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ABSTRACT

This paper considers the relationship between unions and labour productivity in a sample of British engineering firms. Rather than use a single indicator of union presence to determine the union effect a number of measures of unionisation are combined to form a union presence index. An average union non-union productivity differential calculated using this measure is found to be statistically insignificant although there is considerable variation around this average displayed by the firms in the sample. Firm size is also found to be a key determinant of the union impact on productivity and firms with more than 1000 employees are characterised by negative statistically significant union effects. On the other hand, in smaller firms the union impact is neutral although not very well determined. The results using the index are contrasted with the effects of the closed shop on labour productivity where firm size is also found to be important such that neutral effects occur in small firms but in larger firms the closed shop is associated with lower levels of value added per employee.

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1. Introduction.

British evidence on the impact of unions on productivity is very scarce. Aside from a historical study by Pencavel(1977) who uses data on British coal mining in the early 20th century, an analysis of the impact of strike activity on industry level value added per employee hour by Knight(1988) and a more institutional based analysis by Edwards(1987) no published work exists to date. This paper uses data on a small sample of British engineering firms over the period 1978-82 to examine this issue. The data is particularly useful in that it yields a great deal of information on a variety of union related issues and thus, rather than simply considering a single indicator of union presence, several dimensions can be considered via construction of a union presence index.[1] In particular this allows recognition of certain institutional characteristics of the sector under study. The richness of the data also allows consideration of the importance of issues like firm size and the nature of the production process in analysing the influence of unions on productivity. Indeed the empirical analysis finds that scale effects are of importance and that larger firms are more likely to be characterised by negative union effects on productivity. The fact that the data consists of a group of relatively homogenous firms operating in the engineering industry is also worthy of discussion since it permits analysis of the influence of unions on performance in a context where the omission of certain industry specific factors is not a problem. On the other hand, its relative disadvantage is that it prevents any generalisation of the results to other industries.

The layout of the paper is as follows. Section 2 considers the methodology to be employed and describes the construction of the union presence index. Section 3 describes the data and the institutional background underlying the sector under study. Section 4 presents empirical estimates of the union impact on productivity and examines in detail the source of such effects and how they vary across the firms in the sample. Parallel results analysing the influence of the closed shop on productivity are also presented for comparison with those derived from the index. The

[1] See Wilson(1987) who utilises this data to estimate union wage and productivity effects using a single indicator of union presence. Estrin and Wilson(1986) also use this data set to examine the impact of profit sharing on wages and employment.

differences between union effects on productivity in small and large firms are also considered in more detail. Section 5 offers conclusions and highlights the main results.

2. Modelling and Estimation of Union Productivity Effects.

The need for economists to analyse the non-wage influence of trade unions is made forcefully by Freeman and Medoff's U.S. work (see Freeman and Medoff(1984) and the numerous references cited therein). They state that researchers should recognise the institutional features of unionism and not simply treat trade unions as monopolistic suppliers of labour whose sole purpose is to push wages above competitive levels thereby inducing allocative inefficiency. Indeed the empirical work of the collective voice school suggests that the non-wage effects of unions may offset the efficiency losses implied by the traditional monopoly view of unionisation. One such route through which this may occur is through the potential for unions to raise productivity via lower turnover amongst unionised workers, reduced rivalry among union employees and through a reduction in X-inefficiency due to the union's monitoring role in the production process. Empirical evidence for positive union productivity effects is provided by, among others, Allen(1984) and Brown and Medoff(1978). However, other studies such as those by Clark(1984), report statistically insignificant effects although very few U.S. studies report significant negative productivity effects (see the surveys in Hirsch and Addison(1986) and Freeman and Medoff(1984) for more details). This seems to suggest that there may be at least some credence in the idea of U.S. unions having some beneficial productivity effects which may act to offset their positive influence on wages.[2] The existing British evidence tends to reflect less of a productivity enhancing role for unions and the results of Pencavel's(1977) historical and Edwards(1987), Knight(1988) and Wilson's(1987) studies point to a neutral or negative impact. It therefore is of importance to consider the influence of unions on productivity in the British context, especially given the considerable institutional differences relative to unions operating in the

[2] Although the evidence on unions and profitability is unambiguous in that all studies to date find that unions reduce profits : for some U.S. examples see Freeman(1983) or Karier(1985) and the discussions in Hirsch and Addison(1986) and Freeman and Medoff(1984); for some British evidence see Machin(1988) or Machin and Stewart(1988).

United States.

Trade union influences on productivity can be expected to manifest themselves in a number of ways. A veritable black box of potential sources of union productivity effects has been identified by U.S. labour economists, some of which are clearly more appropriate than others to the British situation. One popular idea is that a trade union is able to monitor the behaviour of management thereby inducing an improvement in managerial efficiency (on this see Brown and Medoff(1978) and Clark(1980) who allude to a union "shock effect" which may prompt managers into recognising certain internal organisation procedures). However, whilst it is argued that unions can induce certain changes in the organisational set-up of the firm an adversarial industrial relations climate (which is more prevalent in the British situation)[3] might suggest that unions will oppose any managerial attempts to re-define production operations. This is evident in the traditional union opposition to the likes of overtime working or payment by piece rates. Clearly if this non-cooperative situation exists then talk of unions having a depressant effect on productivity may be more appropriate. Indeed this emphasises the point that unions may also be able to exert some control over the relevant production technology and as such may be able to enhance or restrict performance as a show of bargaining power through the control of manning levels or via sanctions like go-slows, overtime bans or strikes (on this power interpretation see Cable(1987)). Of related interest here is Pratten's(1975) evidence that U.S. plants are 50% more productive than British plants in terms of output per person. Of this 50% he attributes 15% to what he terms behavioural factors such as strikes, overmanning and restrictive work practices. The other international productivity study worthy of note is Caves'(1980) comparison of factor productivity in 71 British and U.S. manufacturing industries. He argues that labour relations play an important role in determining productivity and pays particular attention to strikes, restrictive practices and overtime clauses in labour contracts. In a productivity regression (with dependent variable the ratio of British productivity to U.S. productivity) he finds measures of strikes and work days lost have a statistically significant negative influence. Both these studies seem to point to the idea

[3] Although exceptions, most notably the electrician's union, do exist.

that control of the production process and more conflictual industrial relations may be more relevant as a source of dampening union effects on productivity in the British context relative to that presiding in the United States. Also, it should be noted that a prerequisite for discussion of a potential shock effect is that some degree of organisational slack exists and this obviously creates a problem since it is not obvious whether X-inefficiency is more or less likely to be present in union or non-union firms. This suggests that firm size is likely to be of importance in isolating the source of union productivity effects since it is mainly large firms which suffer from poor communication channels resulting from the hierarchical nature of managerial structure within the firm. It should also be noted that the institutional idea that large non-union firms have some form of collective organisation and as such behave in a similar way to large unionised firms creates something of an identification problem in attributing union productivity effects to differences in X-efficiency between union and non-union firms. The implication of this for the empirical work is that one must be careful not to confuse a productivity advantage (or disadvantage) accruing from economies of scale with a union impact on productivity working through notions of X-inefficiency.

Whilst the nature of the production process is obviously a relevant factor in determining productivity levels an importance can also be attached to the nature of labour force adjustment in union and non-union firms. For example, it has been argued that lower labour turnover and quit rates among unionised workers reduces costs and may lead to productivity gains in unionised firms. On the other hand, it may also be that union "equality of opportunity" policies (such as seniority rules) could prevent more ambitious workers from climbing the promotion ladder thus resulting in a potential reduction in productivity. These several possibilities, taken in conjunction with the standard predictions of the monopoly union model that the union wage effect causes a substitution from labour to capital, from unskilled to skilled labour (since unionised workers have a greater job attachment then firms are more likely to invest in training thus raising the average skill ratio) and raises product prices for unionised firms, suggest that the direction of the union impact on productivity is not obvious. Indeed the diversified nature of these possible sources also makes it clear that some are more likely to be applicable than others to certain firms and certain

industries.[4] Thus to answer whether unions raise, lower or have a neutral influence on productivity it is necessary to confront these issues with data and this is the purpose of this paper, namely to analyse the influence of trade union activity on productivity in a sample of firms operating in a sector of British manufacturing industry.

The basic methodology used in the union-productivity literature (see for example the seminal work of Brown and Medoff(1978)) and in the closely linked empirical work on participation (see for example Cable and Fitzroy(1980)) is to estimate a Cobb-Douglas production function augmented by variables indicating characteristics of the production unit under consideration. Consider the following Cobb-Douglas production technology which (as in Brown and Medoff) is amended to allow one to draw the distinction between unionised labour (L_u) and non-unionised labour (L_n),

$$Y = AK^{\beta_1}(L_n + cL_u)^{\beta_2} \tag{2.1}$$

where Y is output, K is capital, A is a technical efficiency parameter and β_1 and β_2 denote the elasticity of output with respect to capital and labour respectively.

If $c>1$ (<1) this implies unionised workers are more (less) productive than their non-union counterparts. Rearranging equation (2.1) gives

$$\ln Y/L = \alpha + \beta_1 \ln K/L + (\beta_2 + \beta_1 - 1)\ln L + \beta_2(c-1)U \tag{2.2}$$

where α is a constant term, $L = L_u + L_n$ and $U = L_u/L$.

This is simply a re-arranged production function allowing for non-constant returns (when $\beta_1 + \beta_2 \neq 1$) and includes a union variable (U) as a determinant of labour productivity. Therefore the basic method of discriminating between productivity levels in unionised and non-unionised establishments is to estimate equation (2.2) supplemented by a number of control variables. The latter are included since the objective of the productivity studies is to determine the impact of unionisation on worker productivity in an otherwise comparable firm. In convenient notation this can be expressed for the ith firm as,

[4] For a more detailed discussion of these and more possible sources of union productivity effects see, among others, Brown and Medoff(1978), Freeman and Medoff(1984) and Hirsch and Addison(1986).

$$Y_i = \alpha + X_i'\beta + Z_i'\gamma + U_i'\delta + \varepsilon_i \tag{2.3}$$

where Y is the logarithm of value added per employee, X is a vector of logarithms of factor inputs (i.e. $ln(K/L)$ and lnL), Z is a vector of additional control variables and U is a (scalar) measure of union presence. The subscript i denotes the ith production unit, α is a constant term and ε a random error.

The variable U is generally either a 1-0 dummy indicating union or non-union status or a continuous measure of union density or the extent of coverage by collective bargaining agreements either within the production unit or in its operating industry. In this formulation the productivity differential between unionised and non-unionised firms is the coefficient δ (or $1-\exp(\delta)$ if U is a binary variable). It may however be that simple use of a single indicator of union presence may not tell the whole story and that consideration of more than one indicator may be more appropriate. Whilst several indicators could be entered into the production function as individual arguments they are likely to be correlated with one another (some more heavily than others) such that results from entering them simultaneously might result in misleading inferences being drawn from the results. It is also true that, in studies such as this where the sample size is fairly small, degrees of freedom limitations prevent inclusion of several indicators especially when interactions between determinants of value added per employee and indicators of unionisation are to be considered. Similarly, a deficiency of the data set to be used in the present study is a lack of information on trade union recognition : this prevents any meaningful union non-union distinction to be drawn and makes a greater need for some appropriate measure of union presence to be derived. Therefore it is proposed to include an index V which is a linear combination of the various components and may be defined as $V = \sum_{i=1}^{s} \phi_i v_i$ where v_i is the ith component, ϕ_i is the weight attached to v_i and there are s components in all. In some respects this is similar to the labour attitude index calculated by Norsworthy and Zabala(1985a,1985b) and in ideas to Katz, Kochan and Gobeille's(1983) study of Quality of Working Life programmes in the U.S. The difference in the Norsworthy and Zabala approach is their use of a translog index which includes second order interactions between the v_i. However in the present study it is preferred to stick with the first

order specification since it is considered that estimation of a full translog model is asking a lot of the data. The main practical problem in constructing V is to ascertain the appropriate weights ϕ_i. As Cable(1985) has noted one obvious point is that choice of weighting structure is somewhat arbitrary and that this may enable researchers to effectively 'get the results they want'. Hence, rather than simply assigning some arbitrary values to ϕ_i, the index is to be constructed as a linear combination of the v_i using the weights implied by the first principal component of the variance covariance matrix of the various constituents of the index.[5]

As a further econometric point, several studies considering the effects of unions on relative wages have stressed the importance of examining interactions between the union variable and the independent variables (see Mellow(1983) or Stewart(1983b)). Thus it may also be interesting to examine whether interactions between the independent variables and the index V are important. That is to say, the analysis to date allows the union effect to operate through the intercept term in the production function. It is however perfectly feasible for unions to influence the slope coefficients. Obviously it is important to see whether or not the results from the interactive model differ to those from the case where the union effect manifests itself as a shift in the intercept term. If the union productivity effect obtained by using V rather than U in equation (2.3) is defined as D then if interactions are included between V and the explanatory variables say Q where $Q = [X, Z]$ then an average union effect will be $\vec{D} = \hat{\delta} + \bar{Q}'\hat{\rho}$ where a bar denotes a mean value and $\hat{\rho}$ is the vector of coefficient estimates on the interaction terms V^*Q. By partitioning the covariance matrix to obtain $\hat{f} = Var(\hat{\xi})$ where $\xi = [\delta, \rho]$ an asymptotic standard error for the union effect can be calculated as $ase(\vec{D}) = (\bar{M}'\hat{f}\bar{M})^{1/2}$ where $M = [1, Q]$.[6]

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[5] See Pencavel(1974) for a similar approach used to calculate an index of industrial morale from information on quits, strikes, absenteeism and accident rates in British coal mining. It should however be noted that use of principal components is not without difficulties. For instance it is necessary that the variables to be transformed have variances of similar size and that scaling of the data may influence the weighting values. However, given that the four indicators to be used are all bounded by 0 and 1 this is not a problem in this study. It should also be noted that use of the first component weightings alone ignores the other $(s-1)$ components. If the first component explains a significant amount of the variance in V then this is reasonable. If however it only explains a small proportion then use of only the first component may be questionable. See Jolliffe(1986) for further details.

[6] Note that the index V is scaled such that it lies in the [0,1] interval so that a non-union situation can be compared with one which has maximum union presence, or alternatively collective voice, where V equals unity.

3. Institutional Background and Data Description.

The production function is to be estimated from a sample of fifty two British engineering firms over the period 1978-82. The source of the data is an ESRC financed survey conducted by J.Cable and N.Wilson. The nature of the data is that time-varying information is available on economic characteristics of the firm although structural characteristics (such as the unionisation variables) are available only in 1982. This precludes any consideration of the intertemporal relationship between unions and productivity (for example in a fixed effects model taking deviations from time means or differencing the data would eliminate the union variables from the estimating equation) and thus the analysis is to be performed on the basic pooled cross section assuming no change in structural characteristics over the five years.[7] Information on the means and definitions of the variables to be used are reported in the Data Appendix. Several important characteristics of the sample should be noted. Firstly, the mean of union density (UNION) suggests the sector under study is highly unionised and exceeds the national average for this period (about 50%-55% : see Price and Bain(1983)). Secondly, the engineering industry is also characterised by multi-unionism : for instance in 1978 23 manual and staff unions were affiliated to the Confederation of Shipbuilding and Engineering Unions which had an affiliated membership of some 2.5 million workers.[8] As Marsh et al.(1981) report the majority of manual union members in 1978 were in one of the following large unions : the Amalgamated Union of Engineering Workers (then the AEUW), the Transport and General Workers Union (TGWU) and the General and Municipal Workers Union (GMWU). Most non-manual employees were in the Association of Professional, Executive, Clerical and Computer Staff (APEX), the Association of Scientific, Technical and Managerial Staffs (ASTMS) and the Technical and Supervisory Section (TASS) of the AEUW. This trend of multiple unionism is borne out in the current sample where a number of firms have

[7] The instrumental variables methodology of Hausman and Taylor(1981) does allow one to obtain the effects of a time invariant variable whilst allowing for the panel nature of the data. However, in the present analysis, the large number of time invariant variables in the data set make things somewhat difficult. All the same a set of Hausman-Taylor estimates were obtained using the time mean of the employment size of the workforce as an instrument for the unionisation index. Results were similar (although sensitive to choice of different instruments) to those obtained from applying least squares to the pooled data and thus the issue was not pursued any further.

[8] It should however be noted that these unions are not solely confined to engineering and are predominantly amalgamated unions.

more than one shopfloor and staff union, as depicted by the variables NSHOP and NSTAFF. Thus four components are to be used to form the union presence index : the union density variable, the two multiple unionism variables and a variable indicating whether a closed shop is present (CLOSED). The correlation matrix of the four components is reported in Table 1 and Table 2 reports the weights derived as the scaled first principal component of the appropriate covariance matrix.[9] The first principal component accounts for some 47.8% of the variation in the four variables and it is also interesting to note that all four weights are positive. Thus the strongest measure of union presence occurs for a firm with 100% union membership, a closed shop and multiple staff and shopfloor unions. This clearly conforms with the institutional background discussed above.

The dependent variable to be used in the empirical analysis is value added per employee where value added is deflated by an appropriate industry level price index (Source : Monthly Digest of Statistics). This deflation is necessary to prevent confounding a union productivity effect with a union induced price effect. Obviously to the extent that the price index is mismatched then the estimated union effect on productivity will be contaminated by price effects. This possible contamination is obviously not a trivial one although the only way to circumvent it is to have some kind of physical output measure which cannot contain any price effects : for instance, Clark's(1980) analysis of the U.S. cement industry uses tons of cement as an output measure. However, such physical measures are for the most part not appropriate to firms operating in the engineering sector of British industry and even in those cases where they are relevant are not readily available for use. Therefore, the possibility of any price effects entering the analysis is one which must be acknowledged and dealt with in the best way possible given the available data, namely the deflation of value added referred to above. Since a Cobb-Douglas specification is to be used, the log of the capital to labour ratio $\ln(K/L)$ is included to control for capital-labour substitution occurring as a response to union wage effects. To allow for non-constant returns to scale it was found that a dummy variable indicating whether a firm has more than 1000 employ-

[9] To obtain the unscaled weights it is simply necessary to multiply each weight by 1.227.

TABLE 1

Correlation Matrix of Union Presence Indicators.				
	UNION	CLOSED	NSHOP	NSTAFF
UNION	1.000			
CLOSED	0.652	1.000		
NSHOP	0.180	0.230	1.000	
NSTAFF	0.397	0.071	0.385	1.000

TABLE 2

Estimated Weights used in Union Presence Index.	
Indicator	Estimated Weight
UNION	0.156
CLOSED	0.258
NSHOP	0.310
NSTAFF	0.277

Notes.

(i) Calculated weights are those suggested by the first principal component of the covariance matrix of the four indicators and re-scaled such that the index based on the weights lies in the 0-1 interval.

ees ($L \geq 1000$) worked best.[10] The importance of variables indicating worker participation and involvement in decision making are often recognised as being important for productivity (see for example Jones and Svejnar(1985)). Results in an earlier version of this paper included in the production function dummy variables indicating whether the firm has any quality circles, a works council, a cash based profit sharing or value added scheme or a share option scheme. Unfortunately, however, these variables are only available as a single observation and as such exhibit no time series variation and, when modelled as dummy variables, give no indication as to the relative importance of these functions in each firm. Thus it is not possible to judge whether a positive coefficient on such variables indicates whether progressive already productive firms are introducing these functions or whether they have been introduced and are instrumental in raising productivity. Similarly it is not clear whether a negative coefficient means a need has been identified or whether they are actually damaging productivity. Thus instead of including all four of these 0-1 variables it is preferred to use a variable (BONUS) which does indicate the relative importance of one of these functions across firms, namely the percentage of wages that is paid, on average, in the form of a profit sharing or value added bonus. This is for the most part a small percentage although does reach as high as 10% in some of the firms in the sample. Whilst this still suffers from some of the problems discussed in the context of the other four variables it does exhibit cross firm variation and may be viewed as a proxy either for progressive management or perhaps for the productivity gains that might accrue from the incentive effects of having workers' pay linked to the performance of the firm. Finally variables indicating the production technology used by the firm are included : these are dummy variables indicating whether the dominant mode of production is by job (JOB) or using flow lines (FLOW) compared to a base of batch production methods and the proportion of skilled workers in the manual workforce (SKILL) so as to ascertain the productive quality of the workforce.

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[10] The usual practice is to simply include lnL as an explanatory variable. Inclusion of lnL did produce qualitatively similar results (although not as strong statistically as the dummy) although, as the empirical work to follow shows, it is attractive to model some kind of small firm to large firm decomposition especially in the light of the theoretical discussion undertaken in Section 2.

4. Estimates of the Union Productivity Effect.

The discussion in Section 2 highlighted that determination of the sign and magnitude of the trade union impact on productivity is largely an empirical issue. Thus to explore these issues in the context of British engineering firms estimates of augmented production functions are presented in Table 3. In the first two columns the parameters of the production function are allowed to differ with the degree of unionisation (as measured by the union presence index in equation (1) and the closed shop dummy in equation (2)) via the interaction terms which are statistically supported against the null hypothesis of a model which simply allows for an additive union effect, the relevant $\chi^2(6)$ statistics being 18.80 and 23.79 respectively. Columns (3) and (4) allow the parameters to differ between large and small firms and again the interactive model is preferred to a specification including a large firm dummy alone, the appropriate $\chi^2(4)$ statistics being 14.70 and 21.45.

The specifications in Table 3 identify a number of determinants of productivity, a number of which have differing impacts conditional on the degree of unionisation and firm size. Considering initially equations (1) and (2) non-union firms are more likely to have higher productivity if they have in excess of 1000 employees, more sophisticated production technologies (as measured by the flow lines variable) and a higher proportion of skilled workers. As the degree of unionisation increases with higher values of INDEX in column (1) the positive effect of the skill variable remains but the flow lines variable actually exerts a negative effect as does the other technology variable JOB. This suggests that if unions are able to exert some control over production technologies then they may be able to reduce productivity through the likes of overmanning and restrictive work practices. Also, if employees are paid a higher profit sharing bonus unionised firms may be more productive, compared to the non-union situation where no such effect was observed.[11] This supports the arguments aired in Gregg and Machin(1988) who suggest that profit sharing is likely to have differing impacts in unionised and non-unionised situations.

[11] Either that or firms with a more progressive management strategy, as proxied by the flexible payment scheme variable, in conjunction with union presence are more productive. This may conceivably be viewed as a proxy for the idea that cooperative industrial relations practices may raise productivity.

TABLE 3

Estimates of the Impact of Unionisation and Firm Size on Labour Productivity.					
Equation No.	(1)	(2)		(3)	(4)
	U=INDEX	U=CLOSED		U=INDEX	U=CLOSED
Constant	8.309(0.457)	8.056(0.407)	Constant	8.902(0.362)	8.977(0.323)
ln(K/L)	0.054(0.058)	0.075(0.053)	ln(K/L)	-0.021(0.048)	-0.027(0.046)
$L \geq 1000$	0.364(0.174)	0.095(0.071)	$L \geq 1000$	-1.603(0.910)	-1.838(0.854)
BONUS	-0.026(0.016)	0.032(0.012)	BONUS	0.008(0.007)	0.010(0.006)
JOB	0.202(0.121)	0.091(0.074)	JOB	-0.058(0.076)	-0.078(0.074)
FLOW	0.735(0.228)	0.231(0.081)	FLOW	0.031(0.137)	0.106(0.097)
SKILL	0.400(0.160)	0.502(0.134)	SKILL	0.469(0.114)	0.471(0.113)
U	0.651(0.838)	1.304(0.532)	U	0.053(0.075)	-0.002(0.054)
U*ln(K/L)	-0.078(0.096)	-0.148(0.068)	$L \geq 1000$*ln(K/L)	0.211(0.106)	0.231(0.101)
U*$L \geq 1000$	-0.620(0.240)	-0.324(0.105)	$L \geq 1000$*U	-0.444(0.193)	-0.369(0.095)
U*BONUS	0.079(0.026)	0.002(0.014)	$L \geq 1000$*BONUS	0.058(0.021)	0.062(0.021)
U*JOB	-0.813(0.297)	-0.730(0.117)	$L \geq 1000$*JOB	[a]	[a]
U*FLOW	-1.297(0.391)	-0.218(0.147)	$L \geq 1000$*FLOW	[b]	[b]
U*SKILL	0.031(0.305)	-0.126(0.172)	$L \geq 1000$*SKILL	-0.001(0.265)	-0.086(0.243)
R^2	0.161	0.191		0.145	0.183
logL	-118.86	-114.06		-120.91	-115.23
N	260	260		260	260

Notes.

(i) The dependent variable is the log of (deflated) value added per employee : its mean is 9.005.

(ii) Heteroskedastic consistent standard errors are in parentheses.

(iii) [a] denotes that in the case of JOB only two observations were characterised by a firm having 1000 or more employees which meant that the remaining three observations for that firm corresponded to less than 1000 : thus the interaction was omitted.

(iv) [b] denotes that all firms with FLOW equal to one have 1000 or more employees : thus the interaction term $L \geq 1000$*$FLOW$ would, if entered, be perfectly collinear with FLOW and was thus omitted.

TABLE 4

The Relationship Between Union Productivity Effects and Firm Size.				
Based on Equation No.	Average Union Non-Union Effect	Average Large Firm Small Firm Effect	Average Union Non-Union Effect in Small Firms	Average Union Non-Union Effect in Large Firms
(1)	-0.105(0.066)	0.050(0.073)	0.064(0.077)	-0.556(0.204)
(2)	-0.159(0.048)	-0.069(0.052)	-0.070(0.050)	-0.394(0.098)
(3)	-0.068(0.076)	0.029(0.078)	0.053(0.075)	-0.391(0.182)
(4)	-0.103(0.046)	-0.033(0.055)	-0.002(0.054)	-0.372(0.080)

Notes.

(i) These effects are calculated by setting INDEX/CLOSED and the large firm dummy equal to 1, 0 or mean values where appropriate and all the other variables are set to mean values. Variable means are reported in the Data Appendix.

(ii) Asymptotic standard errors, calculated using the methods of Stewart(1987) and described in Section 2, are in parentheses.

Finally large highly unionised firms are not likely to have the productivity advantages that scale economies give to large non-union companies relative to their smaller counterparts. The effects in equation (1) are largely similar for the closed shop measure in equation (2) with the exception of the flow lines and profit sharing effects. Again of considerable interest is the strength of the negative coefficient for large firms with a closed shop. In the third and fourth equations this scale effect is again observed where larger unionised firms are at a productivity disadvantage compared to both smaller firms and non-unionised large firms. Also profit sharing and a higher capital to labour ratio only seem to exert an influence in larger firms. Finally the skill ratio is positively related to productivity but no additional advantages accrue to larger firms.

The major result emerging from Table 3 seems to be that union effects on productivity interact in an important way with firm size, at least in the context of this data set. Consequently the average union non-union and large firm small firm effects on productivity deduced from the models in Table 3 are reported in Table 4. Also reported is the average union non-union effect among larger and smaller firms derived from equations (1) and (2) and an analogous measure derived from equations (3) and (4). The effects deduced from both models point to the same conclusion : the average union non-union effect among larger firms is always negative and statistically different from zero. On the other hand, productivity levels do not seem to differ with the degree of unionisation among smaller firms. Similarly scale effects are unimportant unless a firm is highly unionised since the productivity difference between large and small firms across the whole sample is always insignificant at any reasonable level of significance. Thus negative union productivity effects only occur in larger firms and in firms with less than 1000 employees the effect of trade unions is largely innocuous.[12]

The results to date are strong evidence to suggest that trade union effects on productivity in this sample of engineering firms are significantly negative among large firms but insignificant among the rest. However, they yield little information about the distribution of these effects over the firms in the sample. Thus it is also of interest to calculate union productivity effects for each

[12] These results are not sensitive to the inclusion of either a set of industry dummies or time dummies or both in the specifications in Table 3 : these results are available on request.

firm. Table 5 presents a summary of such a procedure and illustrates that the effects (which are averaged over the five years for each firm) vary quite considerably about the average differential. In terms of the overall sample the productivity effects deduced from the unionisation index, reported in the upper part of Table 5, suggest that nine out of fifty two firms are characterised by statistically significant positive union effects and eleven by statistically significant negative effects. Thus, despite an overall insignificant union effect, in a considerable percentage (38.5%) of firms in the sample trade unions significantly influence productivity levels. This wide ranging dispersion of union productivity effects supports the idea that no one fixed rule holds for gauging union effects on performance : even in this sample of fairly homogenous firms the deviations from the average are substantial. Given this considerable variation it seems particularly important to attempt to isolate the source of these effects and Table 5 breaks down these union effects by a number of variables and examines the distribution of the significance of the effects in each sub-sample. The results are quite striking. None of the positive effects are located in firms with more than 1000 employees. Also, paying employees a profit sharing bonus features strongly among the firms with significantly positive union effects as all nine have some kind of cash based sharing scheme. This can be viewed as evidence for Weitzman's(1984) advocacy of the potential for performance linked pay to raise productivity, at least in unionised circumstances.[13] Turning to the eleven significantly negative effects they are mostly located among large firms and, of the two firms with flow lines as their dominant production mode, both are among them. Similarly half of those firms in the sample whose production method is mainly by job are in the significantly negative region. No discernible pattern emerges with respect to the three union dummies CLOSED, NSTAFF and NSHOP although it can be seen that positive productivity effects are possible even in the confines of closed shop firms. It is therefore not being unionised alone which reduces productivity nor is it being in a large firm : what implies a negative union influence on productivity is being both large and highly unionised.

[13] See also Wadhwani and Wall(1988) who provide evidence to show that profit sharing raises productivity in a sample of large highly unionised British companies.

TABLE 5a

Estimated Union Productivity Differentials for each firm - based on INDEX.					
Sample	Number of firms	significantly negative	insignificantly negative	insignificantly positive	significantly positive
All firms	52	11	11	21	9
$500>L$	27	2	5	15	5
$500\leq L<1000$	11	1	1	5	4
$L\geq 1000$	14	8	5	1	0
BONUS>0	21	2	5	5	9
JOB=1	6	3	2	1	0
FLOW=1	2	2	0	0	0
CLOSED=1	25	5	3	12	5
NSTAFF=1	21	7	5	4	5
NSHOP=1	25	8	6	6	5

TABLE 5b

Estimated Union Productivity Differentials for each firm - based on CLOSED.					
Sample	Number of firms	significantly negative	insignificantly negative	insignificantly positive	significantly positive
All firms	52	17	19	13	3
$500>L$	27	6	10	9	2
$500\leq L<1000$	11	1	5	4	1
$1000\leq L$	14	10	4	0	0
BONUS>0	21	7	7	4	3
JOB=1	6	6	0	0	0
FLOW=1	2	2	0	0	0
CLOSED=1	25	7	10	7	1
NSTAFF=1	21	8	5	5	3
NSHOP=1	25	11	9	3	2

Notes.

(i) The upper panel is calculated from equation (1) and the lower panel from equation (2) in Table 3.

(ii) Since the number of employees in the firm varies over time a firm is denoted as small, medium or large according to which category it is located in most over the five years.

(iii) Significance levels are based on two tail tests at the 5% level of significance.

Individual firm union productivity effects based on the closed shop are reported in the lower panel of Table 5. For the most part they tend to confirm the picture emerging from the effects on productivity deduced from the index, although fewer firms have statistically significant positive effects and more have significant negative effects. As with the index none of the larger firms have positive effects and the negative union effects associated with the JOB and FLOW variables again emerge as does the location of performance related bonus payments in the positive part of the distribution. No clear-cut relationship ensues from the consideration of the three discrete indicators of union presence CLOSED, NSTAFF and NSHOP. Thus the implications of the results based on the closed shop also indicate that firm size is a major determinant (along with the nature of the production technology and the presence of performance linked pay) of the union productivity effect in this data.

The main result emerging from this analysis is that trade unions have no damaging effect on productivity unless they are located in firms with more than 1000 employees in this sample of fifty two engineering firms. No claims to generalise this result outside of this sample are made here, especially noting the traditional strength of union activity in this sector of British manufacturing. It is also clear that simply being a large firm without union presence implies no productivity disadvantage. Neither is it purely being a unionised firm that results in negative effects. However the importance of unionisation and large firm size taken hand-in-hand suggests that the explanation could be greater X-inefficiency in unionised large firms. On the other hand it might be that in the presence of managerial hierarchies where there exist greater communication problems (i.e. in large firms) unions are able to push the frontiers of control outwards thereby placing more formal structures on work practices, manning levels and so on. Thus the productivity disadvantage faced by larger unionised firms may be attributed to the increased control over the functioning of the production process held by unions relative to the situation in smaller firms where management structures are more closely knit and less subject to informational difficulties.

5. Conclusions.

This paper presents evidence on British union productivity effects taking as a measure of union presence a combined measure of a number of indicators of unionisation. The analysis finds that union effects on labour productivity in the average firm are insignificantly different from zero. However, union effects in firms with over 1000 employees are found to be significant and negative when using either the index or a dummy variable indicating whether the firm has a closed shop to model union presence. Trade union effects are on average found to be neutral for the remainder of the sample. Union non-union effects are also calculated for each firm (averaged over the five years) and are seen to exhibit a considerable variation around the average. This is similar to Stewart's(1983a) finding that the union non-union wage differential varies considerably although the present analysis is based on a far smaller database. Whilst in terms of generalising the results the small and specific nature of the sample is a disadvantage its main advantage is to show that union effects may vary considerably across a relatively homogenous group of firms. This is especially interesting given that a great deal of the now accepted industrial relations orthodoxy was based on case studies of various plants and firms operating in this particular sector of British industry. The analysis also attempts to isolate this variation and it is found that scale economies, the nature of the production technology and paying employees some kind of performance related bonus are important in explaining the influence of unions on labour productivity. The particularly strong result emerging from the analysis is that, at least in this sample, positive union productivity effects are only likely to occur among relatively small firms. Whether this is due to increased X-inefficiency in large unionised firms or due to the increased control over the workings of the production process held by unions in large firms unfortunately cannot be untangled from the empirical results. As a final point, it is not entirely surprising that the U.S. results indicating that unions raise productivity in general are not mirrored using British data. This is especially true given the traditional adversarial relationship between British unions and management compared to the U.S. situation where cooperative industrial relations and business unionism are more the order of the day.

DATA APPENDIX.

Descriptions and Means of Explanatory Variables.		
Variable	Description	Mean
ln(K/L)	log of the capital to labour ratio - the capital input is fixed assets at book value deflated by an annual price index (1980=1) for the price of fixed assets.	8.189
L	Number of employees in the firm.	1153
BONUS	The average percentage of wages paid as a profit sharing or value added bonus.	2.199
JOB	Whether the dominant mode of production is by job.	0.115
FLOW	Whether the dominant mode of production is using flow lines. (Base group is batch production methods)	0.038
SKILL	The proportion of the manual workforce that are skilled.	0.559
UNION	Proportion of employees who are members of a union	0.784
CLOSED	Whether the firm has a closed shop	0.481
NSHOP	Whether there is more than one shopfloor union	0.481
NSTAFF	Whether there is more than one staff union	0.404
INDEX	Union presence index	0.507

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