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Trade Unions and Productivity: Conventional Estimates
Les syndicats et la productivité

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Résumé de l'article

Bien que la question de l'effet des syndicats sur la productivité ait fait l'objet de recherches depuis longtemps, les études sur le sujet sont plutôt rares et plusieurs problèmes demeurent sans réponse. Même si bien des motifs expliquent un tel état de choses, le plus important est sans doute de définir et de mesurer la productivité. Nombre de spécialistes divergent d'avis sur les moyens de l'apprécier. En outre, la question est essentiellement empirique, puisqu'il existe d'abondants arguments qui concluent les uns à un effet positif et les autres à un effet négatif. De plus, les statistiques dont on dispose pour porter un jugement manquent généralement, en particulier lorsqu'il s'agit de comparer celles qui proviennent des entreprises syndiquées et de celles qui ne le sont pas. Dans le cas du Canada, ces données sont de qualité douteuse.

Pour cette raison, la plupart des études portant sur l'effet du rôle des syndicats en ce qui concerne la productivité prennent de par leur nature même la forme d'études de cas. En conséquence, si l'on s'intéresse aux effets macro-économiques des syndicats, on risque d'en arriver à des conclusions erronées. Ainsi, une entreprise, où il n'existe pas de syndicat, peut modifier ses techniques de production dans un effort en vue d'empêcher la syndicalisation ou au moins en diminuer les conséquences si elle se produisait. Par ailleurs, si des firmes syndiquées deviennent plus productives à cause de la syndicalisation, il peut arriver que d'autres qui ne le sont pas changent leur technologie de production pour empêcher une diminution des ventes.

Ces motifs font voir que c'est une chose désirable de mesurer l'effet de la productivité pouvant découler de l'action syndicale au point de vue général, mais ils en montrent en même temps toute la difficulté.

L'article veut apporter une double contribution aux études qui ont portées sur le sujet en discutant les questions et les concepts en jeu. Par la critique qu'il fait de certains travaux récents, il ouvre des voies nouvelles vers une recherche future, car il faut convenir qu'il est besoin de beaucoup d'études additionnelles avant de pouvoir affirmer que l'on comprend les effets des syndicats en matière de productivité. Ceci exige naturellement une augmentation considérable du nombre des données statistiques.

Trade Unions and Productivity:
Conventional Estimates

Dennis R. Maki

This paper discusses the issues and concepts involved here, criticizes recent studies and suggests an agenda for future research. The author also presents some empirical results pertaining to Canadian manufacturing.

Although the question of the effect of trade unions on productivity has been researched for a long time,[1] the literature on the subject is still scanty, and many unanswered questions remain. While there are many potential reasons for this state of affairs, surely the most important must be the conceptual difficulty of defining and measuring productivity in the first place, with even leading experts in the area disagreeing about current practice[2]. Further, the question is basically an empirical one, since there exist abundant theoretical arguments for both positive and negative effects, but data appropriate for investigating the question are generally lacking. In particular, factor share data for union versus nonunion labour are not available, and even unionization data are highly aggregated and of dubious quality, at least in the Canadian case[3]. Partially for this reason, most of the empirical work on the effect of unions on productivity has been of a case study nature[4]. However, if one is interested in the more macroeconomic effects of unions, case study results can lead to erroneous conclusions because of the potential existence of various spillovers[5]. For example, nonunion

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1 BOK and DUNLOP (1970) report economists have debated the question "for more than a century and a half". Quoted in BROWN and MEDOFF (1978).

2 See comments by JORGENSEN (1980).

3 The same comments about the nature of the data probably pertain to the U.S. For example, the unionization estimates presented by FREEMAN and MEDOFF (1979), contain a large number of industries for which union membership exceeds covered workers, a logical possibility, but highly unlikely circumstance.

4 As noted by BROWN and MEDOFF (1978, p. 355), who present more aggregated analysis. For a recent case study approach, see CLARK (1980).

5 Spillover effects of unionization have been noted and discussed in the literature dealing with the effect of unions on wages. Analogous arguments would seem to apply in the case of productivity. See STARR (1973) for a lucid discussion.

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firms might change their production technology in an attempt to prevent unionization or at least minimize the effects if it should occur — a sort of "threat effect". Another sort of spillover could occur if, e.g. unionized firms became more productive due to unionization,[6] then their nonunion competitors in the product market may be forced to change their production technology to prevent loss of sales. While these arguments point to the desirability of measuring the productivity effect of unions at some aggregate level, they also suggest the difficulty of doing so.

This paper makes two contributions to the literature in this area. First, a discussion of the issues and concepts involved, together with a critique of recent studies, suggest an agenda for future research. Second, some empirical results pertaining to Canadian manufacturing are presented.

POTENTIAL EFFECTS OF UNIONS ON PRODUCTIVITY

Since the main arguments are summarized elsewhere,[7] only a brief review of the highlights is presented here. Rees (1963) has presented an excellent statement of the detrimental effects of unions on output (and hence productivity) in the perspective of the usual neoclassical paradigm. There are two main effects. First, by raising wages in unionized firms above those in nonunionized firms, assuming unionized employers respond by increasing the capital-labour ratio and the nonunion labour market is competitive,[8] unions cause reallocation of labour from higher to lower marginal productivity employment. Second, various work rules negotiated by unions, ranging from the infamous "make work" and "feather-bedding" practices to simple seniority systems, may prevent employers from selecting their profit maximizing (most efficient) production technology. While some more "sociologically oriented" writers have questioned the validity, even for analytical as opposed to policy purposes, of comparing a partially unionized world with a competitive ideal which never has and probably never could exist in practice,[9] the two arguments presented above form the theoretical base for expectations of a negative effect of unionization on productivity.

The arguments for a positive effect are more eclectic. One argument, compatible with Leibenstein's (1966) concept of X-efficiency but not

6 This is the sign of the effect found empirically by BROWN and MEDOFF (1978) and CLARK (1980), but it is used here purely for illustrative purposes.

7 See, for example, BROWN & MEDOFF (1978).

8 This is a sufficient, but not necessary set of assumptions. Several other "stories" lead to the same conclusion.

9 See MACDONALD (1966).

necessarily derived from it, contends that when faced with higher production costs due to unionization, management is "spurred" to make changes in operations which exploit previously ignored opportunities to increase profits, and this more than offsets the direct negative effects of unionization on productivity. Another argument notes that the advent of increased fringe benefits, seniority systems and grievance procedures, assumed to coincide with unionization, increases worker motivation and hence productivity. A more tangible variant of this argument notes that unionization appears to reduce voluntary turnover,[10] increasing worker experience and the willingness of employers to provide training, both of which might increase productivity.

Even given this abbreviated list of potential effects, it is clear that the overall effect of unions on productivity is an empirical question. It is also clear that, for purposes of testing theoretical implications, there are a number of other, potentially more interesting, empirical questions. In essence, whatever the overall effect, what are the magnitudes of the separate positive and negative effects, and from what causes do they follow?

CONSIDERATIONS REGARDING PRODUCTIVITY DEFINITIONS

Thus far, we have used the term "productivity" as if it were a well defined concept. In reality there are many possible definitions of productivity, labour versus total factor productivity, for example; and marginal versus average concepts. Further, as May and Denny (1979, page 764) point out, "It is quite possible that an industry with relatively high productivity using one measure has relatively low productivity using a different measure." Finally, one can discuss productivity as a point in time concept, i.e., a scale parameter in some production function; or in dynamic terms, i.e. the rate of change of that parameter over time.

The choice of definition obviously depends upon the question of interest, and it should be noted that the effects noted in the previous section cannot all be investigated using the same measure. The concept of X-efficiency, for example, calls for some measure of total factor productivity (or perhaps some measure of management productivity), while departures from Pareto Optimality require measures of marginal labour productivity.

10 See FREEMAN (1977).

CONSIDERATIONS REGARDING PRODUCTIVITY MEASUREMENT

Recent studies have investigated the static form of productivity using a Cobb-Douglas form of production function[11]. The conventional use of this form of function does not allow testing of whether it is labour productivity or total factor productivity which is affected by unionization, though separate estimates are derivable[12]. This restrictive property of the Cobb-Douglas form is particularly bothersome in the present context. If the *only* effect of unions is to raise wages of covered workers, and employers respond by moving back along their derived demand curves until the marginal product of labour is equal to the new wage rate, the resulting increase in productivity is measured as "due to" unions. In a sense, this may be the case, but it is not a very interesting effect. Clark asserts (1980, p. 454), " the traditional effect of unionization on input ratios is assumed to be captured in changes in the capital-labour ratio...". It is easily demonstrated that this is not the case for a Cobb-Douglas production function. Illustrating with a simple constant returns to scale (CRTS) production function:[13]

$$Y = AL^{(1-a)}K^{a} \tag{1}$$

where Y is output, L is labour input, K is capital input and A and "a" are parameters. Equating marginal products to factor prices, w and r for labour and capital, respectively, yields:

$$\delta Y / \delta K = aA\,(L/K)^{(1-a)} = r \tag{2}$$

$$\delta Y / \delta L = (1-a)A(L/K)^{-a} = w \tag{3}$$

Assume a firm initially in equilibrium at values of w and r such that (2) and (3) are simultaneously satisfied. Then assume a union raises w to w' > w. Equality in (3) could be attained by raising (K/L) sufficiently, but this would destroy equality in (2). The only way both equations can be satisfied is to allow either A or "a" to change as well as (K/L), and the conventional solution has been to estimate an equation of the form:

$$\ln(Y/L) = b_0 + b_1 \ln(K/L) + b_2 U \tag{4}$$

11 BROWN and MEDOFF (1978) use pure cross-section data, and hence cannot investigate dynamic effects using their data base. CLARK (1980) chooses to model the effect of unions as a step function, i.e. a scale factor shift, rather than a change in the time trend. Clark also reports that experimentation with other types of production functions did not change the inferences derived.

12 See BROWN & MEDOFF (1978, p. 361). Assuming constant returns to scale, the productivity differential of union establishments is simply labour's share times the productivity differential of union workers.

13 Neither CLARK (1980) nor BROWN and MEDOFF (1978) found any basis for rejecting CRTS.

where U is same measure of unionization, i.e. to allow A to change. Since A is interpreted as the total factor productivity parameter, the conclusion of such an approach is that if unions manage to raise the price of labour relative to capital, and employers are not "forced off their demand curves", then unions increase total factor productivity. The contention herein is that it would be instructive to investigate functional forms that allow labour's share to change, instead of or in addition to total factor productivity[14]. An obvious corollary to this point is that we are concerned with total factor productivity, and not the investigation of the extent to which employers have been "forced off their demand curves" by unions.

Stated another way, we would like to investigate the nature of changes in the isoquant map caused by unionization, and are not very interested in simple substitution effects (movements along existing isoquants) or perhaps even movements from one isoquant to another in an existing map (scale effects). It is not clear how these questions may best be empirically investigated,[15] but it appears that functions more general than Cobb-Douglas, i.e. the translog, may offer a reasonable starting point. The translog may be viewed as a second order Taylor series expansion approximation of any unknown production function. For this reason, we include some estimations based on a translog form in the empirical section of this paper, though the impact of unionization was measured only in conventional ways.

Following Brown and Medoff (1978), one estimation was undertaken using a Cobb-Douglas function where labour's share was a linear function of unionization. This consisted of estimating a function:

$$\ln(Y/L) = b_0 + b_1 \ln(K/L) \tag{5}$$

The production function underlying this estimating equation is:

$$Y = Ae^{bu}K^{(a-cu)}L^{(1-a+cu)} \tag{6}$$

which assumes that labour's share increases linearly with U. When U = zero, the marginal conditions are still given by equations (2) and (3). When U = unity, the marginal conditions are:

$$\delta Y/\delta K = Ae^{bu}(a-cu)(L/K)^{(1-a+cu)} = r \tag{7}$$
$$\delta Y/\delta L = Ae^{bu}(1-a+cu)(L/K)^{(cu-a)} = w \tag{8}$$

If the introduction of the union raises the wage rate, equality of the marginal conditions can be attained with b greater than, less than, or equal

14 BROWN & MEDOFF (1978, p. 370) tested a functional form allowing labour's share to change, but did not report their results, stating that they could not estimate both effects with "any precision" due to collinearity.

15 See NADIRI (1970) for general discussion unrelated to the unionization question.

to zero, because two "variables" (the factor ratio and the constant c) are sufficient to satisfy two equations. Thus the effect of unions on total factor productivity, given by the coefficient b, is not constrained to be positive due to simple substitution effects. This estimation is not viewed as "the" solution to the problem, and is included merely to indicate the effect of relaxing the conventional assumption.

A second measurement consideration, which is the focus of the difference between Jorgensen and Mansfield,[16] is whether one measures changes in net productivity (output defined as value added and using only capital and labour as inputs) or gross productivity (output defined as shipments and using capital, labour and materials as inputs)[17]. Jorgensen's argument that the potential effects of rapidly changing energy prices in the 1970's mandate consideration of gross productivity is persuasive, but this approach requires more data than the net productivity approach. If the requisite data are not available, or if available, are of poor quality, the net productivity approach may be preferable. This point is elaborated below.

A third consideration relates to the degree of disaggregation by industry to be employed. This is of course partially determined by the question(s) of interest and data availability, but there are reasons to suspect aggregation bias may increase, and homogeneity of inputs decrease, with the degree of aggregation. Conceptually, dynamic productivity effects could be investigated using time series data at a very high level of aggregation, but investigation of static differences requires cross-section variability.

A fourth measurement consideration relates to the number of characteristics, other than the degree of unionization, which are to be simultaneously investigated. Mansfield (1980) considers expenditures on basic research and applied R & D as well as unionization as factors affecting productivity growth. Clark (1980) treats production workers and supervisory labour as separate inputs, and includes a variable measuring the rate of utilization of capital (a cyclical factor proxy). Brown & Medoff (1978) include a variable measuring the "recentness" of the capital stock (a vintage effect proxy) as well as introducing regional control variables to capture the geographical concentration of different industries. All of these characteristics were found to be statistically significant in the various studies noted, and this brief review is of course not exhaustive of variables which could be considered. Given relatively small samples of available data,

16 See again the comments by JORGENSEN (1980).

17 The parenthetical definitions are only indicative of the difference in approaches. Shipments should be adjusted for inventory change, materials may be disaggregated to separate fuel and power, and other inputs such as research and development (R & D) efforts may be included.

multicollinearity would be expected to be a serious problem if a large number of these characteristics were to be simultaneously investigated.

A fifth measurement consideration is the question of adjusting the labour inputs for quality differences. As Clark notes:

> "the union wage effect gives firms incentive to recover costs by substituting higher for lower quality workers. The implication is that the capital-labour ratio must be adjusted for labor quality differences in order to identify the union impact due to organizational factors." (Clark, 1980, pp. 453-4).

Both Clark (1980) and Brown and Medoff (1978) go to some lengths (using very different approaches) to adjust for these quality differences, and both studies conclude that it makes very little difference whether the adjustment is made.

Finally, it should be noted that there is often more than one data series available as a measure of some variable, and more often there is no theoretically correct available series, and some proxy is used. As an example of the former case, net output can be measured as value added (say from the Census of Manufactures) or as gross domestic product by sector of origin (from the National Income Accounts). As an example of the latter problem, labour costs are often proxied by the wage bill, owing to lack of data on fringe benefit costs.

Given the considerations discussed in this and the preceding section it is apparent that the effect of unions on "productivity" can be measured in a large number of ways, and it is not clear theoretically that any one approach is "correct". Therefore, the contention herein is that a number of empirical investigations should be undertaken. If the findings from these are compatible, some consensus on the effects of unions on productivity may begin to emerge. If they are not compatible, some focus for needed theoretical work will hopefully become apparent.

The empirical estimates in the following section are presented in light of this position. They give some information about probable effects of unions on productivity; but are not defended as the only correct (or even the best possible) estimates. In particular, they use conventional approaches which impose restrictions between labour and total factor productivity estimates, except for the final estimate given as equation 11.

EMPIRICAL ESTIMATES — CONVENTIONAL FORMULATIONS

The nature of the estimations undertaken was conditioned partly on interest and partly on data availability. Recent studies of the effect of unions on the *level* of productivity[18] found a positive effect, while studies producing estimates of the effect of unions on the *rate of change* of productivity[19] found a negative effect. It was decided to concentrate on static effects in this paper, since the finding of a positive effect seemed intuitively less plausible than the results of the dynamic analyses. This necessitated the use of cross-section data. To increase the degrees of freedom available, it was decided to pool the data over time. At this point, data availability virtually dictated the sample. Unionization data by industry as published by the Department of Labour were reported under the 1948 Standard Industrial Classification (SIC) through 1966, although the data on value added, employment and so forth, as published by Statistics Canada, were reported under the 1961 SIC as of 1961. It is impossible to reconcile the 1948 and 1961 SIC codes for any reasonably comprehensive sample of industries, meaning that 1967 was the earliest year for which comparable data were available. The latest data available at time of writing were for 1977, and for all variables, only annual data are published. Finally, although all required data are available by the 3-digit SIC, the changeover from the 1961 to 1971 SIC again occurred at different time points for the unionization data from the Department of Labour versus the other series from Statistics Canada. Since the changes involved in the 1961 to 1971 SIC change do not seriously affect the 2-digit level of aggregation, it was decided to work at this level. Because of missing data problems in the unionization series, three industries: textiles, knitting mills and clothing industries, were combined into a single category. This yielded 17 industries for analysis, comprising all manufacturing industries except the "miscellaneous" category[20]. This yields 187 observations (17 industries for 11 years), but 4 observations (1967-70, inclusive, for non-metallic mineral products) had to be deleted because of missing unionization data. Hence all estimations reported herein are based on 183 observations of raw data.

There are two important results of this sample selection. First, estimates of effects based on variability over time versus estimates of effects based on cross-section variability may differ due to differences in data quality between the two dimensions[21]. Partly for this reason, some of the analysis is presented in the form of means over the eleven year period. The

18 CLARK (1980) and BROWN & MEDOFF (1978).

19 MANSFIELD (1980) and KENDRICK (1973).

20 A technical appendix listing the industries considered and giving detailed variable definitions and data sources is available from the author on request.

21 The unionization data in particular display considerable year-to-year variation around a trend. They apparently represent tabulations of returns of a questionnaire, with no adjustment for non-return. Since only the ratio, covered workers divided by total workers, is used, the problem *may* not be serious.

other point which should be noted is that there is no industry in the data set which was in any year less than 50 per cent unionized. Hence all we can estimate with reasonable confidence is the effect of an increase in unionization, in the range of 50 to 100 per cent. Given potential nonlinearities, it would be hazardous to make counterfactual predictions of what productivity "would have been" if unionization were zero, based on the data used herein.

Two considerations led to the use of a net productivity approach rather than a gross productivity approach. First, multicollinearity problems in the estimation of translog production functions increase severely as the number of inputs considered increases. More important, input price indices disaggregated to 2-digit SIC are not available, and the blanket application of price indices for manufacturing as a whole to all 2-digit industries would surely have produced very misleading results[22].

On the basis of presumed homogeneity of inputs, it was decided to define output as value added from manufacturing activity and labour input as production worker man-hours. Unionization rates pertain to non-office employees only. Data exist to perform the estimations on the basis of total activity[23]. Capital inputs were measured as total capital, despite previous studies showing that, at least for some purposes, one should disaggregate into structures versus equipment[24]. Data to perform this disaggregation are available. No adjustment for quality differences in the labour input were made prior to calculating productivity measures, largely on the basis of previously cited findings that such adjustments made little difference. Again, data for making at least crude adjustments are available. Finally, other factors, such as R & D expenditures, were not considered.

Using the data set selected, the null hypothesis tested was: H_0: Trade unions have no effect on the level of total factor productivity. This hypothesis was tested a number of ways, using both a Cobb-Douglas production function and a Translog production function. Within each of these functional forms, the effect of factors other than unionization was allowed for in some estimations by introducing intercept dummies for each industry (capturing any industry specific productivity effects which were constant over the period of analysis), and by introducing two types of time trends: (i) a simple overall trend, or (ii) a set of dummy variables for each year (capturing cyclical effects as well as nonlinear secular trends). For the translog

22 Consider, for example changes in the price of purchased inputs for petroleum refining as opposed to wood products, over the period considered.

23 Labour input would have to be measured on an employment basis, since hours data are not available for non-production workers.

24 See BERNDT and CHRISTENSEN (1973) and WOODLAND (1975).

form, some results are not constrained for Hicks' Neutral Technical Change (HNTC). These use a quadratic time trend with a time-factor ratio interaction term. The results based on Cobb-Douglas are reported in Table 1, and the Translog results in Table 2.

Following this, various productivity measures averaged by industry were calculated from the parametric estimates excluding the unionization variable. These results are reported in Table 3.

The next three subsections of this paper present a description of how the estimations were performed. Interpretation of the results is contained in the section following this presentation.

Estimates Based on the Cobb-Douglas Function

Several estimations were performed using a Cobb-Douglas production function constrained for CRTS. The first was simply to add U as a regressor in an equation with ln(Y/L) as function of ln(K/L). This can be justified either by following Brown and Medoff (1978) in assuming that labour productivity differs between union and non-union labour in such a manner that the ratio of the two marginal products is a constant, or by following Clark (1980) in assuming that unionization represents a shift in the total factor productivity parameter (intercept)[25]. Since a number of variants were estimated, the results are presented in tabular form in Table 1. Equations (1.7) through (1.9) are discussed in the section dealing with the industry average estimates.

Estimates Based on the Translog Function

A two-factor translog production function, constrained for CRTS and HNTC, can be written:

$$\ln(Y/K) = b_0 + b_1 \text{Time} + b_2 \ln(L/K) + b_3 \left[\frac{(\ln L)^2}{2} - (\ln L)(\ln K) + \frac{(\ln K)^2}{2} \right] \tag{9}$$

the term in square brackets is denoted SOTRM in Table 3 (mnemonically, "second order term"). Some estimates not incorporating a constraint for HNTC are also reported. This involves adding two terms to the right-hand-side of equation (9).

25 CLARK (1980) uses a dummy variable for unionization in his case study approach. His assumption must be extended to assume the logarithm of the scale factor increases linearly with U for present purposes.

$$b_4 \text{Time}\left[\ln(L/K)\right] + b_5\frac{(\text{Time})^2}{2} \quad (10)$$

If one assumes that unions affect the level of productivity in such a manner that the logarithm of the scale factor increases linearly with unionization, one can add U as a regressor in equation (9)[26]. Assuming that productivity levels differ among industries for reasons unrelated to unionization allows the incorporation of industry and year dummies. Estimations performed under various combinations of these assumptions are reported in Table 2.

Industry Average Estimates

In an attempt to find out how the various productivity measures implied by the different approaches taken were related to each other, industry average productivity measures were calculated. There are a total of 5 measures. The intercepts from equation (1.7) were denoted Pl, those from (1.8) were denoted P2, and those from (1.9) were denoted P3. The intercepts from equation (2.8) were denoted P4 and those from (2.11) were denoted P5.

Equations (2.7), (2.9) and (2.10) thus yield no direct or indirect measure of the effect of unions on productivity, and are reported only for comparison with other equations. The last two of these equations are not constrained for HNTC, and hence do not yield unique productivity indices.

The 5 productivity measures were then regressed on average unionization and a labour quality variable denoted LQ (results in Table 3). The labour quality variable, defined as the proportion of the employed labour force with more than 9 years of education, is a proxy for the measure of interest, since it is not restricted to production workers. There are two reasons why this proxy was used instead of mean years of education. First, at least in formal skill training programs with some form of government involvement, grade 10 completion is often a prerequisite for entry. Thus LQ measures the proportion of employees "trainable" for skilled jobs, which may be an appropriate measure of labour quality for investigating productivity effects. The second reason was based on the assumption that almost all workers with 9 years or less of formal education completed would be production workers, mitigating the measurement errors of not being able the measure educational attainment for production workers alone.

26 The BROWN & MEDOFF (1980) derivation using the assumption that the marginal product of union labour is some constant times the marginal product of nonunion labour does not lead to the addition of U as a regressor in equation (7). Incorporating this assumption would involve estimating under a set of non-linear restrictions on the coefficients.

INTERPRETATION OF RESULTS — CONVENTIONAL FORMULATIONS

No evidence of a negative effect of unions on productivity levels was found. Thus the question of whether H_0 should be rejected is a question of whether the effect is positive or zero. The estimates in Tables 1 and 2 indicate U is statistically significant in all equations which do not include industry dummies, and insignificant otherwise, except for equation (1.4) which includes industry dummies but no time trend variables. If one discounts equation (1.4) under the argument that some explicit recognition of productivity growth over time should be made, the results are consistent in finding that no significant effect of unions on productivity levels is obtained considering only pooled time series variability (ignoring interindustry variation). However, note that the coefficients of the union variable in all equations including industry dummies are positive and have t values in excess of unity.

Table 3 discloses that H_0 cannot be rejected on the basis of pure interindustry variation either, though it should be noted that these estimates are based on a small number of degrees of freedom, do display sign consistency, and t values for the unionization variable are in excess of unity except in the case of Pl.

When pooled time series *and* interindustry variation are used, H_0 is rejected. Equations (1.2), (1.5), (2.1) and (2.5) all yield this result and appear reasonable on other grounds[27].

Subject to two caveats, H_0 is thus rejected. The caveats are: (i) the direction of causation has not been established, i.e. unions may choose to organize high productivity industries (or the demand for union services may be greater in such industries), and (ii) the estimates herein all rely on conventional functional forms which do not clearly separate substitution and scale effects from other changes in production methods due to unions.

The variety of estimates performed in this paper provides information useful in further work on productivity. Also, discussion of some of the findings regarding time trends and functional forms aids in assessing the reliability of the estimates reported.

All of the time trend coefficients in Tables 1 and 2 are positive. The unreported coefficients for the year dummies agree with this in the estimations including industry dummies (equations (1.6), (1.9), (2.6) and (2.11)), which show productivity rising monotonically, though by different amounts from year to year. The estimations excluding industry dummies (equations

27 They all contain some treatment of time trends, and yield believable factor share estimates.

(1.5) and (2.5)) show productivity rising until 1969, dipping in 1970, and then rising to a peak in 1973 which was not reattained in the sample period. For present purposes, it does not appear to matter much whether one uses a time trend or year dummies, since the effects of unions on productivity are virtually the same in equations (1.2) and (1.5), or (2.1) and (2.5). Under the argument that some explicit recognition of cyclical effects is desirable, we prefer the formulations using year dummies.

Finally, regarding the choice between Translog and Cobb-Douglas functional forms, the coefficients of SOTRM in Table 2 are universally nonsignificant, implying that nothing is gained by the use of the Translog form (equations (1.5) and (2.5) are virtually identical). This result coincides with Clark's (1980) findings, previously noted.

ESTIMATION UNDER VARIABLE FACTOR SHARES

On the basis of the previous discussion, the "best" estimate of the effect of unions on productivity levels is provided by equation (1.5). The coefficient for U in this equation is 0.33, which is higher than the estimates obtained for the U.S. by Brown and Medoff[28]. This estimate allows for time trends, cyclical effects and energy price effects (through the year dummies) as long as they affect productivity in all industries equally, but does not allow for any industry specific factors except factor ratios and unionization. Attempting to capture industry specific effects through industry dummies not only produced a nonsignificant coefficient for U (which would have simply been treated as a test result), but also produced unrealistic factor share estimates.

In an attempt to see how sensitive these results are to assumptions underlying the functional forms used, an estimation was performed of equation (5), including year dummies but not industry dummies. Thus we are estimating the "best" result from the conventional estimates, equation (1.5), with one additional term which allows labour's share to be a function of unionization. The resulting equation is:

$$\ln(Y/L) = \underset{(16.22)}{4.234} + \underset{(9.32)}{0.858} \ln(K/L) - \underset{(-3.93)}{1.406}U - \underset{(-5.20)}{0.694}U \ln(K/L) \qquad (11)$$

$$+ \text{Year Dummies} \quad R^2 = .77$$

The difference from previous results is dramatic. Instead of a positive effect of unions on total factor productivity around 30 per cent, we now have

[28] BROWN & MEDOFF (1980, p. 366) report coefficients ranging from 0.22 to 0.24.

a statistically significant *negative* effect of about the same magnitude[29]. This decline is accompanied by a very substantial (and statistically significant) estimated increase in labours' share. Indeed the estimated change in labour's share is probably too large to be believable. At 50 per cent unionization, the estimated share is 0.49, while at 100 per cent unionization it is 0.84.

CONCLUDING COMMENTS

Given the opposite conclusions reached in equation (11) versus the estimates presented in previous sections, it is obvious that much work remains to be done. Additional theoretical development is required to provide standards for judging the meaning of quantitative results. For example, deciding whether the results in equation (1.5) or equation (11) are more reliable is not an empirical question. This decision must ultimately rest on theoretically-based tests of whether unions have affected factor shares.

Alternatively, it could be argued that existing theoretical development is adequate, if sufficient amounts of proper data for sequential testing of relevant hypotheses were available. The time series utilized in this paper were very short for the intended purpose, and the linking of data over SIC code changes was often performed in a naive manner. Multicollinearity problems become very severe with short time series using the types of specifications suggested by existing theory. Thus, data development is a necessary part of future work.

Finally, the implication of these comments, and the central theme of this paper, is that there is little reliable information on the effects of trade unions on productivity contained in existing research.

29 Comparing zero unionization to complete unionization the difference is 1.406/4.234 = 33 per cent. Remember the caveat previously made about extrapolating from this data set to the case of "zero unionization".

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Les syndicats et la productivité

Bien que la question de l'effet des syndicats sur la productivité ait fait l'objet de recherches depuis longtemps, les études sur le sujet sont plutôt rares et plusieurs problèmes demeurent sans réponse. Même si bien des motifs expliquent un tel état de choses, le plus important est sans doute de définir et de mesurer la productivité. Nombre de spécialistes divergent d'avis sur les moyens de l'apprécier. En outre, la question est essentiellement empirique, puisqu'il existe d'abondants arguments qui concluent les uns à un effet positif et les autres à un effet négatif. De plus, les statistiques dont on dispose pour porter un jugement manquent généralement, en particulier lorsqu'il s'agit de comparer celles qui proviennent des entreprises syndiquées et de celles qui ne le sont pas. Dans le cas du Canada, ces données sont de qualité douteuse.

Pour cette raison, la plupart des études portant sur l'effet du rôle des syndicats en ce qui concerne la productivité prennent de par leur nature même la forme d'études de cas. En conséquence, si l'on s'intéresse aux effets macro-économiques des syndicats, on risque d'en arriver à des conclusions erronées. Ainsi, une entreprise, où il n'existe pas de syndicat, peut modifier ses techniques de production dans un effort en vue d'empêcher la syndicalisation ou au moins en diminuer les conséquences si elle se produisait. Par ailleurs, si des firmes syndiquées deviennent plus productives à cause de la syndicalisation, il peut arriver que d'autres qui ne le sont pas changent leur technologie de production pour empêcher une diminution des ventes.

Ces motifs font voir que c'est une chose désirable de mesurer l'effet de la productivité pouvant découler de l'action syndicale au point de vue général, mais ils en montrent en même temps toute la difficulté.

L'article veut apporter une double contribution aux études qui ont portées sur le sujet en discutant les questions et les concepts en jeu. Par la critique qu'il fait de certains travaux récents, il ouvre des voies nouvelles vers une recherche future, car il faut convenir qu'il est besoin de beaucoup d'études additionnelles avant de pouvoir affirmer que l'on comprend les effets des syndicats en matière de productivité. Ceci exige naturellement une augmentation considérable du nombre des données statistiques.

TABLE 1

Regression Results-Cobb-Douglas Production Functions (Dependent Variable = ln(Y/L), n = 183)[a]

Eqn. No	*Intercept*	*ln(K/L)*	*U*	*Time*	*Industry[b] Dummies*	*Year[b] Dummies*	R^2
(1.1)	3.024	0.391	0.349		No	No	.73
	(24.82)	(20.52)	(2.65)				
(1.2)	2.988	0.389	0.332	0.007	No	No	.73
	(23.78)	(20.28)	(2.50)	(1.15)			
(1.3)	2.649	0.015	0.140	0.024	Yes	No	.98
	(20.61)	(0.23)	(1.09)	(7.48)			
(1.4)	3.231	0.425	0.307		Yes	No	.97
	(27.35)	(9.67)	(2.10)				
(1.5)	3.055	0.389	0.333		No	Yes	.73
	(22.02)	(19.91)	(2.47)				
(1.6)	2.918	0.034	0.167		Yes	Yes	.98
	(27.46)	(0.52)	(1.38)				
(1.7)	3.4447	0.458			Yes	No	.97
	(58.01)	(11.04)					
(1.8)	2.730	0.020		0.251	Yes	No	.98
	(25.93)	(0.29)		(7.78)			
(1.9)	3.022	0.038			Yes	Yes	.98
	(40.25)	(0.59)					

Notes: [a]Student's t values in parentheses.

[b]Full information on the results for the dummy variables is available from the author on request. The excluded category for the Industry Dummies was SIC 37 (Chemicals), and for the year dummies 1977 was the excluded category. Thus the intercepts reported refer to the excluded category or categories in equations containing dummy variables.

TABLE 2

Regression Results, Translog Production Functions Dependent Variable = ln(Y/K), n = 183)[a]

Eqn. No	*Intercept*	*Time*	*ln(L/K)*	*SOTRM*	*Tln(L/K)*	$T^2/2$	*Union*	*Industry[b] Dummies*	*Year[b] Dummies*	R^2
(2.1)	2.988	0.007	0.618	-0.003			0.324	No	No	.85
	(23.71)	(1.14)	(9.13)	(-0.10)			(2.17)			
(2.2)	2.679	0.025	0.943	0.020			0.150	Yes	No	.99
	(19.44)	(7.48)	(9.90)	(0.61)			(1.15)			
(2.3)	2.944	0.029	0.613	-0.002	0.0004	—0.004	0.326	No	No	.85
	(16.30)	(0.90)	(7.18)	(-0.63)	(0.06)	(-0.91)	(2.17)			
(2.4)	2.116	0.074	1.318	-0.099	-0.008	-0.005	0.230	Yes	No	.99
	(6.06)	(4.50)	(5.03)	(-1.17)	(-1.62)	(3.88)	(1.74)			
(2.5)	3.055		0.616	-0.002			0.328	No	Yes	.86
	(21.95)		(8.93)	(-0.08)			(2.15)			
(2.6)	2.962		0.910	0.027			0.180	Yes	Yes	.99
	(25.28)		(10.00)	(0.89)			(1.47)			
(2.7)	3.192	0.008	0.675	-0.033				No	No	.85
	(37.71)	(1.34)	(10.70)	(-1.23)						
(2.8)	2.757	0.025	0.948	0.015				Yes	No	.99
	(22.93)	(7.75)	(9.95)	(0.47)						
(2.9)	3.139	0.032	0.675	-0.033	-0.0002	-0.004		No	No	.85
	(19.85)	(0.97)	(8.29)	(-1.18)	(-0.02)	(-0.90)				
(2.10)	2.415	0.066	1.179	-0.058	-0.005	-0.004		Yes	No	.99
	(7.89)	(4.16)	(4.70)	(-0.71)	(-1.09)	(-3.74)				
(2.11)	3.064		0.916	0.021				Yes	Yes	.99
	(32.23)		(10.04)	(0.72)						

Notes: See Table 1.

TABLE 3

Productivity Measure Regressed on Unionization and Labour Quality (n = 17)[a]

Productivity Measure	*Intercept*	*Average Unionization*	*LQ*	R^2
P1	2.839	0.175	0.728	.12
	(5.77)	(0.39)	(1.29)	
P2	-0.685	1.289	2.926	.51
	(-0.86)	(1.79)	(3.21)	
P3	0.017	0.787	2.797	.59
	(0.03)	(1.48)	(4.16)	
P4	-0.401	0.857	2.905	.60
	(-0.66)	(1.55)	(4.16)	
P5	-0.010	0.844	2.827	.60
	(-0.02)	(1.59)	(4.22)	

Notes: [a]Student's t values in parentheses.