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

by

A.J. Phipps and J.R. Sheen

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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

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1 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 (1984) who 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, 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 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 managers' 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.)

1 The authors would like to thank Alan 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.


3 The US evidence is succinctly summarised by Addison and Hirsch (1989) and the UK 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 is that they have 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 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 (WIRSs 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 their work organisation. Because no direct measures of labour productivity or productivity growth were available from the WIRS data, the impact of unionism 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 their work organisation. The absence of objective measures of output in the WIRS and AWIRS data sets is, we believe, a recurring problem for work aimed at assessing 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 do not provide a direct measure of productivity, the authors have had to use a potentially variable proxy - i.e. based on the answers given by General Managers to a question in the survey asking 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 values judgements about what the sort of issue that is being addressed. Drago and Wooden (1992) also analyse the AWIRS data. Using a similar proxy for labour productivity to that employed by Crockett at el, 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. 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

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 productivity (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; was easier or quicker to introduce change; improved management-employee relations; and improved product or service quality. 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. 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 union 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 AWIRSs data retains some of the major advantages of both approaches.

The second broad justification for our study derives from previous empirical work on the causes of the slowdown in productivity growth in Australia 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), 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 a reduction in the rate of growth of capital intensity after 1983, which has been linked to lower levels of investment. This view is widely held and appears to have become the accepted wisdom in some government

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1These are clearly yes/no, zonal or variables.
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, policed decisions and external events were the driving factors. The potential importance of changes in the composition of industry for aggregate labour productivity behaviour beg 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 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:

\[
\ln(Y_{it}/L_{it}) = \ln A_i + \ln(K_{it}/L_{it}) \alpha_i + \ln L_{it} \beta_i + \eta_i t
\]

(1)

where \(Y_{it}, L_{it}\) and \(K_{it}\) 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 \(\eta_i\) is the associated rate of TFP growth. Under constant returns to scale, \(\alpha_i + \beta_i = 1\) and the coefficients on \(\ln L\) 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

\[
\ln A_i = \gamma_{1i} + X_{it} \gamma_2
\]

(2)

where \(X_{it}\) is a vector of \(i\)th industry union, payment system and industrial relations characteristics and \(\gamma_i\) is a vector of corresponding coefficients.9 For TFP growth, we assume similarly that

\[
\ln(L_{it}/L_{it-1}) = \gamma_{3i} + X_{it} \gamma_4 + \ln(K_{it}/L_{it}) \alpha_i + \lambda_1 t + \lambda_2 \gamma_{5it} + \eta_i t
\]

(3)

where \(Z_{it}\) 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

\[
\ln(Y_{it}/L_{it}) = \gamma_{1i} + X_{it} \gamma_2 + \ln(K_{it}/L_{it}) \alpha_i + \lambda_1 t + \lambda_2 Z_{it} + \eta_i t
\]

(4)

where \(\eta_i\) is an error term.10 If returns to scale are not constant, the \(\ln L\) 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 variance component 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 \(\gamma_{1i}\) 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 \(X_{it}\) 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 \(Z_{it}\) 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 \(\ln\) (rather than \(\ln\)) 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:

\[ Y = AK^{\alpha}L^{\beta} \]

where \(L\) and \(K\) are non-union and union capital 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:

\[ \ln(Y/L) = \ln A + \alpha \ln(K/L) + (\alpha - 1) \ln L + (1 - \alpha) \ln K \]

(7)

where \(TUD\) is a dummy variable which enters the equation in a non-linear form.

10 A potential problem may arise because equation (3) is presumably stochastic with an error term, say \(\varepsilon_{it}\), in which case \(\gamma_{1i}\) contains a non-stationary component \(\gamma_{1i}\).

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 AHS quarterly time-series data covering each of fourteen industries for the period 1974(1) to 1990(4) on real gross product (Y), employment (Z) and the capital stock (the sum of plant and equipment and non-dwelling construction for public and private enterprises). Annual data for the capital stock are taken from ABS 5222.0. 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 in the same quarter. None of the data are seasonally adjusted.

Secondly, the cross-sectional data on trade union, payment system and industrial relations characteristics (the vectors X, and Z) 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 the AWIRS variable 40)
- **NTU** = the number of trade unions having members at the workplace (mean value for each industry of the AWIRS variable 6)

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 output 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.

The main data are summarised in rate of change form in Appendix A. This method has the disadvantage it assumes that the same rate of depreciation applies to each of the manufacturing sub-industries.

This is a variable constructed by the AWIRS team. The starting point is the variable e(k2) 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 e(k2) to give the number of union members in each occupational group. These are then summed and divided by the total number of employees to give e(k).

**NAW** = the number of awards operating at the workplace (mean value for the industry of the AWIRS variable 4).

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 5).
- **SOS** = the proportion of non-managerial workers who own shares under share-owning schemes (mean value for the industry of the AWIRS variable 10).

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 14).

We believe this may be both an indicator of good, modern industrial relations practice and a kind of efficiency wage payment. It should be stressed that these AWIRS variables, which we use to proxy the vectors X, and Z, are 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, 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 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

---

15 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 output 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.

16 The main data are summarised in rate of change form in Appendix A. This method has the disadvantage it assumes that the same rate of depreciation applies to each of the manufacturing sub-industries.

17 This is a variable constructed by the AWIRS team. The starting point is the variable e(k2) 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 e(k2) to give the number of union members in each occupational group. These are then summed and divided by the total number of employees to give e(k).

18 We hope to try some more-obviouly IR related variables in the near future.

19 Phillips, Sheen and Wilkins (1992)

20 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))

<table>
<thead>
<tr>
<th></th>
<th>Const</th>
<th>In(Y/L)</th>
<th>T</th>
<th>T'NUG</th>
<th>T'NAW</th>
<th>T'PPS</th>
<th>T'SOS</th>
<th>T'SUP</th>
<th>Rbar2</th>
<th>SER</th>
<th>Houseman test for FE or RE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 FE</td>
<td>.57</td>
<td>(.11)</td>
<td>.002</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.48</td>
<td>.095</td>
<td>(\chi^2(3) = 4.38, .09)</td>
</tr>
<tr>
<td>2 RE</td>
<td>.52</td>
<td>(.11)</td>
<td>.002</td>
<td>(.00)</td>
<td>(.01)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.48</td>
<td>.095</td>
<td>(\chi^2(3) = 3.10, .08)</td>
</tr>
<tr>
<td>3 RE</td>
<td>.44</td>
<td>(.05)</td>
<td>.009</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.54</td>
<td>.095</td>
<td>(\chi^2(3) = 2.50, .09)</td>
</tr>
<tr>
<td>4 RE</td>
<td>.43</td>
<td>(.05)</td>
<td>.004</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.54</td>
<td>.095</td>
<td>(\chi^2(3) = 5.81, .06)</td>
</tr>
<tr>
<td>5 RE</td>
<td>.49</td>
<td>(.05)</td>
<td>.001</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.48</td>
<td>.095</td>
<td>(\chi^2(3) = 6.14, .06)</td>
</tr>
<tr>
<td>6 RE</td>
<td>.46</td>
<td>(.05)</td>
<td>.002</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.48</td>
<td>.095</td>
<td>(\chi^2(3) = 3.13, .08)</td>
</tr>
<tr>
<td>7 RE</td>
<td>.46</td>
<td>(.05)</td>
<td>.002</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.49</td>
<td>.095</td>
<td>(\chi^2(3) = 2.56, .09)</td>
</tr>
<tr>
<td>8 RE</td>
<td>.44</td>
<td>(.05)</td>
<td>.004</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.56</td>
<td>.088</td>
<td>(\chi^2(3) = 5.15, .06)</td>
</tr>
<tr>
<td>9 RE</td>
<td>.37</td>
<td>(.05)</td>
<td>.006</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.56</td>
<td>.088</td>
<td>(\chi^2(3) = 4.12, .06)</td>
</tr>
<tr>
<td>10 RE</td>
<td>.37</td>
<td>(.05)</td>
<td>.008</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.56</td>
<td>.088</td>
<td>(\chi^2(3) = 5.15, .06)</td>
</tr>
<tr>
<td>11 RE</td>
<td>.42</td>
<td>(.05)</td>
<td>.002</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>(.00)</td>
<td>.58</td>
<td>.085</td>
<td>(\chi^2(3) = 5.15, .06)</td>
</tr>
</tbody>
</table>

Notes: 1. T = time; FE = estimated by 'fixed effects' or LSDV method; RE = estimated by 'random effects' or varcomp method.
2. t-values 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 RE estimates.

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))

<table>
<thead>
<tr>
<th>Const</th>
<th>ln(K/L)</th>
<th>TUD</th>
<th>NTU</th>
<th>PSS</th>
<th>SOS</th>
<th>T</th>
<th>T' TUD</th>
<th>T' NA</th>
<th>T' SUP</th>
<th>Rbar2</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 RE</td>
<td>1.49 (3.07)</td>
<td>.45 (11.1)</td>
<td>-2.17 (2.45)</td>
<td>.012 (8.70)</td>
<td>.010 (3.62)</td>
<td>-0.01 (4.67)</td>
<td>.18 (8.00)</td>
<td>.59</td>
<td>.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 RE</td>
<td>1.32 (3.01)</td>
<td>.45 (11.2)</td>
<td>-2.24 (2.81)</td>
<td>.50 (2.37)</td>
<td>.016 (8.65)</td>
<td>.010 (3.68)</td>
<td>-0.01 (4.72)</td>
<td>.18 (7.95)</td>
<td>.59</td>
<td>.085</td>
<td></td>
</tr>
<tr>
<td>14 RE</td>
<td>1.34 (3.87)</td>
<td>.41 (10.2)</td>
<td>-1.89 (2.92)</td>
<td>1.96 (2.19)</td>
<td>.011 (3.69)</td>
<td>-0.01 (4.37)</td>
<td>.18 (7.82)</td>
<td>.59</td>
<td>.084</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 RE</td>
<td>0.91 (3.09)</td>
<td>.44 (11.0)</td>
<td>-1.19 (2.14)</td>
<td>.012 (8.66)</td>
<td>.010 (3.50)</td>
<td>-0.01 (4.59)</td>
<td>.18 (8.05)</td>
<td>.59</td>
<td>.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 RE</td>
<td>0.87 (3.64)</td>
<td>.45 (11.6)</td>
<td>-1.28 (3.59)</td>
<td>.70 (3.67)</td>
<td>.012 (8.54)</td>
<td>.010 (4.61)</td>
<td>-0.01 (8.04)</td>
<td>.59</td>
<td>.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 RE</td>
<td>0.92 (4.52)</td>
<td>.39 (10.2)</td>
<td>-1.19 (3.02)</td>
<td>2.57 (3.18)</td>
<td>.010 (3.56)</td>
<td>-0.01 (4.13)</td>
<td>.18 (7.84)</td>
<td>.59</td>
<td>.086</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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))

<table>
<thead>
<tr>
<th>Const</th>
<th>ln(K/L)</th>
<th>TUD</th>
<th>NTU</th>
<th>PSS</th>
<th>SOS</th>
<th>T</th>
<th>T' TUD</th>
<th>T' NA</th>
<th>T' SUP</th>
<th>Rbar2</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 RE</td>
<td>3.01 (5.62)</td>
<td>.43 (11.8)</td>
<td>-4.76 (4.97)</td>
<td>.01 (7.1)</td>
<td>.009 (3.30)</td>
<td>-0.01 (3.02)</td>
<td>.14 (5.67)</td>
<td>.60</td>
<td>.084</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 RE</td>
<td>2.69 (5.79)</td>
<td>.43 (12.3)</td>
<td>-4.50 (5.44)</td>
<td>.56 (3.24)</td>
<td>-0.01 (7.3)</td>
<td>.010 (3.33)</td>
<td>-0.01 (3.25)</td>
<td>.15 (6.01)</td>
<td>.60</td>
<td>.084</td>
<td></td>
</tr>
<tr>
<td>21 RE</td>
<td>2.20 (5.42)</td>
<td>.43 (10.4)</td>
<td>-3.03 (4.29)</td>
<td>1.46 (1.81)</td>
<td>-0.01 (9.0)</td>
<td>.009 (3.17)</td>
<td>-0.01 (3.28)</td>
<td>.17 (6.83)</td>
<td>.59</td>
<td>.086</td>
<td></td>
</tr>
<tr>
<td>22 RE</td>
<td>1.41 (4.47)</td>
<td>.46 (11.2)</td>
<td>-0.34 (3.51)</td>
<td>.01 (7.2)</td>
<td>.010 (3.56)</td>
<td>-0.01 (3.29)</td>
<td>.15 (5.60)</td>
<td>.59</td>
<td>.081</td>
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<td></td>
</tr>
<tr>
<td>23 RE</td>
<td>1.33 (4.94)</td>
<td>.46 (12.0)</td>
<td>-0.42 (4.82)</td>
<td>.81 (4.22)</td>
<td>-0.01 (7.3)</td>
<td>.010 (3.63)</td>
<td>-0.01 (3.63)</td>
<td>.15 (5.75)</td>
<td>.60</td>
<td>.084</td>
<td></td>
</tr>
<tr>
<td>24 RE</td>
<td>1.01 (4.89)</td>
<td>.37 (10.0)</td>
<td>-0.18 (2.94)</td>
<td>2.66 (3.62)</td>
<td>-0.01 (8.2)</td>
<td>.010 (3.26)</td>
<td>-0.01 (3.61)</td>
<td>.18 (7.09)</td>
<td>.59</td>
<td>.087</td>
<td></td>
</tr>
</tbody>
</table>

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.
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 NTU 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 \( \alpha \), the coefficient on \( \ln(K/Y) \), is constant across industries would appear to be inappropriate. It is possible, by the use of multiplicative dummy variables, to estimate separate values of \( \alpha \) 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 \( \alpha \) separately for each of the three categories. This division into capital-intensive industries, including mining, electricity, gas and water 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 \( \alpha \) 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 \( \alpha \) 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.
References

Alexander, Michael J. and Roy Green, 'Workplace Productivity and Joint Consultation,' Australian Bulletin of Labour, 18, 2 June 1992.


AWIRS Project Team 'The Australian Workplace Industrial Relations Survey (AWIRS) - Objectives and Methodology', AWIRS Seminar Series Paper No.1, Commonwealth Department of Industrial Relations, Canberra, July 1990.


Appendix A

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

<table>
<thead>
<tr>
<th>Industry</th>
<th>(1) Y/L</th>
<th>(2) X/L</th>
<th>(3) TFP1</th>
<th>(4) TFP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>0.0662</td>
<td>0.0084</td>
<td>0.0000</td>
<td>0.0034</td>
</tr>
<tr>
<td>Electricity, Gas &amp; Water</td>
<td>0.0105</td>
<td>0.0051</td>
<td>0.0075</td>
<td>0.0072</td>
</tr>
<tr>
<td>Construction</td>
<td>0.0610</td>
<td>0.0090</td>
<td>0.0031</td>
<td>0.0014</td>
</tr>
<tr>
<td>Retail &amp; Wholesale Trade</td>
<td>-0.0010</td>
<td>0.0025</td>
<td>0.0023</td>
<td>0.0003</td>
</tr>
<tr>
<td>Transport, Storage &amp; Communication</td>
<td>0.0035</td>
<td>0.0054</td>
<td>0.0062</td>
<td>0.0053</td>
</tr>
<tr>
<td>Recreation</td>
<td>-0.0014</td>
<td>0.0060</td>
<td>0.0043</td>
<td>0.0044</td>
</tr>
<tr>
<td>Food, Beverages &amp; Tobacco</td>
<td>0.0089</td>
<td>0.0056</td>
<td>0.0067</td>
<td>0.0039</td>
</tr>
<tr>
<td>Textiles, Clothing &amp; Footwear</td>
<td>0.0056</td>
<td>0.0052</td>
<td>0.0035</td>
<td>0.0030</td>
</tr>
<tr>
<td>Paper</td>
<td>0.0074</td>
<td>0.0014</td>
<td>0.0067</td>
<td>0.0098</td>
</tr>
<tr>
<td>Chemicals</td>
<td>0.0075</td>
<td>0.0035</td>
<td>0.0053</td>
<td>0.0050</td>
</tr>
<tr>
<td>Base Metals</td>
<td>0.0102</td>
<td>0.0065</td>
<td>0.0068</td>
<td>0.0065</td>
</tr>
<tr>
<td>Fabricated Metals</td>
<td>0.0077</td>
<td>0.0034</td>
<td>0.0023</td>
<td>0.0026</td>
</tr>
<tr>
<td>Transport Equipment</td>
<td>0.0007</td>
<td>0.0046</td>
<td>0.0001</td>
<td>0.0011</td>
</tr>
<tr>
<td>Miscellaneous Manu.</td>
<td>0.0003</td>
<td>0.0043</td>
<td>0.0003</td>
<td>0.0013</td>
</tr>
</tbody>
</table>

Notes: (i) Sample period is 1976(3) to 1990(4).
(ii) TFP1 equals column 1 less (1- wages, salary and supplements/industry gross product) * column 2.
(iii) TFP2 was estimated using the RE method with industry dummies without any of the AWIRS variables.

Table B - AWIRS Variables Employed in Regressions

<table>
<thead>
<tr>
<th>Industry</th>
<th>No of Workplaces Surveyed</th>
<th>TDP</th>
<th>NUT</th>
<th>NAV</th>
<th>PSS</th>
<th>SOS</th>
<th>SUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>46</td>
<td>0.5772</td>
<td>2.9748</td>
<td>3.6505</td>
<td>0.7000</td>
<td>0.2560</td>
<td>0.8706</td>
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<tr>
<td>Electric</td>
<td>56</td>
<td>0.7792</td>
<td>4.3787</td>
<td>4.1984</td>
<td>0.0000</td>
<td>0.0188</td>
<td>0.0823</td>
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<tr>
<td>Constr</td>
<td>96</td>
<td>0.6159</td>
<td>3.4694</td>
<td>3.3671</td>
<td>0.0963</td>
<td>0.0760</td>
<td>0.7807</td>
</tr>
<tr>
<td>R&amp;W Tr</td>
<td>316</td>
<td>0.3654</td>
<td>1.8667</td>
<td>2.3965</td>
<td>0.3952</td>
<td>0.6273</td>
<td>0.5694</td>
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<tr>
<td>TSC</td>
<td>149</td>
<td>0.6888</td>
<td>3.6376</td>
<td>4.5338</td>
<td>0.5875</td>
<td>0.6094</td>
<td>0.8533</td>
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<tr>
<td>Recr</td>
<td>151</td>
<td>0.4241</td>
<td>1.7815</td>
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<td>0.0225</td>
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<tr>
<td>FBT</td>
<td>77</td>
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<td>5.4803</td>
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<td>0.7886</td>
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<td>TCF</td>
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<td>0.5806</td>
<td>2.2546</td>
<td>3.9182</td>
<td>0.1925</td>
<td>0.0620</td>
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<td>47</td>
<td>0.5587</td>
<td>2.7872</td>
<td>3.6957</td>
<td>0.1100</td>
<td>0.0533</td>
<td>0.7954</td>
</tr>
<tr>
<td>Chemical</td>
<td>38</td>
<td>0.5418</td>
<td>3.9757</td>
<td>4.1487</td>
<td>0.6510</td>
<td>0.6019</td>
<td>0.9625</td>
</tr>
<tr>
<td>Base Met</td>
<td>30</td>
<td>0.6044</td>
<td>2.4323</td>
<td>2.9560</td>
<td>0.9400</td>
<td>0.1585</td>
<td>0.8640</td>
</tr>
<tr>
<td>Fab Met</td>
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<td>0.5162</td>
<td>2.5614</td>
<td>3.3364</td>
<td>0.1750</td>
<td>0.0787</td>
<td>0.8126</td>
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<td>Trans Eq</td>
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<td>0.6153</td>
<td>4.4166</td>
<td>4.5610</td>
<td>0.0000</td>
<td>0.0409</td>
<td>0.8880</td>
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<tr>
<td>Misc Man</td>
<td>144</td>
<td>0.4894</td>
<td>2.6064</td>
<td>3.6096</td>
<td>0.3961</td>
<td>0.0584</td>
<td>0.7986</td>
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</tbody>
</table>

Notes: TDP = trade union density - proportion of workers unionised; NUT = number of union; NAV = 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 scheme; SUP = proportion of non-managerial employees who are members of an employer-contributing super fund.
Table C - Correlation Matrix of AWIRS Variables

<table>
<thead>
<tr>
<th></th>
<th>TUD</th>
<th>NTU</th>
<th>NAW</th>
<th>PSS</th>
<th>SOS</th>
<th>SUP</th>
<th>Rbar2</th>
<th>SER</th>
<th>F Tests on Restrictions</th>
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</thead>
<tbody>
<tr>
<td>RE</td>
<td>.02</td>
<td>.52</td>
<td>.002</td>
<td>.12</td>
<td>.18</td>
<td>.14</td>
<td>.48</td>
<td>.09</td>
<td>H0: A1 = A2 (p-value)</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(12.1)</td>
<td>(7.41)</td>
<td>(1.3)</td>
<td>(1.93)</td>
<td>(1.66)</td>
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<td></td>
<td>(0.05)</td>
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<tr>
<td>RE</td>
<td>.99</td>
<td>.54</td>
<td>.002</td>
<td>-1.89</td>
<td>.48</td>
<td>.09</td>
<td>H0: A1 = A2 (p-value)</td>
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</tr>
<tr>
<td></td>
<td>(1.87)</td>
<td>(12.1)</td>
<td>(6.83)</td>
<td>(1.93)</td>
<td>(1.93)</td>
<td>(1.93)</td>
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<td>(0.05)</td>
</tr>
<tr>
<td>RE</td>
<td>.51</td>
<td>.54</td>
<td>.002</td>
<td>-1.89</td>
<td>.48</td>
<td>.09</td>
<td>H0: A1 = A2 (p-value)</td>
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<tr>
<td></td>
<td>(1.49)</td>
<td>(12.1)</td>
<td>(6.92)</td>
<td>(1.66)</td>
<td>(1.66)</td>
<td>(1.66)</td>
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<td></td>
<td>(0.05)</td>
</tr>
<tr>
<td>RE</td>
<td>-0.24</td>
<td>.52</td>
<td>.002</td>
<td>.07</td>
<td>.48</td>
<td>.09</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.46)</td>
<td>(12.1)</td>
<td>(7.42)</td>
<td>(0.54)</td>
<td>(0.54)</td>
<td>(0.54)</td>
<td></td>
<td></td>
<td>(0.05)</td>
</tr>
<tr>
<td>RE</td>
<td>-0.13</td>
<td>.50</td>
<td>.002</td>
<td>.49</td>
<td>.48</td>
<td>.09</td>
<td>H0: A1 = A2 (p-value)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(0.68)</td>
<td>(12.2)</td>
<td>(7.83)</td>
<td>(2.14)</td>
<td>(2.14)</td>
<td>(2.14)</td>
<td></td>
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<td>(0.05)</td>
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<tr>
<td>RE</td>
<td>.09</td>
<td>.46</td>
<td>.003</td>
<td>2.35</td>
<td>.48</td>
<td>.09</td>
<td>H0: A1 = A2 (p-value)</td>
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<tr>
<td></td>
<td>(0.54)</td>
<td>(11.3)</td>
<td>(8.56)</td>
<td>(2.35)</td>
<td>(2.35)</td>
<td>(2.35)</td>
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<td></td>
<td>(0.05)</td>
</tr>
<tr>
<td>RE</td>
<td>.31</td>
<td>.52</td>
<td>.002</td>
<td>-3.83</td>
<td>.48</td>
<td>.09</td>
<td>H0: A1 = A2 (p-value)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.49)</td>
<td>(11.9)</td>
<td>(7.23)</td>
<td>(2.35)</td>
<td>(2.35)</td>
<td>(2.35)</td>
<td></td>
<td></td>
<td>(0.05)</td>
</tr>
</tbody>
</table>

Notes: 1. T = time; TUD = trade union density; % of workers unionised at the workplace; NTU = number of unions; NAW = number of awards; PSS = % of non-managerial employees that receive payment from profit-sharing scheme; SOS = % of non-managerial employees who own shares under share-owning schemes; SUP = % 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. J = ratios are in rounded brackets; p = values are in square brackets.

Appendix B - Pooled Time Series/Cross Section Estimates of TFP and AWIRS Variables (Dependent Variable = ln(Y/L))
142 J. Sheen
Real Wages and the Business Cycle in Australia; June 1990

143 C.J. Karfakis

144 C.J. Karfakis & D.M. Moschos
Interest Rate Linkages within the European Monetary System: A Time Series Analysis; August 1990

145 C.J. Karfakis & D.M. Moschos
Asymmetries in the European Monetary System; December 1990

146 W.P. Hogan
International Capital Adequacy Standards; October 1990

147 J. Yates
Shared Ownership: The Socialisation of Private Property in the UK; October 1990

148 G. Butler
The Political Economy of the World Economy; October 1990

149 N. Rao
Some Further Evidence on the Policy Effectiveness of Government Policy; October 1990

150 D.J. Wright
Hidden Action and Learning-by-Doing in Models of Monopoly Regulation and Industrial Policy; November 1990

151 C.J. Karfakis
Testing for Long Run Money Demand Functions in Greece Using Cointegration Techniques; November 1990

152 D. Hutchinson & S. Nicholas
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153 B. Rao
A Disequilibrium Approach to the New Classical Model; December 1990

154 J.B. Towe
The Determinants of American Equity Investment in Australia; December 1990

155 E. Jones
Economists, the State and the Capitalist Dynamic; January 1991

156 J. Sheen & W.A. Sims
Granger Causality Tests and the E-Branch Utility Trees; February 1991

157 N. Rao
A Model of Income, Unemployment and Inflation for the U.S.A.; February 1991

158 W.P. Hogan
New Banks, Impact and Response; March 1991

159 P.D. GroenerWegen
Decentralisation: Tax, Revenue Changes: Recent Initiatives in Australian Federalism; April 1991

160 C.J. Karfakis
Monetary Policy and the Velocity of Money in Australia: A Cointegration Approach; July 1991

161 B. Rao
Disequilibrium, Disequilibrium and the New Classical Model; July 1991

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