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Unionisation, Industrial Relations and Labour Productivity Growth in Australia: A Pooled Time-Series/Cross-Section Analysis of TFP Growth

by

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ABSTRACT

This study examines the impact of unionisation and other industrial relations variables on total factor productivity (TFP) levels and growth in a conventional Cobb-Douglas production function. The estimation employs quarterly time-series data from 1976 to 1990 on output, employment and the capital stock for fifteen separate industries pooled with cross-sectional data on unionisation and other industrial relations characteristics derived from AWIRS. Preliminary results suggest that union density had a negative effect on the level of TFP while the number of awards had a negative effect over the sample period. However, union density has had a positive effect on TFP growth. Variables reflecting the proportion of workplaces having 'enlightened' industrial relations policies, such as profit sharing, worker share ownership and superannuation schemes appear to have been positively related to TFP levels and growth over the sample period. This evidence seems to suggest the existence of a collective 'voice' effect.

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Unionisation, Industrial Relations and Labour Productivity Growth in Australia: A Pooled Time-Series/Cross-Section Analysis of TFP Growth[1]

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I - Introduction

In spite of a veritable avalanche of econometric studies on the subject, there continues to be controversy surrounding the impact of trade unions on labour productivity. While the question has been debated by economists for decades, additional impetus for empirical work on the subject came from Freeman and Medoff's (1984) claim that unions may induce productivity enhancing changes in the workplace through their provision of a collective 'voice' for workers. The debate has been given more urgency in recent years, particularly in Australia, by proposals for labour market reform. A number of such proposals,[2] which have the stated objective of increasing labour productivity, would combine more decentralised bargaining over wages and conditions with a substantial reduction in trade union power. The obvious question to ask of such plans is whether or not any reduction in trade union power is likely to impede or enhance the objective of raising labour productivity. This study aims to provide additional empirical evidence to aid our understanding of the impact of unions on labour productivity in Australia. In order to avoid the criticism that diminishing marginal productivity is likely to render further empirical work in this area pointless, some strong justifications for this particular project are required.

First, we have been motivated strongly by the conflicting conclusions that recent empirical analysis of the union-productivity nexus in the US, the UK[3] and Australia have produced and by what we believe are the flawed methods of some of that analysis. Most studies in the US, following the work of Brown and Medoff (1978), have been cross-sectional in nature and, although they have differed in terms of their coverage and measures of output, they have generally supported a positive impact of trade unions on labour productivity. Freeman and Medoff (1984) have used this as evidence in support of their collective 'voice' hypothesis regarding the role of trade unions. More recently, however, some dissenting opinions have been aired about the US evidence. Addison and Hirsch (1989) argue that trade union productivity gains appear to arise from managements' reactions to a substantial union wage premium and declining profit expectations rather than to a 'voice' effect. (Although, a counter argument would be that much of the effect of a union wage premium might be expected to be reflected in capital-labour substitution and hence in variations in the capital-labour ratio for which almost all of the studies control.)

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[1] The authors would like to thank Ahn Van Nguyen and Chris Wilkins for sterling assistance with data collection and manipulation and with the estimation. Denzil Fiebig provided very helpful comments on an earlier draft.

[2] eg Australian Federal Coalition , Jobsback!, (1992).

[3] The US evidence is succinctly summarised by Addison and Hirsch (1989) and the U.K evidence by Metcalf (1990).

Further, Blanchflower and Freeman (1990) suggest that, while the preponderance of US studies support a positive impact of unions on productivity, there are enough negative results to suggest that it is the state of industrial relations rather than unions *per se* which affect productivity. A weakness of many of the cross-sectional production function studies is that they assume the technology (production function) is similar for both different industries and for union and non-union firms, a point emphasised by Pencavel (1991). A further problem with many of these studies has been their inability to control for different workplace and industrial relations characteristics. The UK evidence is generally at odds with the US evidence. Metcalfe (1990), summing it up, suggests that the UK results, including his own (Metcalfe 1989), are consistent with trade unions' having a negative impact on productivity levels but a positive impact on productivity growth.

More recently, studies undertaken in both the UK and Australia have taken advantage of the wealth of cross-sectional information provided by their respective workplace industrial relations surveys (WIRS in the UK and AWIRS in Australia). Machin and Wadhwani (1989), analysing the 1984 WIRS data, conclude that workplaces where unions were recognised were more likely to have experienced organisational change (in the period 1981-4). However the same study indicates that, in manufacturing, managers of large unionised workplaces *felt* more constrained in work organisation. Because no direct measures of labour productivity or productivity growth were available from the WIRS data, the impact of unionisation was estimated on two proxy dependent variables at least one step removed from realised productivity gains. These were, first, whether organisational change had been achieved and, second, whether managers regarded themselves as being constrained in organising work. The absence of objective measures of output in the WIRS and AWIRS data sets is, we believe, a recurring problem for work aimed at analysing the impact of union and industrial relations characteristics on productivity.

Crockett *et al* (1992) analyse the AWIRS data and conclude that Australian unions, like those in the UK, appear to have negative impacts on (relative) productivity. The effect, gauged by their ordered probit regressions, seems to be strongest when the impact of trade unions is proxied by the number of unions rather than union density. Again, because the AWIRS data, like WIRS, provides no objective measure of productivity, the authors have had to use a potentially doubtful proxy - ie one based on the answers given by General Managers to a question in the survey on where on a five point scale they ranked the level of productivity in their workplace relative to that in other workplaces in their industry. This measure may be unduly subjective and may reflect managerial value judgements about just the sort of issue that is being investigated. Drago and Wooden (1992) also analyse the AWIRS data. Using a similar proxy for labour productivity to that employed by Crockett *et al*, they conclude that the net effect of unions on productivity in Australia appears to be negative, but that the main reason for this is a significantly negative union 'voice' effect[4]. Additionally, in their ordered probit regressions, they find that the significantly negative effect on relative productivity of their 'union membership' variable disappears when combined with the (negative impact of a) 'multiple unions' variable, making their evidence consistent with that of Crockett *et al*. The Drago and

[4]The Drago and Wooden (1992) 'voice' proxy is a composite variable constructed from four separate measures of the extent of union delegate involvement in workplace negotiations, the frequency of meetings between union delegates and workplace management, and the number of union delegates per employee.

Wooden study also analyses the impacts of 'union membership', 'multiple unions' and 'union voice' on relative costs and relative rates of return on investment, each proxied by where managers thought their firm lay on the five point scale. None of the union variables mentioned appeared to have a significant impact on the relative cost variable and only the 'multiple unions' variable had a weakly significant (at the 10% level) negative impact on the rate of return proxy. Why the perceived reductions in productivity attributed to unionisation were not also manifest in the relative cost and rate of return equations is something of a puzzle. Again it raises the question of whether or not variables based on management's perception of their firm's relative performance accurately reflect realised productivity, costs and rates of return.

Alexander and Green (1992) use the AWIRS data to analyse the impact of joint consultation schemes on workplace productivity. Rather than focusing on any single traditional measure of (or proxy for) productivity, they evaluate the productivity outcomes of joint consultation by the assessment of Employee Relations Managers of whether or not such a scheme: improved productivity or efficiency; made it easier or quicker to introduce change; improved management-employee relations; and improved product or service quality[5]. The strongest result generated by their logit analysis was that "in cases where management properly consulted 'the employees most affected' about the establishment of a 'joint consultative committee' or 'quality circle' or 'productivity improvement group', it was much more likely to lead to 'improved productivity or efficiency'. The role of unions in such schemes, however, was more ambiguous."[6] However, the analysis still begs the tantalising question of how Alexander and Green's four indicators of workplace performance relate to measured productivity.

In short, while studies which use data generated by workplace industrial relations surveys may be applauded for the high degree of disaggregation involved and for the use of detailed information on differences in incentive payments and industrial relations characteristics, they may also be criticised for the generally rough and, often subjective, measures of productivity used. Furthermore, with the possible exception of Alexander and Green, they focus only on unions' impact on productivity levels to the exclusion of their impact on productivity growth. Our study tries to overcome these perceived problems by combining some of the cross-sectional information available from AWIRS with more conventional, production-function-based estimates of productivity and productivity growth based on standard ABS data. This marriage of ABS and AWIRS data retains some of the major advantages of both approaches.

The second broad justification for our study derives from previous empirical work we have undertaken on the causes of the slowdown in productivity growth in Australia[7] during the 1970s and 1980s. This empirical work shows that the slowdown in aggregate productivity growth in Australia can be explained by a downward shift in total factor productivity growth after 1974 (probably reflecting the energy price hikes), and a fall in the rate of growth of capital intensity after 1983. This latter feature has been observed by others, eg Dowrick (1990), and has been attributed to labour substitution brought on by cuts in real wages and a fall in the relative price of labour engineered by the Accords between the Labor Government and the ACTU. This view is widely held and appears to have become the accepted wisdom in some government

[5]These are all clearly yes/no, zero/one variables
[6]Alexander and Green (1992), p 116.
[7]Phipps, Sheen and Wilkins (1992).

departments (cf Department of Treasury, 1990, p 35). Phipps, Sheen and Wilkins (1992) argue that this hypothesis is not borne out when disaggregated data is examined. Changes in the composition of Australian industry go a long way in explaining the decline in the aggregate capital-labour ratio and in the decline in the rate of growth of aggregate labour productivity during the 1980s. The substitution hypothesis cannot be applied to those sectors contributing to the change in composition. Instead, political decisions and external events were the driving factors. The potential importance of changes in the composition of industry for aggregate labour productivity behaviour begs an extremely important question which needs to be addressed empirically with Australian data, namely, *what key factors explain the very different productivity and productivity growth performances of Australian industries?* We propose to use pooled cross-section / time-series methods to help provide an answer to this question. This study, which pools the AWIRS and ABS data, represents a tentative first trial of a method which we hope to apply to the impact of many other industry characteristics on total factor productivity (TFP).

In this paper, we examine the impact of unionisation on TFP levels and growth in a conventional Cobb-Douglas production function setting. The estimation employs quarterly time-series data from the September quarter 1976 to the December quarter 1990 on output, employment and the capital stock for fifteen separate industries pooled with cross-sectional data on unionisation and other industrial relations characteristics derived from AWIRS. Preliminary results go some way to mitigating the previous adverse findings regarding the impact of unions on productivity in Australia. Section II of this paper outlines the model, the data and estimation methods employed and Section III presents the results. Tentative conclusions are set out and discussed in Section IV.

II - Modelling Methodology

The General Model

Our previous cointegration analysis of labour productivity and TFP growth[8] indicates, at least at the aggregate level, that acceptance of the restrictions implied by a (constant returns to scale) Cobb-Douglas production function is warranted. Hence, a reasonable starting point for our pooled cross-section / time-series analysis is the following representation of industry labour productivity:

$$\ln(Y_i / L_i)_t = \ln A_i + \ln(K_i / L_i)_t \alpha_i + \ln L_{i,t}(\alpha_i + \beta_i - 1) + \lambda_i t \qquad (1)$$

where Y_i, L_i and K_i are respectively output, employment and the capital stock of the i th industry, A_i represents TFP in the i th industry at the beginning of the sample period while λ_i is the associated rate of TFP growth. Under constant returns to scale, $\alpha_i + \beta_i = 1$ and the coefficients on $\ln L_i$ collapse to zero.

To capture the impacts of different trade union, payment system and industrial relations characteristics across industries on TFP and TFP growth, we make the simple assumption that industry TFP levels and TFP growth rates may be approximated by simple linear functions of a vector of such industry characteristics. Hence, for the level of TFP we assume that

[8] Phipps, Sheen and Wilkins (1992).

$$\ln A_i = \gamma_{1i} + X_i\gamma_2 \qquad (2)$$

where X_i is a vector of i th industry union, payment system and industrial relations characteristics and γ_2 is a vector of corresponding coefficients.[9] For TFP growth, we assume similarly that

$$\lambda_i = \lambda_1 + Z_i\lambda_2 \qquad (3)$$

where Z_i is a vector of (possibly different) i th industry characteristics. Substitution of equations (2) and (3) into (1) yields, in the case of constant returns to scale, our basic estimating equation

$$\ln(Y_i / L_i)_t = \gamma_{1i} + X_i\gamma_2 + \ln(K_i / L_i)_t \alpha_i + \lambda_1 t + \lambda_2 Z_i t + u_{it} \qquad (4)$$

where u_{it} is an error term[10]. If returns to scale are not constant, the $\ln L_i$ terms enter equation (4) in the same way as they enter (1).

Estimation Methods

If it could be assumed that the intercept and slope parameters in (4) were constant across industries and if the combined error term were independently distributed with constant mean and variance, the parameters could be estimated by OLS on all observations - the so-called classic pooling or 'total' regression model. Our data always rejected such a model.[11] Instead, two basic estimation procedures were used, namely, the 'fixed effects' (FE) or 'least squares dummy variable' (LSDV) method and the 'random effects' (RE) or varcomp method. The FE model assumes that the cross-sectional differences between industries can be captured in differences in the intercept term and hence treats the individual γ_{1i} as dummy variables. The FE model is inappropriate when time-invariant industry characteristics are used to explain differences in the levels of TFP, because the X_i will be perfectly collinear with the industry dummy variables. In this case, only the RE approach can be used. Even when only K / L and the tZ_i variables are used as regressors and the FE model can be estimated, it may be unwarranted to assume that the differences across industries can be captured by a parametric shift of the regression equation. In this case, the RE

[9] The seemingly strange assumption that $\ln A$ (rather than A) is a linear function of the industry characteristics is made to render the results more readily comparable with those derived in studies which have followed the Brown and Medoff (1978) methodology. The starting point of their approach is the assumption that the technology can be represented by a variant of the Cobb-Douglas such as

$$Y = AK^{\alpha}(L_n + cL_u)^{1-\alpha}$$

where L_n and L_u are non-union and union labour respectively and c reflects the productivity differences between them ($c > 1$ indicates that union labour is the more productive). Manipulation of the equation produces the following

$$\ln(Y / L) = \ln A + \alpha \ln(K / L) + (1-\alpha)(c-1)TUD$$

where TUD is union density which enters the equation in non-log form.

[10] A potential problem may arise because equation (3) is presumably stochastic with an error term, say ε_i. In which case, u_{it} contains a nonstationary component $t\varepsilon_i$.

[11] Standard F-tests indicated that the assumption of similar coefficients across industries in equation (4) should be rejected for our data set.

approach may be more appropriate. The RE model assumes that the intercepts are drawn from a common distribution and the RE estimator is an optimally weighted average of the 'within' (FE) and 'between' (OLS on means) estimators. Under the null hypothesis of no correlation between the intercepts (random effects) and the regressors, the RE (varcomp) estimator is asymptotically efficient since it is a GLS estimator. If it is difficult to decide *a priori* which of the two models to employ, the Hausman test (basically a test for the orthogonality of the random effects and the regressors) may be used to judge the appropriateness of the RE model.

Data

The data employed to estimate equation (4) brings together two fundamentally different types - time series and cross-section.

Firstly, we have used ABS quarterly time-series data covering each of fourteen industries[12] for the period 1976(3) to 1990(4) on real gross product (Y), employment (L) and the capital stock (the sum of plant and equipment and non-dwelling construction for public and private enterprises, K).[13] Annual data for the capital stock are taken from ABS 5221.0. Quarterly data have been interpolated using national accounts investment series. There are no data available on the capital stock for sub-industries within *manufacturing*. However, the ABS kindly made available to us the appropriate investment data for the manufacturing subdivisions. We allocated the capital stock for *manufacturing* in 1974(1) among the various sub-industries in proportion to the ratio of investment in the sub-industry to investment in manufacturing as a whole averaged over the previous ten years. Then for each subsequent quarter, the increase in the capital stock for *manufacturing* was allocated as increases in the capital stocks of the sub-industries in proportion to the ratio of each sub-industry's investment for that quarter to investment in *manufacturing* as a whole for the same quarter.[14]None of the data are seasonally adjusted.

Secondly, the cross-sectional data on trade union, payment system and industrial relations characteristics (the vectors X_i and Z_i) are derived from the AWIRS database. The variables, which are listed below with mnemonics, are all averages for the workplaces surveyed in each industry.

The variables used to represent **trade union presence** are:

TUD = trade union density (mean value for each industry of AWIRS variable n40)[15]

NTU = the number of trade unions having members at the workplace (mean value for each industry of the AWIRS variable ek1)

[12] Of the industries for which data is available, we have excluded *finance, property and business services, public administration and defence* and *community services* because measures of gross product in these industries are simply formed by extrapolation using labour input. Consequently, by construction, they display no measured productivity growth. We have also excluded *agriculture* because the essentially random impact of climatic change on output makes it very difficult to represent the technology in any simple way

[13] The main data are summarised in rate of change form in Appendix A.

[14] This method has the disadvantage that it assumes that the same rate of depreciation applies to each of the *manufacturing* sub-industries.

[15] This is a variable constructed by the AWIRS team. The starting point is the variable ek2 which measures the proportion of employees in each occupational group who are union members on a four point scale (All = 1, Most = 0.67, Some = 0.33 and None = 0). The number of employees in each occupational group is then multiplied by ek2 to give the number of union members in each occupational group. These are then summed and divide by the total number of employees to give n40.

NAW = the number of awards operating at the workplace (mean value for the industry of the AWIRS variable eb4).

While one might expect an extensive trade union coverage (high trade union density) to be a necessary prerequisite for an effective collective 'voice' for workers, a multiplicity of trade unions is likely to detract from that 'voice'. Furthermore, a large number of unions and awards may give rise to inter- and intra-union rivalry and associated problems such as demarcation disputes.

The variables which we chose to represent (potentially) productivity-improving, **Incentive schemes** are:

PSS = the proportion of non-managerial workers who receive payment from profit-sharing schemes (mean value for the industry of the AWIRS variable ec6).

SOS = the proportion of non-managerial workers who own shares under share-owning schemes (mean value for the industry of the AWIRS variable ec10).

A priori, we should expect *PSS* to have more of an impact on productivity in the short term, as workers try to improve their income from profits over the accounting period (usually the financial year). *SOS* may have longer term effects as workers have an incentive to adopt changes which improve the capital value of their share holdings. In addition, we have included:

SUP = the proportion of non-managerial workers who are members of a superannuation scheme to which the employer contributes (mean value for the industry of the AWIRS variable ed14).

We believe this may be both an indicator of good, modern industrial relations practice and a kind of efficiency wage payment.[16] It should be stressed that these AWIRS variables, which we use to proxy the vectors X_i and Z_i in equations (2) and (3), relate to one specific sub-period only, the year the sample was taken (1989-90). Since these variables may have varied over time, they should ideally have been measured towards the middle of the sample period. However, because they act as shifts on the time-series relationships we are concerned more with their relative than absolute magnitudes and these are less likely to have changed over time.

III - The Results

Our previous cointegration analysis of the aggregate data and testing of restrictions within that framework [17] as well as F-tests on the restrictions within our simplest pooled regressions, indicated that working with the simplifying assumption of constant returns to scale was warranted. We have chosen to present estimates[18] of the impact of the cross-sectional trade union, payments system and industrial relations characteristics on TFP growth first, because we believe they are the more innovative part of our study and because they may be derived for both the FE and RE models.

Productivity Growth Influences

The estimates for union and industrial relations effects on TFP growth, involving the product of time and the separate AWIRS variables, are set out in Table 1. For purposes of comparison, the equations estimated without the AWIRS variables are

[16] We hope to try some more-obviously IR related variables in the near future.

[17] Phipps, Sheen and Wilkins (1992)

[18] All estimates were obtained by use of the PANEL option in TSP.

Table 1 - Pooled Time Series/Cross Section Estimates of TFP Growth and AWIRS Variables (Dep. Var. = ln(Y/L))

	Const	ln(K/L)	T	T*TUD	T*NTU	T*NAW	T*PSS	T*SOS	T*SUP	Rbar2	SER	F - Tests on Restrictions[3] [p-value]	Hausman Test for FE v RE [p-value]
1 FE		.57 (11.7)	.002 (6.20)							.48	.095	H0: Ai,B = Ai,Bi F(13,750) = 77 [0.00]	
2 RE	.02 (0.11)	.52 (12.1)	.002 (7.41)							.48	.095		$\chi^2(2) = 4.78$ [0.09]
3 RE	.33 (1.83)	.44 (10.5)	-.009 (7.80)	.021 (10.19)						.54	.089	H0: Ai,B = Ai,Bi F(39,710) = 9.78 [0.00]	$\chi^2(3) = 3.10$ [0.38]
4 RE	.36 (2.01)	.43 (10.1)	-.004 (5.93)		.002 (9.85)					.54	.090	H0: Ai,B = Ai,Bi F(39,710) = 10.02 [0.00]	$\chi^2(3) = 2.50$ [0.48]
5 RE	.04 (0.87)	.52 (12.0)	.001 (1.25)			.000 (0.87)				.48	.095	H0: Ai,B = Ai,Bi F(39,710) = 13.74 [0.00]	$\chi^2(3) = 4.66$ [0.20]
6 RE	.11 (0.63)	.49 (11.3)	.002 (5.74)				.001 (0.63)			.48	.096	H0: Ai,B = Ai,Bi F(39,710) = 13.89 [0.00]	$\chi^2(3) = 5.81$ [0.12
7 RE	.25 (1.55)	.46 (11.3)	.002 (5.29)					.013 (4.34)		.49	.095	H0: Ai,B = Ai,Bi F(39,710) = 13.15 [0.00]	$\chi^2(3) = 6.14$ [0.10]
8 RE	.31 (1.76)	.44 (10.9)	-.014 (10.69)						.021 (12.82)	.57	.086	H0: Ai,B = Ai,Bi F(39,710) = 7.95 [0.00]	$\chi^2(3) = 3.13$ [0.37]
9 RE	.56 (3.16)	.37 (8.8)	-.006 (4.95)	.027 (11.60)		-.002 (5.29)	.003 (3.63)			.56	.088	H0: Ai,B = Ai,Bi F(65,682) = 5.06 [0.00]	$\chi^2(5) = 2.56$ [0.77]
10 RE	.58 (3.73)	.37 (9.6)	-.008 (6.22)	.024 (10.73)		-.001 (2.64)		.014 (4.68)		.56	.088	H0: Ai,B = Ai,Bi F(65,682) = 4.92 [0.00]	$\chi^2(5) = 5.15$ [0.40]
11 RE	.36 (2.17)	.42 (10.8)	-.012 (8.53)	.010 (3.54)		-.001 (4.67)			.018 (8.00)	.58.	.085	H0: Ai,B = Ai,Bi F(65,682) = 4.01 [0.00]	$\chi^2(5) = 4.12$ [0.53]

Notes: 1. T= time; **FE** - estimated by 'fixed effects' or LSDV method; **RE** - estimated by 'random effects' or varcomp method.
2. t-ratios are in rounded brackets below coefficient estimates; p-values for F and Chi-squared tests are in square brackets.
3. Strictly speaking all the F-tests apply to the corresponding **FE** estimates.

presented as equations 1 and 2. Estimated equations 3 to 8 show the impact of each individual AWIRS variable on TFP growth separately. For brevity, we show only the RE estimates. The Hausman tests indicate that we cannot reject the null of no correlation between the random effects and the regressors. Furthermore, the RE and FE estimates were very similar. The main conclusions from these separate estimates are that both union density (TUD) and the number of unions (NTU) have a positive impact on TFP growth and that the prevalence of superannuation schemes to which employers contribute also tends to increase TFP growth. An interesting feature of these and subsequent regressions is that the estimated parameter of the time trend is significantly negative whenever Z_i variables are included. This suggests that trade union presence and incentive scheme variables are important in facilitating the process of technological development.

Estimated equations 9 to 11 show the impacts on productivity growth of different combinations of our AWIRS variables. TUD and NTU, with a partial correlation coefficient of 0.74, are clearly collinear, so they have not been included together in any estimated equation. Again only the RE results are presented. There are two main differences from the separate estimates. First, the effect of the number of awards on TFP growth becomes significantly negative when included with the impact of union density, which retains its strong positive impact. This suggests to us that, although a broad trade union coverage may be important in securing productivity improving innovations as suggested by the collective 'voice' hypothesis, a multiplicity of awards is an impediment to productivity growth, either because it detracts from the collective 'voice' or because it increases the likelihood of both inter-and intra-union rivalry. Second, while PSS, SOS and SUP all have positive impacts on TFP growth as hypothesised, the most significant impacts come from the variables that one would most associate with longer term incentives, namely share-ownership schemes and employer-contributing superannuation.

Two final observations on the results in Table 1 are in order. Given that we have made no attempt to model the seasonal or short-run, cyclical influences on labour productivity, preferring to focus on the longer-run relationships, we regard the goodness of fit of the estimated equations as more than adequate. On the down-side, however, F-tests indicate rejection of the null hypothesis that the slope coefficients are similar across industries. This suggests the need to include further cross-sectional distinguishing characteristics. We proceed by trying to include the impact of our AWIRS variables on TFP *levels* and then by allowing for further differentiation in the technology across industries by allowing α, the elasticity of output with respect to capital, to vary among broad groups of industries.

Including Productivity Level Influences

Table 2 presents results which allow some of the AWIRS variables to influence the level of TFP across industries in addition to their impacts on TFP growth.[19] In this case, the FE model is completely inappropriate because of the perfect collinearity of the AWIRS variables and the industry dummies. We can estimate only the RE model.[20]

One encouraging result of this experiment is that the conclusions regarding the AWIRS variables' impacts on TFP growth are robust with respect to the inclusion of

[19] The impacts of the AWIRS variables on TFP levels individually (and separately from the effects on TFP growth) are presented in Appendix B.

[20] The Hausman test also becomes inappropriate.

Table 2- Pooled Time Series/Cross Section Estimates of TFP, TFP Growth and AWIRS Variables (Dependent Variable = ln(Y/L))

	Const	ln(K/L)	TUD	NTU	PSS	SOS	T	T*TUD	T*NAW	T*SUP	Rbar2	SER	F - Tests on Restrictions [p-value]
12 RE	1.49 (3.07)	.45 (11.1)	-2.17 (2.45)				-.012 (8.70)	.010 (3.62)	-.001 (4.67)	.018 (8.00)	.59	.085	H0: Ai,B = Ai,Bi F(78,668) = 3.26 [0.00]
13 RE	1.32 (3.01)	.45 (11.2)	-2.24 (2.81)		.50 (2.37)		-.016 (8.65)	.010 (3.68)	-.001 (4.72)	.018 (7.95)	.59	.085	H0: Ai,B = Ai,Bi F(91,654) = 2.74 [0.00]
14 RE	1.34 (3.87)	.41 (10.2)	-1.89 (2.92)			1.96 (2.19)	-.012 (8.67)	.011 (3.69)	-.001 (4.37)	.018 (7.82)	.59	.084	H0: Ai,B = Ai,Bi F(78,668) = 3.26 [0.00]
15 RE	0.91 (3.09)	.44 (11.0)		-.19 (2.14)			-.012 (8.66)	.010 (3.50)	-.001 (4.59)	.018 (8.05)	.59	.085	H0: Ai,B = Ai,Bi F(78,668) = 3.27 [0.0000]
16 RE	0.87 (3.64)	.45 (11.6)		-.28 (3.59)	.70 (3.67)		-.012 (8.68)	.010 (3.54)	-.001 (4.61)	.018 (8.04)	.59	.085	H0: Ai,B = Ai,Bi F(91,654) = 2.74 [0.00]
17 RE	0.92 (4.53)	.39 (10.2)		-.19 (3.02)		2.57 (3.18)	-.012 (8.65)	.010 (3.56)	-.001 (4.13)	.018 (7.84)	.59	.086	H0: Ai,B = Ai,Bi F(91,654) = 2.74 [0.00]

Notes: 1. T= time; **FE** - estimated by 'fixed effects' or LSDV method; **RE** - estimated by random effects' or varcomp method.
2. t-ratios are in rounded brackets below coefficient estimates; p-values for F and Chi-squared tests are in square brackets.
3. Again the F-tests really relate to the corresponding **FE** estimates.

Table 3 - Pooled Time Series/Cross Section Estimates of TFP, TFP Growth and AWIRS Variables with Separate Estimates of Coefficient on ln(K/L) (Dependent Variable = ln(Y/L))

	Const	ln (K/L)	TUD	NTU	PSS	SOS	T	T*TUD	T*NAW	T*SUP	Rbar2	SER
18 RE	3.01 (5.62)	HighK/L .54 (11.8) Manuf .43 (9.9) LowK/L .25 (4.0)	-4.76 (4.97)				-.01 (7.1)	.009 (3.30)	-.001 (3.02)	.014 (5.67)	.60	.084
19 RE	2.69 (5.79)	HighK/L .52 (12.3) Manuf .41 (9.7) LowK/L .26 (4.5)	-4.50 (5.44)		.56 (3.24)		-.01 (7.3)	.010 (3.33)	-.001 (3.25)	.015 (6.01)	.60	.084
21 RE	2.20 (5.42)	HighK/L .43 (10.4) Manuf .35 (8.2) LowK/L .30 (5.5)	-3.03 (4.29)			1.46 (1.81)	-.01 (8.0)	.009 (3.17)	-.001 (3.28)	.017 (6.83)	.59	.086
22 RE	1.41 (4.47)	HighK/L .48 (11.2) Manuf .46 (9.9) LowK/L .28 (4.5)		-.34 (3.51)			-.01 (7.2)	.010 (3.56)	-.001 (3.29)	.015 (5.60)	.59	.081
23 RE	1.33 (4.94)	HighK/L .48 (12.0) Manuf .45 (10.1) LowK/L .29 (5.0)		-.42 (4.82)	.81 (4.22)		-.01 (7.3)	.010 (3.63)	-.001 (3.63)	.015 (5.75)	.60	.084
24 RE	1.01 (4.89)	HighK/L .37 (10.0) Manuf .35 (7.80) LowK/L .35 (6.50)		-.18 (2.94)		2.66 (3.62)	-.01 (8.2)	.010 (3.26)	-.001 (3.61)	.018 (7.09)	.59	.087

Notes: 1. T= time; **FE** - estimated by 'fixed effects' or LSDV method; **RE** - estimated by 'random effects' or varcomp method.
2. t-ratios are in rounded brackets below coefficient estimates, p-values for F and Chi-squared tests are in square brackets

their impacts on TFP levels. Further, PSS and SOS appear to have significantly positive effects on productivity levels as well as on productivity growth as hypothesised. On the other hand, both TUD and NTU seem to have negative impacts on the level of productivity. While this result is consistent with the results of Crockett *et al* (1992) and Drago and Wooden (1992), the impacts in our analysis are specifically on the levels of TFP at the *beginning* of the sample period. Consequently, we prefer to stress the positive effects of TUD (and the negative effects of NAW) on the rate of productivity growth. However, it may well be that the negative impacts of TUD and NTU on productivity levels reflect the impact of union monopoly power and practices such as 'featherbedding'.

Industry clusters

The main weakness of the results in Table 2 is the fact that F-tests reject the null hypothesis of equality of slope coefficients across industries. The assumption that α, the coefficient on $\ln(K/L)$, is constant across industries would appear to be inappropriate. It is possible, by the use of multiplicative dummy variables, to estimate separate values of α for each industry. However, in order to conserve degrees of freedom, we decided to group the industries into three separate categories according to their capital intensity and to estimate α separately for each of the three categories. This division (into *capital-intensive* industries, including mining, electricity, gas and water and transport, storage and communication; *manufacturing* and *labour-intensive* industries, including all the others in our sample) we have found useful in analysing the impact of changing industrial composition on the productivity slowdown of the 1980s (cf Phipps, Sheen and Wilkins, 1992). The results of extending the analysis of Table 2 by allowing α to vary among these three groups are set out in Table 3.

Again it is possible to estimate only the RE model. Even though these results should be treated with a little caution, they do exhibit two features which lend them some credence. The estimates of α for the three industry groupings are always of sensible orders of magnitude. Further, the conclusions regarding the effects of the trade union and payment systems characteristics on TFP levels and growth remain unaltered, indeed the regression estimates of the coefficients on the relevant AWIRS variables are virtually unaffected.

IV - Conclusions

This study has sought to examine the impact of structural factors - in particular unionisation - on TFP levels and growth in a conventional Cobb-Douglas production function setting. The estimation has taken advantage of both ABS time-series data on output, employment and the capital stock for fifteen separate industries and cross-sectional data on unionisation and other industrial relations characteristics for the same industries derived from AWIRS. Our results go some way to mitigating the previous adverse findings regarding the impact of unions on productivity in Australia. They suggest that while union density and the number of awards had negative effects on TFP *levels* over the sample period, union density appears to have had a strong positive effect on TFP *growth*. The latter appears to be consistent with the view that a strong collective 'voice', provided by broad union coverage, may assist in the introduction of productivity-improving innovations and changes in work

practice. An alternative explanation is that changes in industrial and workplace environments in the 1980s forced inefficient, highly unionised firms to improve their productivity more rapidly than the average. However one would have expected such gains to be static in nature, with these inefficient firms being pushed to their 'best practice frontier'. The fact that these improvements in productivity followed a significant positive trend does suggest that the gains may be dynamic and that the 'collective voice' explanation is the more credible.

Variables reflecting the proportion of workers benefiting from payment incentives, such as profit-sharing schemes, share-ownership schemes and employer-contributing superannuation funds all appear to have been positively related to both TFP levels and TFP growth rates over the sample period. Appropriately, the longer term incentives involved with share-ownership and superannuation schemes appear to have had the strongest effects on productivity growth. The superannuation variable may reflect either the payment of an efficiency wage or simply more enlightened employment policies.

From a policy perspective, our results suggest that the processes of award consolidation and union amalgamation, by reducing inter- and intra-union rivalry and by providing a more united collective 'voice', may facilitate the introduction of productivity-enhancing innovations and changes in work practice. Furthermore our results suggest that productivity growth may be enhanced by maintaining a broad union coverage.

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Appendix A

Table A - Average Rates of Growth (per quarter) of Labour Productivity, the Capital-Labour Ratio and Total Factor Productivity

Industry	(1) Y/L	(2) K/L	(3) TFP1	(4) TFP2
Mining	0.0062	0.0084	0.0000	0.0034
Electricity, Gas & Water	0.0105	0.0051	0.0075	0.0072
Construction	0.0010	0.0090	- 0.0031	- 0.0014
Retail & Wholesale Trade	- 0.0010	0.0025	- 0.0023	- 0.0003
Transport, Storage & Communication	0.0085	0.0054	0.0062	0.0053
Recreation	- 0.0014	0.0060	- 0.0043	- 0.0044
Food, Beverages & Tobacco	0.0089	0.0056	0.0067	0.0039
Textiles, Clothing & Footwear	0.0056	0.0052	0.0035	0.0030
Paper	0.0074	0.0014	0.0067	0.0058
Chemicals	0.0075	0.0055	0.0053	0.0050
Base Metals	0.0102	0.0085	0.0068	0.0065
Fabricated Metals	0.0077	0.0034	0.0063	0.0026
Transport Equipment	0.0007	0.0046	- 0.0011	0.0009
Miscellaneous Manufactures	0.0093	0.0063	0.0068	0.0013

Notes (i) Sample period is 1976(3) to 19904).
(ii) TFP1 equals column 1 less (1- wages, salary and supplements/industry gross product) * column2.
(iii) TFP2 was estimated using the RE method with industry dummies without any of the AWIRS variables.

Table B - AWIRS Variables Employed in Regressions

Industry	No of Workplaces Surveyed	TUD	NUT	NAW	PSS	SOS	SUP
Mining	46	0.5772	2.8478	3.6585	0.7000	0.2560	0.8706
Electric	66	0.7792	4.3787	4.1894	0.0000	0.0188	0.8823
Constr	98	0.6195	3.4694	5.3571	0.9063	0.0076	0.7807
R& W Tr	316	0.3854	1.8667	3.2965	0.3952	0.0273	0.6094
TSC	149	0.6888	3.6376	4.5338	0.5875	0.0094	0.8333
Recr	151	0.4241	1.7815	3.0336	0.0225	0.0077	0.4670
FBT	77	0.5449	4.0000	5.4803	0.9400	0.0814	0.7886
TCF	56	0.5806	2.2546	3.9182	0.1925	0.0240	0.8690
Paper	47	0.5387	2.7872	3.6957	0.1100	0.0533	0.7594
Chemical	38	0.5418	3.9737	4.1487	0.6510	0.1186	0.9029
Base Met	30	0.6044	4.2333	2.9500	0.9400	0.1585	0.8640
Fab Met	57	0.5162	2.5614	3.3364	0.1750	0.0787	0.8126
Trans Eq	42	0.6153	4.4146	4.5610	0.0000	0.0409	0.8880
Misc Man	144	0.4884	2.6084	3.6809	0.3961	0.0584	0.7986

Notes:

TUD = trade union density = proportion of workers unionised; **NUT** = number of unions; **NAW** = number of awards; **PSS** = proportion of non-managerial employees who receive payment from profit-sharing scheme; **SOS** = proportion of non-managerial employees who own shares under share-owning schemes; **SUP** = proportion of non-managerial employees who are members of an employer-contributing super fund.

Table C - Correlation Matrix of AWIRS Variables

	TUD	NUT	NAW	PSS	SOS	SUP
TUD	1.00 [0.000]	0.74 [0.002]	0.45 [0.109]	0.05 [0.866]	-0.03 [0.931]	0.69 [0.006]
NUT	0.74 [0.002]	1.00 [0.000]	0.53 [0.054]	0.31 [0.2771]	0.15 [0.599]	0.68 [0.007]
NAW	0.45 [0.109]	0.53 [0.054]	1.00 [0.000]	0.35 [0.216]	-0.25 [0.388]	0.34 [0.235]
PSS	0.05 [0.866]	0.31 [0.277]	0.35 [0.216]	1.00 [0.000]	0.46 [0.102]	0.05 [0.864]
SOS	-0.03 [0.931]	0.15 [0.599]	-0.25 [0.388]	0.45 [0.101]	1.00 [0.000]	0.38 [0.174]
SUP	0.69 [0.006]	0.68 [0.007]	0.34 [0.235]	0.22 [0.435]	0.38 [0.174]	1.00 [0.000]

Notes:

(i) p-values under the null of no correlation are in square brackets.
(ii) **TUD** = trade union density = proportion of workers unionised; **NUT** = number of unions; **NAW** = number of awards; **PSS** = proportion of non-managerial employees who receive payment from profit-sharing scheme; **SOS** = proportion of non-managerial employees who own shares under share-owning schemes; **SUP** = proportion of non-managerial employees who are members of an employer-contributing super fund.

Appendix B - Pooled Time Series/Cross Section Estimates of TFP and AWIRS Variables (Dependent Variable = ln(Y/L))

	Const	ln(K/L)	lnL	T	TUD	NTU	NAW	PSS	SOS	SUP	Rbar2	SER	F - Tests on Restrictions [p-value]
RE	.02 (0.11)	.52 (12.1)		.002 (7.41)							.48	.095	H0: Ai,B = Ai,Bi F(13,750) = 771 [0.00]
RE	.99 (1.87)	.54 (12.1)		.002 (6.83)	-1.89 (1.93)						.48	.095	H0: Ai,B = Ai,Bi F(39,710) = 13.7 [0.00]
RE	.51 (1.49)	.54 (12.1)		.002 (6.92)		-.18 (1.66)					.48	.095	H0: Ai,B = Ai,Bi F(39,710) = 13.8 [0.00]
RE	-.24 (0.46)	.52 (12.1)		.002 (7.42)			.07 (0.54)				.48	.096	H0: Ai,B = Ai,Bi F(39,710) = 13.8 [0.00]
RE	-.13 (0.68)	.50 (12.2)		.002 (7.83)				.49 (2.14)			.48	.096	H0: Ai,B = Ai,Bi F(39,710) = 13.8 [0.00]
RE	.09 (0.54)	.46 (11.3)		.003 (8.56)					2.35 (2.35)		.48	.096	H0: Ai,B = Ai,Bi F(39,710) = 13.8 [0.00]
RE	.31 (0.49)	.52 (11.9)		.002 (7.23)						-.38318 (0.4733)	.48	.096	H0: Ai,B = Ai,Bi F(39,710) = 13.7 [0.00]

Notes: 1. T= time; **TUD** = trade union density - % of workers unionised at the workplace; **NU** = number of unions ; **NAW** = number of awards; **PPSS** = % of non-managerial employees that receive payment from profit-sharing scheme; **PSOS** = % of non-managerial employees who own shares under share-owning schemes; **PSUP** = % of non-managerial employees who are members of an employer-contributing super fund
2. **CP**- estimated by 'classical pooling ' method; **FE** - by 'fixed effects' or LSDV method; **RE** - by 'random effects' or varcomp method
3. t - ratios are in rounded brackets; **p** - values are in square brackets.

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