level of the economy: there will be restructuring out of low skill intensive sectors and into high skill intensive sectors in the skill abundant industrialised country. This will imply adjustment costs for workers laid off in the outsourced sectors who may or may not be able to move into employment in the other sector (e.g., Davidson and Matusz, 2000). A related yet slightly different question is what will happen in the firm that does the outsourcing? Here, models with homogeneous firms (such as Glass and Saggi, 2001) or heterogeneous firms

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[1] See, for example, Blinder (2006) for a good discussion. Blinder not only points out the "textbook" gains but also argues that the current wave of offshoring brings with it additional challenges, as basically speaking all manufacturing and services activities that do not require face-to-face contact are potentially outsourcable from the industrialised countries. Eaton and Kortum (2006) provide a recent theoretical model dealing with the relationship between trade and innovation.

[2] A recent study by Deutsche Bank Research (2004) illustrates the scope for factor costs savings through international outsourcing of services. They calculate that the hourly rates for computer programmers in Germany were €54 in 2004 comparable with rates of €44 in the US. In industrialising countries the same labour could be provided for €9.24 in Russia, €14 in Portugal and China €7 in India. Of course, these statistics hide any underlying productivity differences but they do nonetheless highlight wage differences and provide strong reasons for the outsourcing of international services.

(e.g., Antras and Helpman, 2004) illustrate a similar process. Firms outsource part of the production and concentrate home production on what may be termed their "core activity".

Recently, a small but growing literature using firm or plant level data has established empirically that international outsourcing, in particular of services inputs, is associated with higher productivity in the outsourcing plant, in line with such theory.[3] However, these papers are largely silent on the mechanisms as to how international outsourcing may affect productivity at the level of the firm or plant. Our goal is to contribute to this literature by examining directly how international outsourcing of services activities impacts on innovative activity in the outsourcing establishment. We ask the specific question of whether a firm that sources some of its service activities abroad, consequently increases its rate of innovation – which is what the theoretical argument would suggest. As far as we are aware, this paper is the first to address explicitly the link between international outsourcing and innovative activity.[4]

We use the theoretical analysis by Glass and Saggi (2001) as a starting point for our empirical analysis. They develop a model, based on Ricardian technology differences between an industrialized Northern and a less advanced Southern country, to explain the effect of outsourcing on wages and innovation in the North.[5] In their model, potential wage savings will prompt the North to outsource those processes from the South which are relatively low in technological complexity and retain those other processes which are more truly original, innovative or relatively near the technological frontier. The predicted result is that the wage rate (relative to the South) in the North falls due to outsourcing.

While this result is not new, the innovation in Glass and Saggi (2001) is to set this into a dynamic setting, which shows additional positive effects of outsourcing. As cost

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[3] See, for example, Görg et al. (2008), Hijzen et al. (2008) and Tomiura (2007).

[4] A related literature has looked at correlation between firms' export activity, foreign ownership and innovation, see, e.g., Criscuolo et al. (2005) for a recent paper for the UK.

[5] Their analysis was somewhat inspired by earlier work that looked at the effect of outsourcing on relative wages theoretically (Feenstra and Hanson, 1996) as well as empirically (e.g., Feenstra and Hanson, 1999).

savings are realised (due to the reduction in the wage in the North) firms' profits rise. These additional profits get reinvested (fully or partially) in Northern innovation through increasing R&D expenditure. Hence, the profits accruing to the firm from wage savings can be ploughed back into R&D or efforts to shift the technological frontier in the North further outward. As such the predicted effect of international outsourcing on innovation is unequivocal in the model: increased proportions of international outsourcing lead to higher innovation rates in the outsourcing establishment.[6] Hence, we would expect to be able to identify two effects of international services outsourcing in our data. First, i should lead to increased profits and, second, it should raise innovative activity in the outsourcer. Note that the latter effect strictly speaking works through the profit channel – outsourcing raises profits and, as a result, increases innovation.

These are the two issues we examine empirically in this paper: the effect of international outsourcing of services on innovative activity, and the link between outsourcing, profits and innovation at the level of the establishment. For the empirical analysis we use plant level data for the Republic of Ireland, an economy where international services outsourcing appears to be much more important than in the US, as a rough comparison of our data with Amiti and Wei (2006) in Section 3 suggest. The data run up to the year 2004, and hence capture much of the very recent activity in international outsourcing.

The data set provides a unique source to study these links. Not only does it provide us with plant level information on international outsourcing of services and R&D expenditure (as a proxy for innovation), but also contains information on domestic outsourcing. Hence, we are able to compare and contrast the effects of international and domestic outsourcing on innovation. This is important as, a priori, it is not clear that the

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[6] We should qualify this by saying that positive benefits from international outsourcing are expected to tail off after a certain point. As ever more activities closer to the technical frontier are outsourced abroad, so too does the ease at which foreign manufacturers pose a competitive threat to the North.

two modes of outsourcing should have the same effects on innovation, as we discuss below. Furthermore, the data also allow us to pay particular attention to the possible endogeneity of the outsourcing decision using instrumental variables techniques. Not only does the panel structure provide us with lagged variables as instruments, but we also have a number of other variables that we consider to be good instrumental variables candidates for outsourcing activities of plants. These are discussed in detail in the empirical analysis below.

Previewing our results briefly, we find that there are indeed positive effects of international services outsourcing on innovation, in line with expectations. These effects appear stronger than those of domestic outsourcing of services. Furthermore, we establish that international outsourcing of services has a positive effect on profitability in the plant, while this is not true for domestic outsourcing.[7] These results are robust to various specifications and also hold in an instrumental variables approach.

The remainder of the paper is structured as follows. In the next section describe the methodology used in the empirical analysis. This is followed by an overview of the data and some summary statistics. Then follows the analysis section and finally a short summary of our main findings.

## 2 Methodology

In order to investigate the hypothesis that international outsourcing of services can impact on plants' innovation activity we formulate the following empirical model,

$$(R \& D / Y)_{it} = \boldsymbol{b}_1 outs_{it-1} + \boldsymbol{b}_2 X_{it-1} + d_{tj} + \boldsymbol{m}_i + \boldsymbol{e}_{it} \quad (1)$$

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[7] The latter finding may reflect firms' choosing to outsource domestically due to strategic reasons which may lead to a prisoners' dilemma situation in which outsourcing firms are worse off, as discussed by Marjit and Mukherjee (2008).

where the measure of innovation activity employed is the R&D intensity, defined as R&D expenditure over total sales, for plant $i$ at time $t$. On the right hand side, *outs* is a measure of international outsourcing of services (defined as imported services inputs relative to sales) at the level of the plant.[8]

The vector *X* considers a number of other plant characteristics that have been identified in the literature as affecting R&D activity. We include log employment as a proxy of firm size, as well as dummy variables if a firm invests in in-house training or is an exporter. The latter controls for the possibility that export active firms may also be more R&D and innovation intensive (e.g., Criscuolo et al., 2005; Salomon and Shaver, 2005). Training activity is included as a rough measure of investment in skills (e.g., van Dijk et al., 1997). From theory, the expected relationship between this variable and R&D intensity is ambiguous, as investment in skills and R&D can be either complements or substitutes (e.g., Redding, 1996). Finally, Acs and Audretsch (1991) and Kohn and Scott (1982), among others, show that plant size is an important determinant of R&D and innovation activity. Hence, we control for this variable in the estimation.[9]

In order to properly identify the effect of international services outsourcing on R&D, we also consider two further variables. As the theoretical model by Glass and Saggi (2001) shows, international outsourcing has an effect on innovation because it increases profits, which can then be reinvested in R&D. Hence, we control for this variable to examine whether it captures all of the (potential) effect of outsourcing on innovation. It is likely that international services outsourcing has an effect on R&D even when we control

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[8] This measure is, thus, somewhat in line with the definitions used by Feenstra and Hanson (1999) and Amiti and Wei (2006) for aggregate data.

[9] Note that it would also be important to control for nationality of ownership, given that foreign-owned firms in Ireland are generally found to be less R&D active than domestic firms in Ireland (e.g., Cassidy et al., 2005). The nationality of ownership information in our data is time invariant, however, which implies that this is captured by the plant specific effect included in the model.

for profitability, for a number of reasons. For one, outsourcing may not impact immediately on profits but this may take some time. Including first lags of both services outsourcing and profitability in the model would therefore not capture these more long-term effects. Secondly, it is difficult to measure economic profitability accurately and our variable may not be a perfect proxy for profits. Thirdly, outsourcing may have a more direct effect on innovation. It may allow the plant to immediately restructure activities towards innovation, which only as a result of the innovation leads to increases in profitability.[10]

As an additional variable we also include domestic outsourcing of services in our model. The main aim here is to see whether domestic and international outsourcing have similar effects on innovation. A priori it is not clear that they should. International outsourcing is the activity modelled by Glass and Saggi (2001), which is driven by international factor cost differences. Domestic outsourcing may of course also be driven by some factor cost differences between regions but these are unlikely to be as important as the potentially much larger international factor cost differences are for international outsourcing. Domestic sourcing is more likely to reflect mainly efforts by the firm to respond to competitive pressure through restructuring activities and gains from specialising in core activities.

Finally, the equation also includes a full set of two digit industry specific time dummies ($d_{jt}$) to control for any sector specific time varying effects that are unobserved in this econometric specification. The final error term is composed of a plant specific time invariant effect $\mu_i$ and a remaining white noise error term $e$. Note that in the econometric specification, all plant level control variables are included as one year lags in order to minimise potential endogeneity problems, but also to allow for time lags in the effect. For

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[10] This would be observationally similar to the "outsourcing-affecting-profits" hypothesis but different in the chain of events, as outsourcing first affects innovation which in turn impacts on profits. Unfortunately, we cannot investigate this hypothesis in more detail, due to the short time dimension of our data.

example, services outsourcing in time $t$ may only affect R&D activity in later periods. While it would be ideal to allow for longer lags this is not possible given the short time dimension in our panel.

Glass and Saggi (2001) show that international outsourcing allows firms to increase profits (due to international factor cost differences) which in turn allows them to spend more on R&D. In order to investigate explicitly the relationship between international services outsourcing and profits we also estimate a second equation

$$profitratio_{it} = \boldsymbol{g}_1 outs_{it-1} + \boldsymbol{g}_2 Z_{it-1} + d_{jt} + \boldsymbol{n}_i + \boldsymbol{f}_{it} \qquad (2)$$

where $Z$ is a vector of plant and industry characteristics including log employment as a measure of size, a plant's market share (in terms of sales) in the three digit industry and two (potentially time varying) dummies for plants that are exporters or provide in-house training. At the industry level, we include the growth rate of three digit industry sales. This variable, together with the market share variable, proxy levels of competition in the industry and the plant's relative standing in it. Also, in addition to international outsourcing we again include domestic services outsourcing in the equation. From Glass and Saggi (2001) we would expect the coefficient $?_1$ to be positive in the estimation.

In the first instance we estimate the two equations separately using a fixed effects panel estimator treating lagged outsourcing (international and domestic) as exogenous. We relax this assumption subsequently using instrumental variables for the two outsourcing variables in both equations (which are within transformed to purge the plant specific fixed effect). Furthermore, it may arguably be the case that the two error terms $e$ and $\boldsymbol{f}$ are correlated. In order to allow for this possibility we also estimate within-transformed

versions of the two equations jointly using a three stage least square estimator also treating lagged international and domestic outsourcing as endogenous.

## 3 Data description and preliminary analysis

For the econometric part of our paper, we use recent micro-data from the Republic of Ireland. This is plant level information collected by Forfás, the Irish policy and advisory board with responsibility for enterprise, trade, science, and technology in Ireland. Specifically, our data source is the *Annual Business Survey of Economic Impact (ABSEI)*, covering the period from 2000 until 2004. This is an annual survey of plants in Irish manufacturing with at least 10 employees, although a plant, once it is included, is generally still surveyed even if its employment level falls below the 10 employee cut-off point. The survey was started in 2000 and the response rate is estimated by Forfás to be around 55 to 60 percent of the targeted population per year. This data set provides information on services purchases, distinguishing imported and domestically procured services, as well as total R&D expenditure at the plant level. Further data available from this source that is relevant to the current paper are total sales (as a measure of output), employment, expenditure on wages and total purchases, exports (distinguishing exports to the UK, EU and the rest of the world), expenditure on in-house training, nationality of ownership, and three digit sector of production.[11,12]

In 2002, the survey also started collecting information on whether a plant uses the internet for their purchases of intermediates, and if so, how much as a percentage of sales. As we use this variable as an instrument for outsourcing in our econometric estimation, this

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[11] 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 most inward foreign direct investment has been greenfield rather than acquisitions of local firms. Note that our data only provide a dummy based on this definition rather than a percentage of ownership, and that this dummy relates to nationality of the plant in 2004, i.e., is fixed over time.

[12] All nominal variables are deflated using the consumer price index.

necessarily restricts the time period of our econometric analysis to 2002 to 2004. Fortunately, this is the most up-to-date data available from the survey which covers recent activity in international outsourcing of services.

In order to have a first look at the data and the possible relationship between R&D and outsourcing of services, Table 1 shows the means, medians and standard deviations for these variables from our plant level data, based on the sample that is also used in the regression analysis below.

The average ratio of internationally outsourced services to sales is around 4 percent over the period 2002 to 2004. There has been some increase in the arithmetic mean of this variable between 2003 and 2004 but it is difficult to judge whether this is persistent as no post-2004 years are available. In any case, it is notable that, although not perfectly comparable, these mean values appear higher than those found by Amiti and Wei (2006) for the US. They report that between 1992 and 2000, services outsourcing (calculated similarly as imported services over total production in a sector) increased from 0.2 to 0.3 percent.[13] From our data we can also calculate the measure of international services outsourcing for the full sample in 2000. This shows that the mean of this ratio stands at roughly 3 percent (with the median at 0.6 percent). Hence, it is unlikely that the higher values of international services outsourcing are merely due to our sample covering more recent years.

We are also able to observe the extent of domestic outsourcing of services in our data. This is defined as the value of domestically procured services inputs relative to sales. The mean of this variable, shown in Table 1, represents around 20 to 22 percent in the period analysed. In the econometric analysis below one important question is whether the effect of international and domestic outsourcing of services on innovation is similar or not.

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[13] When we apply the median values, we get a picture more consistent with the US data although still higher. The median ratio of internationally outsourced service inputs to sales is around 0.8 percent in our data.

As concerns the average R&D intensity the table indicates that the mean has fluctuated around 8 to 10 percent of sales, although the medians are far lower at around 0.3 percent. It is important to consider in this context that Ireland generally registers a relatively low level of R&D intensity, a fact noted by the OECD (1998). Total business expenditure on R&D in total amounted to only 0.8 percent of GDP which leaves Ireland closer to Mediterranean countries which in general are characterised by low-technology output than the Northern European countries which tend to have higher technological intensities and higher R&D expenditures.

*[Table 1 here]*

Since we are investigating the relationship between international services outsourcing and the intensity of R&D, it is illuminating to format the same information across the group of firms who do not procure any internationally outsourced services at all and those who do. We see from Table 2 that firms reporting at least some internationally outsourced services have, on average, higher R&D intensities. They are also larger in terms of employee numbers and export more, on average, than their counterparts who do not report any internationally outsourced services. There is no obvious difference, however, in terms of profitability and investment in skills in the raw data. Of course, this simple look at the data does not allow controlling for the potential impact of any other variable, and this is something we will turn to in the next section.

*[Table 2 here]*

Before moving on to the results from our regressions, however, it is worthwhile looking briefly at which sectors are most actively engaged in international outsourcing of services. To do so, Table 3 reports the percentage of plants in each broad sector, which outsource at least some services internationally. The first impression we get is that there is considerable sectoral variation in international outsourcing. Within the services sector,

Transport and Storage, Real estate & Business services, and Community & Personal services register the highest levels of internationally outsourced services. However, according to Forfás, the coverage of our data is not as exhaustive for services sectors as it is for manufacturing and, hence, is somewhat biased towards the latter. Within the set of manufacturing plants, at 67 percent, the Textiles sector has the highest proportion of firms purchasing service inputs on foreign markets. However Chemicals, Machinery and Transport Equipment are in close range with percentages well close to 60 percent also.

*[Table 3 here]*


## 4 Econometric results

In order to investigate the relationship between international outsourcing of services and R&D activity more formally we now turn to the estimation of equations (1) and (2). The results for various specifications of equation (1) are reported in Table 4. Column (1) reports the simplest specification of the model which is estimated using OLS to establish a benchmark. In this estimation we find that there is a positive and statistically significant association between international services outsourcing and R&D activity, in line with expectations. This estimation does of course not control for unobserved plant level heterogeneity. In order to do so we estimate equation (1) using a (within transformation) fixed effects estimator in column (2). Hence, the coefficients are identified using the within-plant variation (deviations from the mean) in variables.[14] This does not change the positive coefficient on the outsourcing variable, though the coefficient size is now somewhat reduced from 0.30 to 0.17.

The theoretical idea behind the empirical analysis is that outsourcing affects profits, which in turn enhances a firm's ability to invest in R&D. In order to investigate whether

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[14] Specifically, this implies for the coefficient on international services outsourcing that it reflects the effect of within plant *changes* in outsourcing on changes in R&D activity, as suggested by the theoretical model.

our data is fully in line with this explanation we include an empirical measure of plant profitability in the model. As column (3) shows, the coefficient on this variable is positive and statistically significant as expected. However, it does not reduce the impact of the outsourcing variable, which is still positive and statistically significant.[15] As pointed out in Section 3, there are various explanations for why our empirical estimation may not fully capture the true impact of profits in this model: first, due to measurement problems, second, because including outsourcing and profits measured in the same period does not allow for a more long- or medium term impact of outsourcing on profits. Furthermore, outsourcing may indeed have a direct effect on innovation, that is not mediated through profits, if it leads directly to restructuring in the firm towards more R&D. This would only as a result affect profitability and, hence, would not be captured by the profits variable (which is measured in the same period as outsourcing) in the empirical estimation.

The model thus far may be mis-specified as it does not consider domestic outsourcing. If domestic and international outsourcing decisions are correlated then not controlling for the former in the estimation would lead to a biased coefficient on the latter. Column (4), therefore, presents estimation results which include a measure of domestic outsourcing of services. This variable also returns a statistically significantly positive coefficient. It can also be noted that the coefficient size on the international outsourcing variable is now reduced, suggesting that in the model in column (3) the effect of domestic and international outsourcing are confounded. While it appears from a casual look that the coefficient on international outsourcing is higher (which may be expected, as it provides more opportunities for exploiting international factor cost differences) a simple F-test does

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[15] Inspection shows that the coefficient is now larger than in column (2). This may be due to a strongly negative correlation in the raw data between international outsourcing and profitability. This negative unconditional correlation does not hold when controlling for other variables, as shown below in the estimation of equation (2).

not allow us to reject the hypothesis that the two are statistically equal (probability value 0.19).

A potential criticism with the analysis thus far is that international and domestic outsourcing are treated as exogenous – arguably a strong assumption.[16] While the lagged variable is intended to address this problem this may not be sufficient. In order to deal with this more appropriately we therefore now proceed to treat international and domestic outsourcing explicitly as endogenous in the estimation. The challenge is to find instrumental variables candidates that are highly correlated with outsourcing but not with the error term in equation (1).

We use the following instruments for services outsourcing: first, twice lagged growth rates of international and domestic outsourcing intensities, as these are highly correlated with lagged levels of outsourcing, but a priori are not obviously correlated with the error term. Second, we use a dummy indicating whether a plant exports to the UK, as well as the share of exports relative to sales by a plant that are directed to the UK rather than other export markets. The choice of these variables is inspired by Ruane and Sutherland (2005) who find that there is little evidence that Irish firms that export to the UK have performance premia compared to non-exporters. However, they find that Irish exporters compared to the rest of the world are clearly more productive, technology intensive and pay higher wages. Hence, while exporting to the UK clearly indicates cross border engagement, which may also help to find partners for international outsourcing, this variable should be less correlated with R&D activity. Furthermore, we use the percentage of inputs purchased over the web as an additional instrument. Again, this should be correlated with outsourcing but is likely to be orthogonal to R&D. We of course test for the validity and relevance of the instruments in the estimations.

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[16] For example, Bartel et al. (2005) argue that technological change is partly responsible for the increase in outsourcing and if general technological change is correlated with plant level R&D expenditure then this may cause an endogeneity problem.

Column (5) presents the estimation result. Note that the instruments used for outsourcing are valid as indicated by the Sargan test for overidentifying restrictions, which cannot reject the hypothesis of instrument validity. Furthermore, we ascertain that the instruments used are relevant in that they exhibit sufficiently strong correlation with the instrumented variable. We report the F-statistic for the excluded instruments (and associated p-value) from the first-stage regression.[17] When the F-statistic is small (or the corresponding p-value is large), the instrumental variable estimates and confidence intervals would be unreliable. We find that our instruments are appropriate on this criterion.

The regression results confirm the importance of international outsourcing of services for R&D activity. Taking the point estimate at face value suggests that an increase in the ratio of internationally outsourced services to sales by one percentage point increases the R&D ratio by 2.5 percentage points. This is an economically important effect. The IV regression also shows that the coefficient on international outsourcing is higher than that on domestic outsourcing, the magnitude of which is not changed. This difference is confirmed in an F-test, which rejects the equality of the two coefficients (p-value 0.00).

To sum up, our analysis thus far suggests an important role for international services outsourcing for plants' innovative activity. This effect is not fully captured by profits in the same period, and is more important than the impact of domestic outsourcing of services.[18]

*[Table 4 here]*

Theory posits that international services outsourcing allows firms to increase profits, as they have access to cheaper intermediate inputs abroad. As shown above, this mechanism is not fully captured in our data, as inclusion of the profit variable does not

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[17] The F-statistic tests the hypothesis that the instruments should be excluded from the first-stage regressions.
[18] In terms of the control variables we find in column (5) that employment is negatively correlated, a result in line with, e.g., Acs and Audretsch (1991) who argue that small firms may not be able to bear the costs of the high expenditure on setting up and running R&D facilities. The coefficients on the export and training dummy variables are not statistically significant.

render the outsourcing measure insignificant in the R&D equation. Still, it is of interest as to whether there is any positive relationship between international outsourcing and profits, and we now turn to investigate this link with our data by estimating different specifications of equation (2). The results are reported in Table 5. Column (1) presents a specification which is based on a (within transformation) fixed effects estimator, column (2) shows coefficients obtained from an IV regression on within transformed variables, and column (3) also presents a similar IV regression but including more plant level controls.[19]

All estimations show that international outsourcing has a positive effect on profitability, as expected. The point estimate in column (3) indicates that a one percentage point increase in the international services outsourcing intensity increases the profit ratio by roughly 0.4 percentage points. However, we also find a consistently negative effect on profits from domestic outsourcing of services. This even holds in the IV estimations which treat the variable as endogenous using suitable and valid instruments. A possible theoretical explanation for such profit reducing outsourcing is given by Marjit and Mukherjee (2008) who show that in an oligopoly model, outsourcing can reduce profits as it creates a prisoner's dilemma situation for firms, in particular if the costs of outsourcing are not too high. This is likely to be the case for domestic outsourcing, while the cost for international outsourcing is arguably high enough to prevent such a scenario, due to additional sunk and search costs of operating abroad.

*[Table 5 here]*

The analysis thus far treats equations (1) and (2) as unrelated and, hence, they are estimated separately. However, it is arguable that the error terms in both equations may be correlated as the dependent variable in (2), as well as other covariates, are also included as exogenous variables in equation (1). If this is the case then estimating the two equations

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[19] International and domestic outsourcing intensities are treated as endogeneous, using the same instruments as in the estimation of equation (1). The tests again support the validity and relevance of the chosen instruments.

jointly improves efficiency of the estimates. Hence, we now proceed to treat (1) and (2) as a system of equations and estimate them jointly using 3 stage least squares (3SLS) techniques. We also treat outsourcing as endogenous using the same set of instruments as employed previously. The results are reported in Table 6.

In the R&D equation in column (1) we see that the signs, significance and magnitude of the coefficients is very similar to those reported in the IV regression in Table (4). In the profit equation we still find a negative and statistically significant coefficient on domestic outsourcing, although the coefficients size is somewhat smaller than in the IV regressions in Table 5. The coefficient on international services outsourcing is still positive and statistically significant, but has doubled in size: the point estimate now suggests that a one percentage point increase in international services outsourcing increases profitability by almost 0.9 percentage points.

*[Table 6 here]*

## 5 Conclusions

Recent breakthroughs in information technology and the wholesale adoption of purchasing media such as the internet have provided scope for an explosion in the proportions of services that are outsourced internationally. Theory has something to say about the predicted effect of internationally outsourced inputs on the ability of a firm to sustain growth through its growth in innovative activity. Starting from these theoretical predictions we provide, to the best of our knowledge for the first time, a comprehensive empirical analysis of the link between international outsourcing, domestic sourcing, profits and innovation using plant level data covering the recent period 2002 to 2004.

Consistent with the predictions of theory (e.g., Glass and Saggi, 2001) we observe a positive relationship between international outsourcing of services and innovative activity,

measured in terms of R&D, at the plant level. Such a positive effect can also be observed for domestic outsourcing of services, but the magnitude is smaller. This makes intuitive sense, as international outsourcing allows more scope for exploiting international factor price differentials, therefore giving the establishment higher profits and more scope to restructure production activities towards innovation. We also find, again in line with theory, that international outsourcing has a positive effect on profitability, although this does not appear to be the case for domestic outsourcing.[20] Overall, the outsourcing of international services is seen in our analysis as a force for the good: a firm's innovation rates rise, hence allowing plants to continue to shift their technological frontier further outwards and, hence, sustaining their competitive position.

A recent fear even among proponents of international outsourcing is that developed countries started with outsourcing unskilled-intensive (manufacturing) production but have now moved to skilled-intensive (including services) activities also. If this process continues it may lead to a "hollowing out" of production in the industrialised countries.[21] However, if international services outsourcing indeed promotes innovation, as our analysis suggests, then there is a case to be made for its continuance. If involvement in international outsourcing causes the technology frontier to shift through further innovation, the technological gap between industrialised and industrialising countries remains and outsourcing is then a persistent strategy. Thus understanding the impact of international outsourcing on innovation is key to understanding whether we can expect it to continue in the future.

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[20] This result can be explained by recent models such as Marjit and Mukherjee (2008) which show that outsourcing can lead to a prisoner's dilemma situation where it leads to reductions in profits.
[21] See Sinn (2006) for an argument along those lines made for the particular example of Germany.

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## Table 1: Summary statistics: R&D and outsourcing

|  |  | 2002 | 2003 | 2004 |
|---|---|---|---|---|
|  |  |  |  |  |
| International services outsourcing | mean | 0.042 | 0.036 | 0.047 |
|  | median | 0.008 | 0.008 | 0.008 |
|  | std.dev. | 0.325 | 0.108 | 0.325 |
|  | obs. | 1596 | 1596 | 1701 |
|  |  |  |  |  |
| R&D intensity | mean | 0.080 | 0.105 | 0.097 |
|  | median | 0.003 | 0.004 | 0.003 |
|  | std.dev. | 0.771 | 0.961 | 0.826 |
|  | obs. | 1596 | 1596 | 1701 |
|  |  |  |  |  |
| Domestic services outsourcing | mean | 0.201 | 0.206 | 0.226 |
|  | median | 0.119 | 0.120 | 0.121 |
|  | std.dev. | 0.794 | 0.802 | 1.067 |
|  | obs. | 1596 | 1596 | 1701 |

**Variable definitions:**
R&D intensity: expenditure on R&D / sales
International services outsourcing: imported services inputs / sales
Domestic services outsourcing: domestic services inputs / sales

## Table 2: Summary statistics by outsourcing activity

|  |  | R&D intensity | Profit ratio | employment | training intensity | export intensity |
|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |
| No international services outsourcing | median | 0.001 | 0.058 | 31 | 0.002 | 0.200 |
|  | std.dev. | 0.948 | 6.742 | 228 | 0.034 | 0.396 |
|  | obs. | 1517 |  |  |  |  |
|  |  |  |  |  |  |  |
| International services outsourcing | median | 0.006 | 0.055 | 44 | 0.002 | 0.72 |
|  | std.dev. | 0.845 | 5.481 | 312 | 0.056 | 0.390 |
|  | obs. | 1780 |  |  |  |  |
|  |  |  |  |  |  |  |

**Variable definitions:**
R&D intensity: expenditure on R&D / sales
Profit ratio: (sales – wages – total purchases) / sales)
employment: number of employees
training intensity: expenditure on in-house training / sales
export intensity: exports / sales

**Table 3: Percentage of plants in sector outsourcing at least some services**

| STAN code | Description | Number of plants | % of total sector |
|---|---|---|---|
| 1 | Food, beverages and tobacco | 216 | 49.8 |
| 2 | Textiles, leather and footwear | 80 | 66.7 |
| 3 | Wood and wood products | 53 | 52.5 |
| 4 | Pulp, paper, printing & publishing | 52 | 38.5 |
| 5 | Chemicals, rubber & plastics | 221 | 62.1 |
| 6 | non-metallic mineral products | 45 | 50.6 |
| 7 | Basic and fabricated metal products | 106 | 39.1 |
| 8 | Machinery and equipment | 393 | 58.5 |
| 9 | Transport equipment | 40 | 58.8 |
| 10 | Other manufacturing and recycling | 91 | 50.5 |
| 11 | Wholesale and retail trade | 19 | 45.2 |
| 12 | Hotels and restaurants | 2 | 40.0 |
| 13 | Transport and storage | 11 | 57.9 |
| 14 | Post and telecommunications | 7 | 53.9 |
| 15 | Financial intermediation | 12 | 42.9 |
| 16 | Real estate, renting & business services | 376 | 56.9 |
| 17 | Community, social & personal services | 50 | 63.3 |
| | Total | 1774 | 54.2 |

## Table 4: R&D equation

|  | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
|  | OLS | FE | FE | FE | IV |
| International services outsourcing | 0.302 | 0.165 | 0.912 | 0.426 | 2.516 |
|  | (0.154)** | (0.078)** | (0.115)*** | (0.160)*** | (0.136)*** |
| Profit ratio |  |  | 0.105 | 0.127 | 0.304 |
|  |  |  | (0.012)*** | (0.013)*** | (0.011)*** |
| Domestic services sourcing |  |  |  | 0.180 | 0.182 |
|  |  |  |  | (0.042)*** | (0.020)*** |
| Training | 0.035 | 0.334 | 0.308 | 0.291 | 0.069 |
|  | (0.055) | (0.119)*** | (0.116)*** | (0.115)** | (0.100) |
| Export dummy | -0.191 | 0.073 | 0.150 | 0.122 | -0.250 |
|  | (0.104)* | (0.173) | (0.169) | (0.168) | (0.128)* |
| Employment | -0.045 | -0.044 | 0.009 | 0.040 | -0.063 |
|  | (0.008)*** | (0.123) | (0.120) | (0.119) | (0.107) |
| Observations | 3297 | 3297 | 3297 | 3297 | 3297 |
| Plants | 1929 | 1929 | 1929 | 1929 | 1929 |
| F-test service outsourcing |  |  |  |  | 2012.32 |
| F-test domestic outsourcing |  |  |  |  | 567.28 |
| Sargan test (p-value) |  |  |  |  | 0.22 |
| R-squared | 0.06 | 0.01 | 0.07 | 0.08 | 0.24 |

Dependent variable: R&D intensity as defined in notes to table 1
Column (5) is an IV regression on within transformed variables.
Instrumented variables are international and domestic outsourcing intensity.
Instruments used are twice lagged outsourcing variables, dummy for exporting to the UK, export intensity to UK, dummy for purchases of inputs via the web
Regression includes constant and full set of industry*time dummies
All RHS variables are lagged one period
standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

## Table 5: Profit equation

|  | (1) | (2) | (3) |
|---|---|---|---|
|  | FE | IV | IV |
| International services outsourcing | 0.515 | 0.376 | 0.373 |
|  | (0.434) | (0.215)* | (0.216)* |
| Domestic services outsourcing | -0.303 | -0.430 | -0.430 |
|  | (0.106)*** | (0.036)*** | (0.036)*** |
| Industry sales | 0.348 | -0.212 | -0.203 |
|  | (0.582) | (0.332) | (0.333) |
| Market share | -0.000 | -0.000 | -0.000 |
|  | (0.000) | (0.000) | (0.000) |
| Training dummy |  |  | -0.064 |
|  |  |  | (0.177) |
| Export dummy |  |  | -0.047 |
|  |  |  | (0.228) |
| Employment |  |  | -0.016 |
|  |  |  | (0.191) |
| Observations | 3297 | 3297 | 3297 |
| Plants | 1929 | 1929 | 1929 |
| F-test service outsourcing |  | 2899.99 | 2882.42 |
| F-test domestic outsourcing |  | 652.12 | 639.21 |
| Sargan test (p-value) |  | 0.16 | 0.16 |
| R-squared | 0.03 | 0.05 | 0.05 |

Dependent variable: profit ratio as defined in notes to table 2
Columns (3) and (4) are IV regressions on within transformed variables.
Instrumented variables are international and domestic outsourcing intensity.
Instruments used are twice lagged outsourcing variables, dummy for exporting to the UK, export intensity to UK, dummy for purchases of inputs via the web
Regression includes constant and full set of industry*time dummies
All RHS variables are lagged one period
Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

**Table 6: Simultaneous estimation**

|  | (1) | (2) |
|---|---|---|
|  | R&D intensity | Profit ratio |
| International services outsourcing | 2.494 | 0.881 |
|  | (0.116)*** | (0.193)*** |
| Domestic services outsourcing | 0.155 | -0.306 |
|  | (0.014)*** | (0.025)*** |
| Profit ratio | 0.258 |  |
|  | (0.008)*** |  |
| Training | 0.058 | -0.069 |
|  | (0.098) | (0.175) |
| Export dummy | -0.291 | 0.152 |
|  | (0.126)** | (0.225) |
| Employment | -0.076 | -0.179 |
|  | (0.104) | (0.186) |
| Industry sales |  | 0.193 |
|  |  | (0.200) |
| Market share |  | 0.000 |
|  |  | (0.000) |
| Observations | 3297 | 3297 |
| R-squared | 0.23 | 0.05 |

3SLS regression on within transformed variables.
International and domestic outsourcing intensities assumed endogenous, instruments as before.
Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%