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Outsourcing, foreign ownership and productivity: Evidence from UK establishment level data*

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Abstract

This paper presents an empirical analysis of "outsourcing" using establishment level data for UK manufacturing industries. We analyse an establishment's decision to outsource and the subsequent effects of outsourcing on the establishment's productivity. We compare outsourcing in domestic with foreign-owned establishments. Our empirical results suggest that high wages are positively related to outsourcing, suggesting that the cost saving motive is important. We also find that foreign-owned firms have higher levels of outsourcing than domestic establishments. In the productivity analysis we find that an establishment's outsourcing intensity is positively related to its labour productivity and total factor productivity growth and that this effect is more pronounced for foreign establishments.

Keywords: outsourcing, foreign direct investment, productivity
JEL classification: F23, L23

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1 Introduction

"Outsourcing" can be loosely defined as the contracting out of activities that were previously performed within a firm, to subcontractors outside the firm.[1] It appears to become more and more widespread and attracts increasing attention in the popular business press as well as in the academic literature. For example, the *Financial Times* asserts that: "Subcontracting as many non-core activities as possible is a central element of the new economy" (*Financial Times*, 31 July 2001, p. 10). Also, a recent article on car manufacturers in *The Economist* points out that: "The whole industry is disintegrating (or becoming less vertical) as vehicle assemblers try to outsource more and more of what they once did for themselves" (*The Economist*, 23 February 2002, p. 99). There is plenty of anecdotal evidence that this is not limited to the car industry but is also observed in other manufacturing sectors.

Outsourcing or fragmentation has also affected the pattern of international trade. For example, Hummels et al. (2001) find that outsourcing (or vertical specialisation in their parlance) accounts for 22 percent of US exports in 1997, and for 30 percent of the growth in the US export share of merchandise GDP between 1962 to 1997. Görg (2000) reports that between 1988 and 1994, around 20 percent of US exports to the EU are for inward processing, that is, they are exported to the EU for processing and subsequent export outside the EU.

Various aspects of the trend to outsource have been discussed in the academic literature. A large literature starting with the seminal paper by Coase (1937) and including more recent papers by Grossman and Hart (1986), Bolton and Whinston (1993) and Grossman and Helpman (2002a,b) examines theoretically a firm's decision of whether to produce in-house or to outsource. At the heart of this literature are issues concerned with transaction

[1] This phenomenon, which we refer to as outsourcing may also be termed "make or buy decision" (Grossman and Helpman, 2002b), "vertical disintegration" (Holmes, 1999), "fragmentation" (Arndt and Kierzkowski, 2001), "vertical specialisation" (Hummels et al., 2001) to mention but a few synonyms.

costs and, in particular, incomplete contracts leading to either vertical integration or specialisation. Lyons (1995) provides an empirical application to evaluate the importance of transaction costs theory for firms' outsourcing decisions.

More recently, the trade related aspects of outsourcing have also attracted increasing attention in the literature. Trade theoretic models such as Deardorff (2001), Jones and Kierzkowski (2001) and Kohler (2001) examine the effects of trade in "fragmented products" on countries' patterns of specialisation and resulting implications for factor prices. On the empirical side recent papers by Feenstra and Hanson (1996, 1999) and Hijzen et al. (2002) have analysed the effect of international outsourcing (or fragmentation) on relative wages and labour demand using industry level data for the US and UK respectively. In line with traditional HOS trade theory these papers find that international outsourcing (moving low skill intensive production to low skill abundant countries) leads to increased demand and increases in the wage premium for high skilled workers in the US and UK. Egger and Egger (2001) investigate the effect of outsourcing on the productivity of low skilled labour in the EU using industry level data. They find that increases in outsourcing have a negative effect on low skilled labour productivity in the short run, but a positive effect in the long run.

In this paper we are not concerned with the international trade dimension to outsourcing. Rather, we investigate empirically an establishment's decision to outsource and the subsequent effect of outsourcing on productivity of that establishment. We do not distinguish between international and domestic outsourcing since we are interested in the establishments' characteristics that determine outsourcing. We therefore may consider it immaterial as to whether the activities are outsourced to firms abroad or in the domestic economy. Also, as we are interested in the subsequent effect on productivity for the outsourcing establishment it should not matter whether outsourcing takes place internationally or domestically. All we may assume is that the firm will minimise transaction costs when

outsourcing activities to a subcontractor that can be located in the domestic economy or abroad.

This paper uses establishment level data for UK manufacturing industries for the empirical analysis. It contributes to the literature in a number of ways. Firstly, this is, to the best of our knowledge, the first study to analyse the establishment level determinants of outsourcing using data for the UK.[2] Secondly, the analysis of the effect of outsourcing on productivity of the establishment is an innovation of the paper.[3] Thirdly, we investigate whether there are differences in the determinants of outsourcing, and productivity effects of outsourcing between domestic establishments and foreign-owned establishments which can be assumed to be part of a larger multinational company.[4]

We focus our analysis on establishments in three broad UK manufacturing sectors, namely, chemicals, mechanical and instrument engineering, and electronics.[5] Foreign-owned firms are important players in all three industries, accounting for about 12, 15 and 19 percent of total employment in the sectors respectively (see Griffith and Simpson, 2003, Table 4). We examine these three sectors separately as one may expect at least some heterogeneity in the use of outsourcing and, perhaps more importantly, differences in the impact of outsourcing on productivity across these sectors.

The data used in this paper are available from the Annual Respondents Database (ARD) which is described in more detail in the next section. Section 3 then examines the

[2] Greenhalgh et al. (1999) have recently documented that there is an increase in contracting out of services in the UK. Our approach is closely related to the paper by Abraham and Taylor (1996) who analyse the determinants of outsourcing using plant level data for the US. However, they do not distinguish between domestic and foreign owned establishments. A related paper by Swenson (2000) examines the decision to import intermediates for firms located in US foreign trade zones paying particular attention to the effect of changes in international prices on imported inputs.

[3] There are a few papers that look at the effects of outsourcing on manufacturing (ten Raa and Wolff, 2001) or service sector (Fixler and Siegel, 1999) productivity using industry level data. Also, in related papers, Görzig and Stephan (2002) and Görg and Hanley (2003) look at the relationship between outsourcing and profitability, using firm level data.

[4] Note that with the data available we are not able to identify UK multinationals.

[5] More precisely, using SIC 1980 classifications, chemicals is SIC 25, mechanical and instrument engineering (hereafter referred to as engineering) includes SIC32 and SIC 37, electronics includes SIC 33 (manufacture of office machinery and data processing equipment) and SIC 34 (electrical and electronic engineering).

determinants of outsourcing at the level of the establishment while Section 4 presents the results of our analysis of productivity effects of outsourcing. Section 5 summarises our main findings and concludes.

2 Data description and summary statistics

For the empirical estimations, this paper draws on the Annual Respondents Database (ARD) provided by the Office for National Statistics. The ARD consists of individual establishments' records that underlie the Annual Census of Production and the data used cover the period 1980 to 1992. As Barnes and Martin (2002) provide a useful introduction to the data set, we only include a brief discussion of some of the features of the data that are relevant to the present work. For each year the ARD consists of two files. What is known as the 'selected file', contains detailed information on a sample of establishments that are sent inquiry forms. The second file comprises the 'non-selected' (non-sampled) establishments and only basic information such as employment, location, industry grouping and foreign ownership status is recorded. Some 14,000-19,000 establishments are selected each year, based on a stratified sampling scheme. The scheme tends to vary from year to year, but during the period under consideration, the sample included all establishments with more than 100 employees plus a selection of smaller ones.

In the ARD, an establishment is defined as the smallest unit that is deemed capable of providing information on the Census questionnaire. Thus a 'parent' establishment reports for more than one plant (or 'local unit' in the parlance of ARD). For selected multi-plant establishments, we only have aggregate values for the constituent plants. Indicative information on the number of plants is available in the 'non-selected' file. In the sample period considered in this paper (1980-92), about 95 percent of the establishment that are present in these industries are single-plant firms. In the actual sample we used for the econometric estimation this figure is around 80 percent. Hence, most of the data used is

actually plant level data.

The focus of this paper is on outsourcing activities of an establishment. While there has been some empirical research in that area there does not appear to be a standard definition of what constitutes outsourcing. For example, papers in the empirical trade literature (e.g., Feenstra and Hanson 1996, 1999; Hijzen et al., 2002) define outsourcing essentially as trade in intermediate products. This appears as a rather wide measure of "outsourcing", especially when considering outsourcing at the level of the establishment. Using a more narrow definition, Abraham and Taylor (1996) define as outsourcing various activities, namely, contracting out of machine maintenance services, engineering and drafting services, accounting services, computer services and janitorial services. Our definition includes the first two categories but not the latter three. We define as outsourcing the "cost of industrial services received" by an establishment. This includes activities such as processing of inputs which are then sent back to the establishment for final assembly or sales, maintenance of production machinery, engineering or drafting services etc. Note that "non-industrial services" such as accounting, consulting, cleaning or transportation services are not part of that definition.

Outsourcing can be seen as a substitute for in-house production and may therefore, 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 occurred to in-house employees if the services had not been contracted out. We therefore decided to calculate an indicator of an establishment's propensity to outsource as an outsourcing intensity equal to the cost of industrial services received relative to the total wage bill of the establishment. Some summary statistics for this measure for the three broad manufacturing industries are presented in Table 1. Note that the average outsourcing intensity in the electronics sector is considerably lower than in chemicals and engineering, although the standard deviation is also

considerably higher. We also find that the mean outsourcing intensity for foreign owned establishments appears to be higher than that for domestic owned establishments in the same sector.

[Table 1 here]

Figures 1a to c also plot the development of the outsourcing intensity by sector over time. Figure 1c in particular indicates that the propensity to outsource in the electronics sector has increased sharply since 1989/1990, leaving it at about the same rate as in the other two sectors at the end of the period under consideration in this paper. Hence, the lower means in Table 1 can be attributed to the very low levels in the early 1980s. This recovery appears to have been mainly due to domestic establishments where we see a considerable growth in outsourcing since 1989. However, we also find that the outsourcing intensity in foreign owned establishments has increased over the total period 1980 to 1992, although there has been a slight decrease since 1989.

[Figures 1a to 1c here]

3 Determinants of outsourcing

This section investigates what determines firms' use of outsourcing. Abraham and Taylor (1996) postulate that there are three general considerations that may affect firms' decisions in that regard, namely, wage costs savings, output cyclicality and economies of scale.

Firms may try to cut costs by contracting out activities to firms that operate at lower costs, i.e., offer lower wages to their employees. For outsourcing abroad, this may be the case if market wages are lower in the foreign country due to the abundance of labour. Even if firms outsource in the domestic economy this argument may still hold if, for example, a unionised firm pays wages higher than what it would otherwise choose to pay. Even if a firm is not unionised a firm may still pay high wages due to paying "efficiency wages" (e.g.,

Weiss, 1991) to its employees. In this case, while it may be sensible to pay efficiency wages to the firm's "core" workforce there may be other more peripheral activities for which the payment of above market rate efficiency wages may not be justified. These activities could, therefore, be easily contracted out to low wage producers.[6,7]

If the firm's output is subject to heavy seasonal or cyclical fluctuations it may also revert to outsourcing in order to smooth the work load for the core workforce. Some firms may choose to even the workload by assigning peak period tasks to outside contractors, thereby increasing outsourcing. Other firms may, however, decide to reduce outsourcing during slow periods by having work performed in-house that would have otherwise been assigned to outside contractors. Hence, fluctuations in output may affect the use of outsourcing either positively or negatively, depending on the preferences of the firm in question.

The third reason put forward by Abraham and Taylor (1996) for the use of outsourcing is that there may be economies of scale for specialised services. Hence, it may not be optimal for small or medium sized enterprises to provide a full range of support services, but they may be better off sourcing these from specialised providers outside, which are able to reap scale economies.

While we take into account these three reasons put forward by Abraham and Taylor (1996) we extend their argument by postulating that we would also expect the nationality of ownership of a firm to matter for its use of outside contractors. Foreign establishments, which are by definition part of a multinational company can be expected to use higher levels of technology than purely domestic firms, due to their having access to firm specific assets

6 This argument of course implies that firms cannot pursue different wage strategies, paying high (efficiency) wages to core workers and lower wages to other workers. This may be due to unionisation, or to internal equity considerations.

7 Outsourcing may also be undertaken to save on costs other than wages or to provide access to better technology, more favourable regulations etc. Unfortunately, we cannot from our data measure such other determinants and therefore cannot include them in the empirical analysis.

(e.g., Markusen, 1995). The use of high technology may lead to the contracting out of activities, in particular low-tech activities. Also, if the foreign establishment is part of a vertical multinational there will be specialisation of activities and, by definition, outsourcing of activities to vertically linked plants within the same multinational. Such specialisation of activities may be less for purely domestic firms.[8] Furthermore, given that they are embedded in an international production network through their relationship with parent and other affiliates abroad they may be expected to have different strategies for dividing in-house and outsourced production, and may have better access to external providers of services than do purely domestic firms. Hence, we would expect that foreign firms have higher propensities of outsourcing than domestic firms.[9]

In order to test for the importance of these determinants we estimate empirically variants of the following equation

$$\begin{aligned} outs_{it} &= \beta_0 + \beta_1 w^{s}_{it-1} + \beta_2 w^{us}_{it-1} + \beta_3 un_{jt-1} + \beta_4 size_{it-1} + \beta_5 foreign_{it} + \ldots \\ &\ldots + D_j + D_t + D_r + dv_{jt} + \varepsilon_{it} \end{aligned} \tag{1}$$

where *outs* is measured as the log of the cost of industrial services received by establishment *i* at time *t*. The regressors w^s and w^{us} are the log of wage rates for skilled and unskilled workers respectively while *un* captures the degree of unionisation in the four digit industry *j*, calculated using data from the *New Earnings Survey*. These variables are included to capture the "cost saving" motive for outsourcing. Given our discussion above we would expect high wage firms to do more outsourcing than other firms. Also, firms in highly unionised sectors may prefer outsourcing as union work rules may act to increase costs, even if wages are no different in unionised and non-unionised firms.[10] The *size* variable is the log of establishment size measured in terms of employment and is included to control for the

[8] Although it may be similar for domestic establishments which are part of a UK multinational. Unfortunately, we are not able to observe UK multinationals in our dataset.
[9] The fact that multinationals have been found to import more of their intermediate inputs than domestic firms (e.g., Turok, 1993) may give some preliminary support for this assumption.

economies of scale effect. Based on this reasoning we would expect smaller firms to be more intensive users of outsourcing. However, given that our dependent variable is measured in absolute terms the size variable controls for the fact that large firms may do more outsourcing (in absolute terms) than smaller firms. *foreign* is an ownership dummy equal to one if the establishment is foreign owned and zero otherwise. As pointed out above, we would expect this variable to have a positive coefficient if foreign firms are more intensive users of outsourcing. Furthermore, sectoral time dummies (dv_{jt}) are also included to control for the effect of cyclical or seasonal variations in output in the four digit industries. Finally, we include four digit sector (D_j), time (D_t) and region (D_r) dummies in equation (1).

Equation (1) is estimated for each of the three broad sectors (chemicals, engineering and electronics) separately using ordinary least squares (OLS) estimation. We allow for heteroskedasticity of the error term, as well as an unspecified correlation between error terms within establishments, but not across establishments. This allows for the possibility that there may be unobserved establishment specific effects which are correlated with the regressors but which we do not explicitly account for in the empirical model. The estimation results for the three sectors are presented in Table 2.

[Table 2 here]

In line with our prior expectations we find that high wages are positively correlated with outsourcing, which concurs with the hypothesis that high wage establishments are more prone to outsource in order to reduce costs. The distinction between skilled and unskilled wages shows that the larger effects seem to stem from the former, rather than the latter part of labour costs. For example, for the engineering sector (column 4) we find that the elasticity of outsourcing with respect to skilled wages is 0.38, while the elasticity for the unskilled wage rate is 0.15. The rate of unionisation can only be included for the engineering sector where

[10] On the other hand, as a referee pointed out to us, unions may attempt to prevent outsourcing in order to safeguard jobs, which would have a negative effect on outsourcing.

the coefficients turn out to be positive, albeit statistically insignificant. Large firms also outsource more than small firms – in all cases, the elasticity is between 1.5 to 1.8. This may reflect a pure size effect – large firms produce higher levels of output and therefore have more activities, in absolute terms, to outsource than smaller firms.

We now turn to the importance of nationality of ownership for the use of outsourcing. As pointed out above we would expect foreign firms to be more intensive users of outsourcing. As can be seen from columns (1), (3) and (5) this result is borne out by the data for all three manufacturing sectors. Controlling for size, labour costs and cyclicality of production, foreign owned establishments use more outsourcing than domestic establishments.

A reasonable question to ask then is whether the determinants of outsourcing are systematically different for the former compared to the latter as well. In other words, do the slope coefficients on the regressors differ between foreign and domestic establishments? To investigate this issue we interact all establishment level regressors (i.e., wage and size variables) with the ownership dummy and re-run the augmented specification of equation (1). The results are reported in columns (2), (4) and (6) of Table 2.

We test for the joint significance of the three interaction terms using an F-test. The test statistics suggest that for the chemicals and electronics sector we cannot reject the hypothesis that the interaction terms are jointly equal to zero. Hence, we do not find systematic differences in the determinants of outsourcing between foreign and domestic establishments in these sectors. This is different in the engineering sector, where the interaction terms are jointly significant. We still find that the ownership dummy is statistically significant and positive suggesting that foreign firms use more outsourcing. What differs also between the foreign and domestic groups of establishments is the effect of the other regressors included in the equation. The size effect is reduced substantially for foreign

establishments with the elasticities being 1.58 for domestic firms and 1.18 for foreign firms. Also, the elasticity of outsourcing with respect to skilled wages is larger for foreign (0.71) than domestic establishments (0.38).

Two criticisms could be directed at equation (1). First, if there are time-invariant establishment-specific effects that are not captured in the explanatory variables but that are correlated with them then our estimation may produce biased and inconsistent estimates. In other words, if the error term included in equation (1) equals $\varepsilon_{it} = v_i + u_{it}$ then a simple OLS regression is problematic. In order to take this into account we relate the change in the outsourcing variable to changes in the wage and size variables, thus purging the establishment-specific effect v_i in the levels specification. However, we still include *foreign* and *un* in levels, as we are interested in establishing whether foreign firms or more unionised sectors experience higher growth of outsourcing than others. Second, if there is persistence in the outsourcing decision then we may expect that the decision to outsource in period *t* is related to the level of outsourcing in the previous period *t*-1. To allow for such temporal correlation between outsourcing in *t* and *t*-1 we include the lagged level of outsourcing also in the equation. Hence, our alternative specification is described by the following equation

$$\begin{aligned}\Delta(outs_{it}) &= \beta_0 + \beta_1\Delta(w^{s}_{it-1}) + \beta_2\Delta(w^{us}_{it-1}) + \beta_3 un_{jt-1} + \beta_4\Delta(size_{it-1}) + \ldots \\ &+ \beta_5 foreign_{it} + \beta_6 outs_{it-1} + D_j + D_t + D_r + dv_{jt} + \varepsilon_{it}\end{aligned} \tag{2}$$

The results of estimations of this equation using data for the three manufacturing sectors separately are presented in Table 3. Note that the lagged level of outsourcing is highly statistically significant and negative in all cases suggesting that there is indeed temporal correlation in outsourcing, i.e., present outsourcing is heavily influenced by previous outsourcing. Inclusion of the lagged level leads to most of the explanatory variables being statistically insignificant. However, most importantly from our point of view, the finding that

foreign establishments outsource more than domestic ones, ceteris paribus, is robust to the inclusion of the lagged level of outsourcing.

[Table 3 here]

4 Productivity effects of outsourcing

Having analysed the determinants of outsourcing we now turn to investigate whether outsourcing leads to an improvement in establishments' performance. More specifically we analyse whether outsourcing has a positive effect on productivity, measured in terms of labour or total factor productivity (TFP), of the establishment that decides to outsource the activities.

In a recent paper ten Raa and Wolff (2001) argue and provide evidence that TFP growth in manufacturing industries is positively related to an increased use of outsourcing, defined as inputs purchased from services industries. Their empirical evidence is based on industry level data using US input-output tables to calculate the importance of outsourcing. The effects of outsourcing for services industries have also been investigated recently. Fixler and Siegel (1999) argue that outsourcing has played a major role for the growth of the services sector. Their empirical evidence, based on industry level data for the US, suggests that outsourcing has led to short run reductions in service sector productivity, but that there have been positive effects in the long run. Extending this literature our paper is, to the best of our knowledge, the first study to investigate with establishment level data the effects of outsourcing on productivity in the establishment undertaking the outsourcing.

As argued in the previous section one of the reasons for outsourcing may be to economise on labour costs. An increase in outsourcing may therefore lead directly to a reduction of employment, while keeping output constant. Outsourcing may, therefore, have an immediate effect on labour productivity. Our investigation of this issue is based on the

following equation of labour productivity augmented by a measure of outsourcing intensity at the level of the establishment:[11]

$$\Delta y / l_{it} = \alpha_0 + \alpha_1 \Delta k / l_{it} + \alpha_2 \Delta m / l_{it} + \alpha_3 out\,\text{int}_{it} + D_t + D_R + \varepsilon_{it} \qquad (3)$$

where y is output, l is labour, k is capital and m is material inputs, D_t and D_R are time and regional dummies respectively, and ε is the error term function. The outsourcing intensity *outint* is calculated as the value of industrial services received divided by total wage costs, as in Section 2.[12] In order to see whether there are different productivity effects of outsourcing for foreign and domestic firms we allow α_3 to vary for the two nationality groups. Outsourcing may not only affect the productivity of labour but also that of other factors of production if it leads to an adjustment of the production process. In order to capture these productivity effects we also examine whether outsourcing affects total factor productivity (TFP) growth.[13] Both labour and total factor productivity equations are estimated in levels as well as first-differences.

A major econometric concern with the above equation is that there may be a potential endogeneity problem, i.e., there may be unobserved covariates that are correlated with productivity and outsourcing intensity that may be driving the results. For example, it may be the case that highly productive establishments are more skill intensive and therefore more likely to use outsourcing in order to shift the production of low skill intensive components outside the firm. In order to take account of this possibility we instrument for outsourcing intensity with the past level of outsourcing intensities, the growth rates and lagged values of establishment size, skilled and unskilled wages. We use the robust form of Sargan's test of overidentifying restrictions to examine the null hypothesis that the correlation between the instrumental variable candidates and the error terms in the productivity equation is zero; a

[11] We assume that the intensity of outsourcing shifts the technology parameter of the underlying production.
[12] Note that we do not simply measure outsourcing as use of intermediate inputs (m) in the production function.
[13] See Appendix for a description of how TFP is calculated.

necessary condition for the validity of the instrumental variables regression approach. Depending on the particular sector and equation in question (TFP or labour productivity; levels or differences) instruments which are found to be invalid, are dropped from the specification.

We are also careful to assess the strength of the relationship between the instruments and the potentially endogenous regressors. It has been noted in the econometric literature (see, 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. 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.

Tables 4 and 5 present the empirical estimates from the labour productivity and TFP equations respectively. As in the previous section we estimate the model separately for the three manufacturing sectors. As might be expected the estimates display some heterogeneity across sectors.

[Table 4 here]

Turning to labour productivity first and focusing on the specification in levels, it can be seen from Table 5 that for the chemical and engineering sectors outsourcing is positively related with labour productivity. It does not seem to exert any influence of the productivity path of plants in the electronics sector, however. The elasticity of labour productivity with respect to outsourcing is about three times higher in the engineering than in the chemicals sector. Furthermore, this productivity effect of outsourcing is more pronounced in the sample

of foreign-owned establishments as indicated by the positive coefficients on the interaction terms.

The first-difference specification does not yield strong results. Labour productivity and outsourcing growth rates appear to be correlated in foreign establishments within the engineering sectors. This lack of robust correlation may be due to the weakness of the instrumental variable candidates, which are too weak as evidenced by the low F statistics from the first-stage regressions for the chemicals and electronics sectors.[14] In the absence of other instrumental variable candidates or a 'natural experiment' for the outsourcing variable, it does not seem appropriate to draw a firm conclusions about the effect of outsourcing on productivity based on the first-differenced specifications.

Table 5 reports the results of the TFP estimations. The level of TFP seems to respond to changes in the outsourcing intensity, again in the chemical and engineering sectors. This is particularly pronounced for foreign establishments. TFP adjusts faster to outsourcing in the engineering sector, particularly in foreign establishments. From the first differenced estimation there is also evidence of a positive relationship between TFP growth and the changes in the degree of outsourcing for the engineering sector. For the other two sectors, the low F-statistics from the first stage regressions may again indicate the weakness of the instruments used which may explain the lack of a significant correlation between outsourcing and TFP.

[Table 5 here]

The econometric estimates reported in the above tables give some idea as to the relationship between outsourcing and productivity, and the statistical significance of this association. An interesting question to ask then is what is the economic significance of outsourcing in the establishment level productivity trajectory? As a first attempt towards answering this question we calculate the implied change in productivity resulting from the

change in outsourcing intensity,[15] and relate it to the actual productivity growth observed in the data. Table 6 reports the results from this experiment.

[Table 6 here]

Consistent with the reported point estimates, outsourcing played a more important role in the engineering sector: nearly a quarter of the observed change in *total factor productivity* and almost 15 percent of the change in *labour productivity* in domestic plants is attributed to the change in outsourcing intensity. The effects on foreign firms' productivity are much smaller with 0 and 7 percent, respectively. Of course, to the extent that the outsourcing variable captures the effect of some omitted variable, the figures in Table 6 might overstate the importance of outsourcing. Nonetheless these 'back-of-envelope' calculations are indicative that the role of outsourcing in enhancing productivity, at least in the engineering sector, is likely to be economically significant.

5 Conclusions

This paper presents an empirical analysis of "outsourcing" using establishment level data for UK manufacturing industries. We analyse an establishment's decision to outsource and the subsequent effects of outsourcing on the establishment's productivity. Our empirical results suggest that high wages are positively related to outsourcing, suggesting that the cost saving motive is important. We also find that foreign-owned firms have higher levels of outsourcing than domestic establishments. In the productivity analysis we find that an establishment's outsourcing intensity in the chemical and engineering sectors is positively related to its productivity. This relationship appears to be more pronounced in foreign- owned establishments.

[14] Notice that these instruments are valid according to the Sargan test, however.
[15] The point estimates from the equations in level are used to this end. We confine our analysis to establishments with more than 5 years data.

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Appendix: TFP estimation

Using log values, we write the production function as $y_{it} \equiv f(l_{it}^{s}, l_{it}^{u}, k_{it}, m_{it}, TFP_{it})$, where y is output and there are four factors of production: skilled labour (l^s), unskilled labour (l^u), materials or cost of goods sold (m) and capital stock (k). For estimation purposes we employ a first-order Taylor approximation and write the production function as:

$$y_{it} = \beta_0 + \beta_s l_{it}^{s} + \beta_u l^{u}{}_{it} + \beta_k k_{it} + \beta_m m_{it} + TFP_{it} \qquad \text{(A1)}$$

TFP is assumed to follow the following AR(1) process:

$$TFP_{it} = \rho TFP_{it-1} + \delta D_t + f_i + v_{it} \qquad \text{(A2)}$$

where D is a common year-specific shock, f is a time-invariant firm specific effect and v a random error term. Note that we do not simply model productivity as a fixed effect, as that would imply that TFP differences are fixed, and there is no role for technology diffusion (convergence).

Recently the fundamental assumption of pooling individual times series data has been questioned. Pesaran and Smith (1995) demonstrate that standard GMM estimators of dynamic panel models lead to invalid inference if the response parameters are characterised by heterogeneity. They argue that one is better off averaging parameters from individual time series regressions. This is not feasible here since the individual firm's time series data is not of adequate length. However, we take some comfort from a recent comparative study by Baltagi and Griffin (1997) which concludes that efficiency gains from pooling are likely to more than offset the biases due to individual heterogeneity. Baltagi and Griffin (1997) especially point out the desirable properties of the GLS-AR(1) estimator, and we use this estimator to obtain estimates of the factor elasticities, and derive TFP as a residual term. We estimate equation (4) for each of the four-digit SIC80 industries available in our sample.

Table 1: Mean outsourcing intensity by sector
(standard deviation in parentheses)

Sector	All	foreign	domestic
Chemicals	0.138	0.161	0.128
	(0.279)	(0.256)	(0.343)
Engineering	0.140	0.161	1.136
	(0.360)	(0.288)	(0.226)
Electronics	0.091	0.097	0.090
	(0.554)	(0.458)	(0.599)

Figure 1a

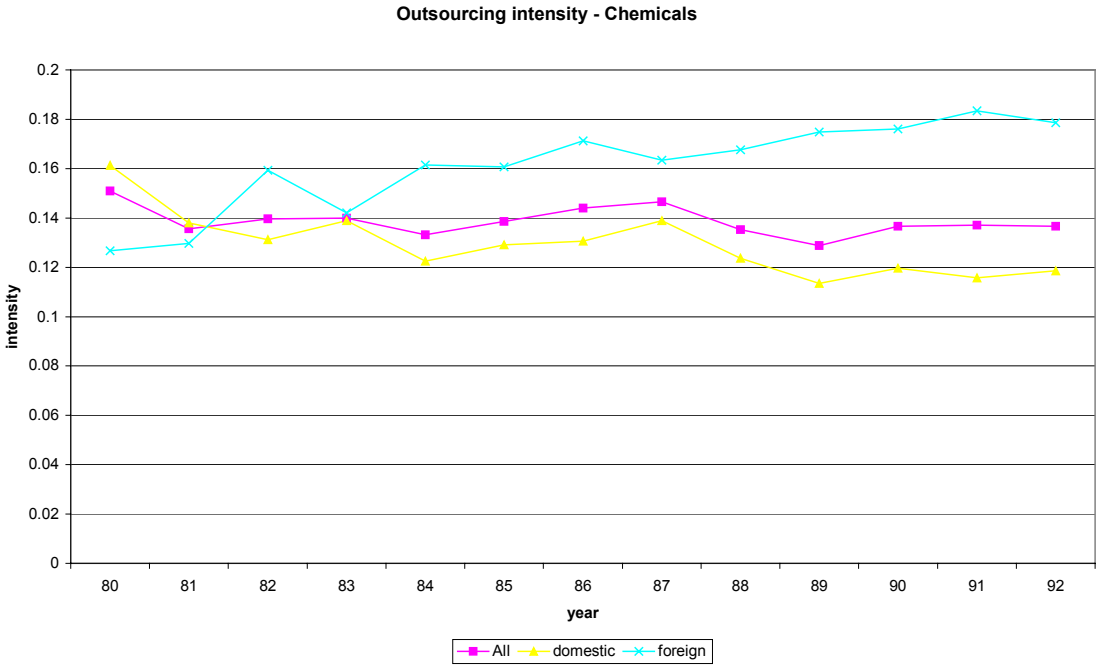

Figure 1b

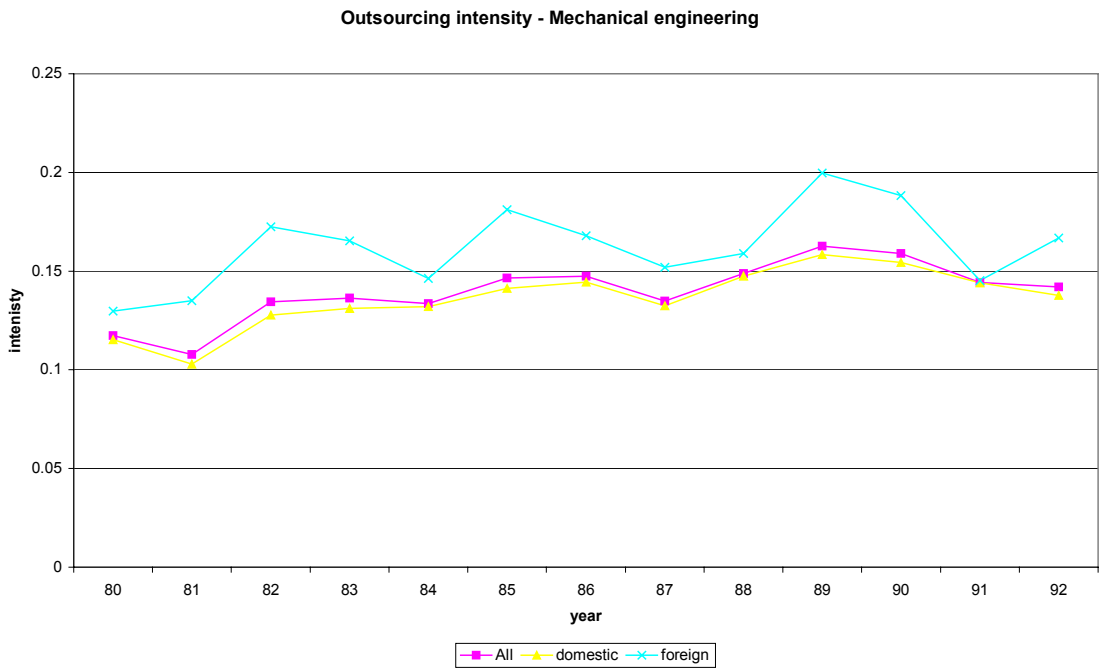

Figure 1c

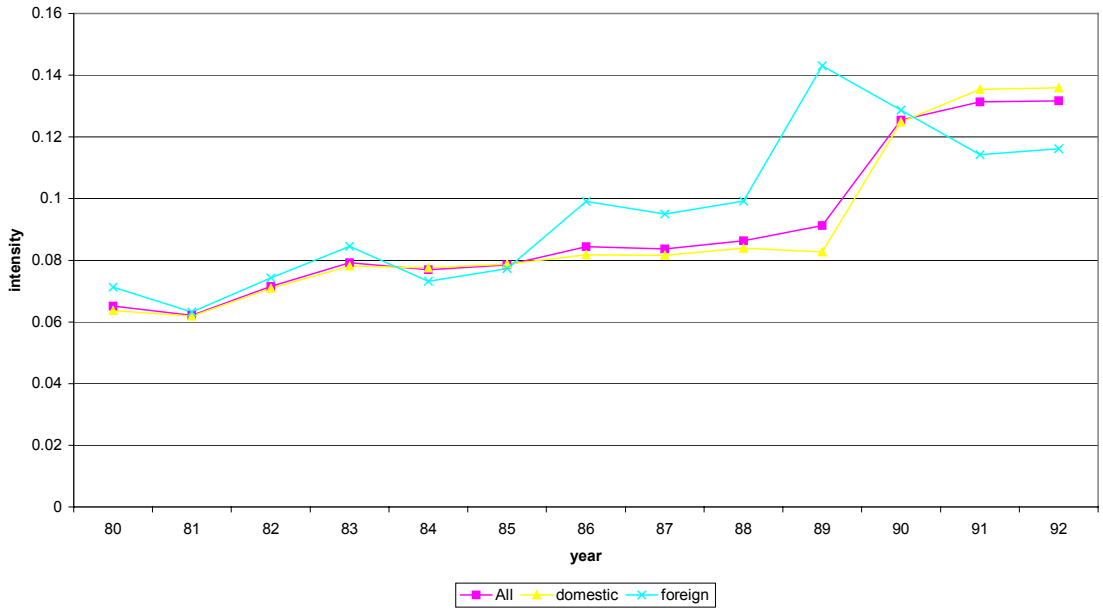

Table 2: Determinants of outsourcing – OLS regression in levels
Dependent variable: log of industrial services received

	(1)	(2)	(3)	(4)	(5)	(6)
	chem I	chem II	engin I	enging II	electr I	electr II
$size_{t-1}$	1.542	1.587	1.521	1.578	1.754	1.767
	(0.060)**	(0.067)**	(0.047)**	(0.048)**	(0.046)**	(0.050)**
skilled $wage_{t-1}$	0.837	0.814	0.399	0.378	0.392	0.384
	(0.216)**	(0.226)**	(0.163)*	(0.162)*	(0.137)**	(0.138)**
unskilled $wage_{t-1}$	0.028	0.006	0.117	0.148	0.068	0.065
	(0.152)	(0.174)	(0.049)*	(0.057)**	(0.058)	(0.063)
foreign dummy	0.665	0.433	0.612	0.574	0.309	0.144
	(0.139)**	(0.233)+	(0.120)**	(0.140)**	(0.144)*	(0.185)
foreign * $size_{t-1}$		-0.183		-0.404		-0.097
		(0.119)		(0.147)**		(0.120)
foreign* skilled $wage_{t-1}$		0.042		0.330		0.069
		(0.268)		(0.102)**		(0.129)
foreign * unskilled $wage_{t-1}$		0.103		-0.083		0.015
		(0.270)		(0.055)		(0.114)
union			1.218	1.121		
			(1.368)	(1.363)		
Constant	-5.731	-5.667	-3.999	-4.175	-10.001	-10.041
	(2.510)*	(2.484)*	(1.969)*	(1.948)*	(2.901)**	(2.911)**
Observations	6917	6917	23555	23555	12552	12552
F-test		1.31		3.49*		0.52
R-squared	0.32	0.32	0.20	0.21	0.26	0.26

Notes:
Heteroskedasticity-autocorrelation consistent standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%
Regressions include 4-digit sector, time, region and sectoral time dummies
Union variable in (1), (2), (5) and (6) is dropped due to multicollinearity with the sectoral time dummies
F-test is for joint significance of three interaction terms

Table 3: Determinants of outsourcing – first differences with lagged level of outsourcing
Dependent variable: log of industrial services received

	(1)	(2)	(3)	(4)	(5)	(6)
	chem I	chem II	engin I	enging II	electr I	electr II
outs $_{t-1}$	-0.346	-0.345	-0.353	-0.353	-0.327	-0.327
	(0.021)**	(0.021)**	(0.010)**	(0.010)**	(0.012)**	(0.012)**
Δ size$_{t-1}$	0.211	0.264	-0.131	-0.132	0.156	0.162
	(0.309)	(0.325)	(0.125)	(0.126)	(0.152)	(0.157)
Δ skilled wage $_{t-1}$	0.414	0.344	0.002	-0.005	-0.081	-0.071
	(0.270)	(0.281)	(0.089)	(0.089)	(0.143)	(0.144)
Δ unskilled wage $_{t-1}$	-0.006	0.052	0.151	0.184	-0.050	-0.069
	(0.149)	(0.184)	(0.054)**	(0.064)**	(0.051)	(0.055)
foreign dummy	0.501	0.490	0.581	0.584	0.385	0.390
	(0.083)**	(0.085)**	(0.063)**	(0.065)**	(0.081)**	(0.084)**
foreign * Δ size $_{t-1}$		-0.130		0.015		-0.045
		(0.213)		(0.134)		(0.160)
foreign* Δ skilled wage $_{t-1}$		0.266		0.096		-0.113
		(0.247)		(0.103)		(0.118)
foreign * Δ unskilled wage $_{t-1}$		-0.185		-0.118		0.145
		(0.239)		(0.074)		(0.072)*
union			-0.796	-0.821		
			(1.524)	(1.527)		
Constant	4.804	3.482	4.120	4.131	5.776	5.788
	(1.090)**	(1.257)**	(0.777)**	(0.778)**	(1.981)**	(1.979)**
Observations	5707	5707	18428	18428	10095	10095
F-test		0.41		0.98		1.41
R-squared	0.21	0.21	0.20	0.20	0.18	0.18

Notes:
Heteroskedasticity-autocorrelation consistent standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%
Regressions include 4-digit sector, time, region and sectoral time dummies
Union variable in (1), (2), (5) and (6) is dropped due to multicollinearity with the sectoral time dummies
F-test is for joint significance of three interaction terms

Table 4: Labour productivity and outsourcing:
Instrumental variables estimates (labpro_3.do)

	Chemicals sector		Electronics sector		Engineering sector	
	Levels	**First differences**	**Levels**	**First differences**	**Levels**	**First differences**
Capital intensity	0.020	0.004	-0.049	0.026	0.028	-0.000
	(2.84)***	(0.47)	(1.07)	(1.52)	(2.83)***	(0.01)
Material inputs intensity	0.773	0.732	0.991	0.551	0.587	0.531
	(20.40)***	(13.78)***	(5.63)***	(5.49)***	(15.75)***	(17.16)***
Outsourcing Intensity	0.174	0.135	-0.468	-0.410	0.491	0.002
	(6.61)***	(1.28)	(1.13)	(1.63)	(4.63)***	(0.38)
Outsourcing Intensity *foreign dummy	0.019	0.009	0.009	0.014	0.076	0.047
	(1.65)*	(0.84)	(0.24)	(0.63)	(2.25)**	(3.34)***
Exogeneity test (p-value)	0	1	.995	1	.239	0
F (first-stage) {p-value}	18.71 (0)	.19 (.9912)	2.46 (.022)	.51 (.847)	29.1 (0)	51.46 (0)
Sargan (p-value}	.377	.602	.351	.237	543	.202
Observations	6115	6115	10882	10882	18793	13245
Number of plants	1133	1133	2184	2184	4376	4376

Notes:
Regressions include time and region dummies.
Heteroskedasticity consistent standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%
The tests of exogeneity is a Hausman test which examines the null hypothesis that there is no statistically significant difference between the OLS and IV estimates.

Table 5: TFP and outsourcing:
Instrumental variables estimates (tfp_3.do)

	Chemicals sector		Electronics sector		Engineering sector	
	Levels	**First differences**	**Levels**	**First differences**	**Levels**	**First differences**
Outsourcing intensity	0.087	0.257	-0.645	0.054	0.346	0.158
	(4.89)***	(1.70)*	(1.51)	(0.41)	(4.63)***	(2.24)**
Outsourcing intensity *foreign dummy	0.019	0.026	-0.004	-0.011	0.078	0.449
	(2.22)**	(1.22)	(0.10)	(1.63)	(3.12)***	(2.60)***
Exogeneity test (p-value)	.01	.991	1	1	.499	.4627
F (first-stage) {p-value}	67.25 (0)	1.44 (.139)	1.83 (.089)	.32 (.924)	34.49 (0)	38.91 (0)
Sargan (p-value}	.155	.496	.652	.133	.127	.060
Observations	6115	5068	10882	8723	18793	13245
Number of plants	1133	896	2184	1638	4376	2941

Notes:
Regressions include time and region dummies.
Heteroskedasticity consistent standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%
The tests of exogeneity is a Hausman test which examines the null hypothesis that there is no statistically significant difference between the OLS and IV estimates.

Table 6: Contribution of outsourcing to productivity growth:
Median values across establishments (counter.do)

	Chemicals sector		Engineering sector	
	Actual yearly growth rate	**Implied % contribution of outsourcing**	**Actual yearly growth rate**	**Implied % contribution of outsourcing**
Labour productivity				
Domestic	2.17%	4.7%	1.6%	14.7%
Foreign	3.06%	2.4%	2.66%	6.8%
TFP				
Domestic	-.6%	1.1%	-.1%	24.4%
Foreign	0%	0%	-.1%	0%

Note:
The implied changes in productivity due to outsourcing is obtained by multiplying the point estimates of the elasticity of productivity with respect to outsourcing by the actual change in outsourcing intensity in the data. The estimates are obtained from the models in levels.