

WORKING PAPERS IN ECONOMICS

REAL WAGES AND THE BUSINESS CYCLE

IN AUSTRALIA

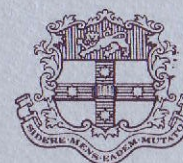
by

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by

JEFFREY SHEEN

ABSTRACT

A wide range of macroeconomic and microeconomic theories are surveyed with particular regard to their prediction on the cyclical behaviour of real wages. After appropriate removal of the non-stationary components of the time series involved, econometric tests are undertaken which show that Australian real wages are procyclical.

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INTRODUCTION

The question of nominal and real wage stickiness is of central interest to macroeconomic theorising and policy-making. In contrast to microeconomic theory, for which there is in general a broad consensus, our understanding of macroeconomic forces is subject to intense disagreement. A crucial element in that disagreement is the question of the behaviour of real wages in the course of the business cycle. Some theories predict procyclicality, some countercyclicality, some acyclicality and some are just plain agnostic.

This issue has been debated for many decades. Perhaps the most substantial early debate centred on the Dunlop-Tarshis observation that the real wage did not appear to move countercyclically as Keynes seemed to predict. The modellers of the Phillips curve, Monetarism, New Classical macroeconomics, the Real Business Cycle and the more recent microeconomic basis of goods and labour markets have all certainly been concerned with the real wage question. However empirical evidence on this matter is very mixed and conclusions do appear to depend on the country and on the timeframe.

In this paper, we begin in Section 1 with a survey of these general theories with particular focus on their predictions for real wages in the business cycle. Section 2 develops an empirical framework for addressing the issue, and Section 3 applies the methodology to Australian data from 1970's and 80's. The Australian labour market is highly institutionalised compared to most other industrialised countries. In the empirical work presented in Section 3, it is assumed that the Arbitration Commission (and implicitly all other related industrial courts) influence the timing of wage determination only, leaving competitive economic forces to determine bargains. The Hawke government came to power in 1983 and has been re-elected on three subsequent occasions.

An important element in its platform has been the voluntary incomes policies, or Accords Mark I-VI, that it negotiated with the trade union movement. In essence, these Accords were designed to tradeoff product wages for social wages and to alter labour market processes in a way that facilitated fiscal and monetary policy in the pursuit of non-inflationary growth and external balance. In Section 3, some evidence on the effectiveness of the Accords is presented.

At the end of the paper, some concluding comments are made suggesting how much faith should be put in the results and what further work has to be done.

SECTION 1: Theories of Real Wage Cyclicalities

In general, economic time series are relatively low order stochastic processes. Those that display cyclical behaviour must be of second order or more. Thus if we observe a cycle in key macroeconomic variables like GDP a theory is needed which at least has a single source of second order dynamics or two sources of first order ones¹.

One type of oscillation that we encounter in economics is begun by exogenous shocks which are then propagated through a complex dynamic system. Alternatively the exogenous shocks may themselves have a persistent or cyclical feature. These shocks are sometimes classified into demand and supply categories, although often the distinction is not clearcut - for example a terms of trade shock may impinge on both the demand and the supply side of the economy.

One of the largest contributors to supply variation is technical progress and this is a slow and sure process, subject to sudden fits and starts occurring

especially during booms. It might seem appropriate to expect it to be a random walk with drift. A random walk of aggregate supply would translate into a similar process for the real wage. Alternatively it is conceivable that technical progress might observe first order serial correlation because discoveries tend to build upon themselves. However a cyclical process is rather unbelievable, it being very unlikely that we would observe regular bouts of technical regress (about trend).

As yet, there is no good basis for environment-based cycles to give rise to the fairly regular business cycles that we observe. One reasonable external source of a cyclical shock could come from the terms of trade of a small open economy. However this begs the wider question of where the terms of trade cycle came from. Nevertheless the interaction of a first order terms of trade process in conjunction with a first order technical progress process could bring about cycles. Monetary shocks may involve disturbances to the money supply process and/or the nominal exchange rate. To the extent that these are exogenous to the domestic economy, they can contribute to cycle generation if the economy exhibits non-neutralities (at least in the short run).

We shall now consider a selection of theories that purportedly provide an explanation for inter-related cycles of macroeconomic variables. In most cases, our strategy will be to presume a cycle in output and to examine its implications in the context of the particular theory. We begin with the main macroeconomic explanations, and then turn to the more micro-based ideas.

1.1 Macroeconomic Theories

1.1a The Classical Walrasian Model

The classical Walrasian model admits no possibility of system-determined cycles in macroeconomic quantities such as employment. With prices adjusting to clear all markets instantaneously, the aggregate supply curve is effectively vertical and the only possible cause of quantity movements is exogenous cyclical shocks. By assuming full employment, cycles have to show up in relative prices and in the sectoral components rather than the aggregate of employment. In general the classical (and neoclassical) model could produce pro- or counter-cyclicalities of the real wage, depending upon whether demand shocks or supply shocks dominate. However, because of the employment prediction, the Great Depression could not be adequately explained by the Classical model, and attention turned to the Keynes school of thought.

1.1b Keynes and the Keynesian Paradigm

In the *General Theory* (1936), Keynes retained what he called the first classical postulate, which was that the real wage equalled the marginal product of labour. He argued that 'In a given state of organisation, equipment and technique, the real wage .. has a unique (inverse) correlation with .. employment' (p17). In his paper on "How to Pay for the War" (1940), he argued that goods prices adjusted faster to aggregate demand shocks than nominal wages because of information lags. On both counts therefore, he appeared to make a case for countercyclical real wages. However the first postulate does not in itself preclude procyclicality in the face of (say) technology shocks. With his multiplier analysis, coupled with his ideas of expectations in capital theory, Keynes was able to provide a reasonable explanation of the Great Depression.

Keynes's effective demand analysis was married to Schumpeter's theory of growth and cycles by Goodwin (1955). The Schumpeterian view was that the cycle had to coexist with growth, which was brought about by discrete improvements in technology. The ensuing (investment/capital stock) flexible accelerator process with implementation lags produced a potentially explosive cycle. Floors and ceilings to investment possibilities generated a simple non-linear system with complex periodic patterns. Goodwin's model may thus be seen as an early precursor of recent chaos models. Such a theory would forbid the decomposition of a macroeconomic time series into trend and stationary components. According to what is known as the superposition theorem this decomposition is valid for linear models only. While it is important that we find out whether non-linearities are empirically significant, this issue is not addressed in this paper.

One important hypothesis suggested by Keynes (1936) is the relative wage hypothesis. In a recession, nominal wages would not adjust because individual wage setters would try to ensure that their wage relative to others' did not suffer. Prices of goods would fall to some extent, and so the real wage would rise. The relative wage hypothesis could become inoperative if labour could be organised to engineer generalised real wage cuts in the face of a recession without affecting relativities. This was possibly one of the guiding principles of Labour's Social Contract with the trade unions in Britain in the late 1970's and the Australian Accords in the 1980's.

The relative wage hypothesis may be about workers resisting relative wage cuts directly, or else about employers wishing to maintain relativities to influence worker productivity through considerations of morale and fairness. The latter idea is a version of the Efficiency Wage hypothesis (for example, see Akerlof (1981)). Despite the existence of an outside unemployment pool, firms

will be reluctant to reduce wages because of the adverse impact on the productivity of the insider employment pool. The insider-outsider model is able to explain why wages seem so unresponsive to unemployment.

However it is not clear that the relative wage hypothesis suggests symmetric real wage cycles. To be consistent, the supposed countercyclicality requires real wages to fall in boom phases. But the hypothesis involved downward inflexibility alone. Thus during a boom one might expect uncoordinated wage setters to make excessive bids to ensure that they are not outperformed by wage competitors. This might easily have the effect of causing nominal wages to rise to outstrip prices, so that real wages increase during booms. The implication would then be that stabilisation policy is needed to reduce the generally upward forces on the real wage. In principle then, the relative wage hypothesis might imply an asymmetric response of the real wage in the business cycle and further that linear econometric modelling might easily present acyclicity.

The standard and familiar Keynesian textbook model abandoned these non-linearities and proceeded to consider the general equilibrium implications of nominal wage and price stickiness. This linear disequilibrium story reached its peak in the work of Barro and Grossman (1972) and Malinvaud (1977). There appeared to be much evidence then that real wages were acyclical, and so it seemed natural to neo-Keynesians to simply assume that wages and prices were fixed and to analyse the fluctuations of employment via the multiplier in response to cyclical demand shocks that could be generated through the investment-accelerator and trade and/or policy shocks. Of course, nominal wage stickiness alone would give rise to countercyclical real wages.

1.1c Monetarism

The Monetarists acknowledged that the prices of goods responded faster than wages to unanticipated demand shocks. Therefore a positive nominal demand shock reduces actual real wages, but at the same time, with nominal wages rising marginally and (adaptive) expected prices remaining virtually unmoved, the expected real wages of workers rise. Thus both labour demand and supply will be greater and employment enhanced (although unemployment may even be unaffected). Conversely negative shocks translate into employment falls through layoffs and/or quits and reduced participation, while the actual real wage is larger. However these cyclical effects arising from price misperceptions will be transitory. Over time all prices and their expectations adjust completely to their Walrasian values, and real variables attain their natural rates. In the Phelpsian island story involving search, workers respond to lower nominal wages in a recession by intensifying their search for better money wages elsewhere thus causing the labour supply schedule to shift leftwards. Thus both the Friedmanian Monetarist and the Phelpsian island models predict countercyclical actual real wages (and procyclical expected real wages).

1.1d New Classical Macroeconomics

The New Classical theorists adopted and refined the price misperception idea, but substituted Muthian rational expectations for the ad-hoc expectations hypotheses of the Monetarists. This proved to be a very powerful substitution because it generated a number of radical and surprising propositions about policy impotence. Further it meant that the wage cycles of the Monetarists (which came from the interaction of actual and expectation adjustments) no

longer applied. Instead, to generate these cycles, the model needed to append either exogenous persistent shocks or else a more complex stock/flow feature (for example see Lucas (1975) and Blinder and Fischer (1981)). With labour supply intertemporally responsive to the locally perceived real wage, unexpected nominal demand shocks would not be built into price expectations and would cause unexpected movement along the labour supply curve. While these unexpected demand shocks do trace out the supply curve for labour, they are by definition unexpected and cannot have a systematic cyclical component. Systematic cycles were irrelevant to Lucasian labour supply and so cyclical demand shocks will trace out a vertical labour supply curve. Therefore the real wage should be expected to be procyclical while employment is unrealistically acyclical. The subsequent development of Real Business Cycle models corrected for this deficiency.

1.1e Modern Real Business Cycle Models

The Classical model has been rejuvenated recently in the form of the so-called Real Business Cycle models (for example, see Kydland and Prescott (1982) and Prescott (1986)). To get cycles, this school adds a growth model to the static real classical system and relies on the somewhat doubtful assumption of large persistent supply shocks. This largeness assumption is required if these models are going to be able to compete with the Keynesian multiplier in predicting the rather substantial amplitude of the GDP cycle. The justification for persistence is often based on the fact that Solow's production function residuals tend to display first order serial correlation. This is not a convincing argument because it is just as likely to be evidence of mis-specification.

Further they improve on the earlier vintage by incorporating rational expectations and by bringing out the amplifying characteristics of intertemporal

substitution of leisure and consumption. The amplification of the assumed large supply shocks is helped by suggesting that the intertemporal substitution leads to a very flat aggregate supply curve. Thus the modern model works with stochastic shifts in the demand for labour schedule superimposed upon an somewhat unrealistically elastic labour supply curve. These shifts trace out the labour supply curve and so the model is able to predict procyclicality of the real wage. However it is worth reiterating the above point that the source of cyclicity in these models is tenuous to say the least. In particular, it would be very hard to explain why some recessions - like in the 1930's - become so deep.

1.1f Staggered Contracting

To counter the extreme propositions emanating from the New Classical school, the widely accepted stylised fact/myth of slower adjustment of wages than prices was added to the model. The justification was based on the observation that the duration of individual nominal wage contracts were randomly distributed or at least staggered over a period much longer than that required for prices to clear goods markets. This meant that the Staggered Contracting model exhibited both the short run Keynesian characteristic of sticky nominal and hence real wages (which might deviate from marginal product), and the long run Monetarist Natural Rate properties (for example, see Taylor (1979)). Thus the Keynesian inheritance of this school endowed the result that exogenous cycles or more complex dynamics would give rise to countercyclicity.

While Staggered Contracting was an important contribution to macroeconomic modelling, it was widely recognised as being simply an assumption that had not been explained by economic theory. Attention turned to finding good theoretical reasons for wage and price stickiness.

1.2 Microeconomic Foundations of Real Wage Cycles

The obsession with rigidity or stickiness of wages and prices had produced a somewhat mechanical interpretation of the problem. In fact, what was at stake was a relationship over time between individual workers and employers, and between individual firms and their customers in a non-auction setting. Clearly microeconomic foundations were crucial for understanding whether and why wages could cycle around their marginal product.

Why might firms be willing to pay wages greater than marginal product?
Why might workers be willing to accept wages less than their marginal product?

1.2a Imperfect Competition

The first explanation is that goods and labour markets are manifestly imperfectly competitive². Market power can produce equilibrium real wages different to marginal product. One popular and simple approach assumes that the markup of prices on marginal cost is constant; if wages comprise the major share of costs, then the real wage will be more or less constant over the cycle.

Consider a firm with monopsonistic power. Small transitory shocks would in principle require adjustment of the nominal wage, or else marginal profits would be positive. For a firm that had been offering the optimal wage, the losses from not adjusting are of second order only. (This is because the optimal wage will be at the peak of the concave profit function.) If we now introduce so-called "menu costs" of wage adjustment, only a small menu cost is needed to more than cancel out the small lost profit opportunities of not adjusting (for example see Mankiw (1985)). Alternatively "near rational" firms may forgo these small profits even with no menu costs (see Akerlof and Yellen (1985)). Thus imperfect competition can explain why wages hardly respond to

moderate and transitory shocks in marginal product. If this monopsonistic firm faced a competitive goods market, goods prices would be procyclical and the real wage would be countercyclical. Conversely, using the same logic, a firm with goods market power only would have procyclical real wages.

In oligopolistic goods markets, implicit collusion will prevent frequent price adjustment because of the risk of losses in the event of an outright price war. Only when it is clear that shocks are perceived as systematic throughout the industry do prices adjust. Individual Bertrand participants cannot respond to every stochastic variation in the business cycle. However the deeper a recession or the loftier a boom, the less likely is collusion to be maintained. Nevertheless during moderate stochastic business cycles, price inertia would lead to procyclical real wages.

1.2b Trade Union models

Models with unionised and non-unionised sectors add a story of compositional effects. In the simple non-bargaining model where unions maximise an objective function of union wages and employment subject to a demand function for labour, the optimal union wage is typically greater than the non-union wage (provided the union is prepared to accept some employment losses). Under certain (reasonable) circumstances the union/non-union wage differential will be independent of aggregate demand - for example, with a constant elasticity or an exponential labour demand function. This occurs because the first order condition depends on the slope and not the position of the demand curve. If the non-union real wage went up on account of a general labour demand boom, the union wage would increase to maintain the union/non-union differential³. So the simplest union models add little extra to the real wage cyclicity debate. We only need to know what happens to the non-union wage in the business cycle.

Wage-bargaining models involving unions and firms can certainly produce a procyclical conclusion (e.g. see McDonald and Solow (1981)). Firms maximise profits which are a function of employment and wages. Similarly unions maximise some utility function of these variables. The tangency points of the concave isoprofit and convex isoutility curves (in wage-employment space) trace out the positively sloped contract curve of efficient bargains. At any wage, the efficient employment bargain exceeds that which the firm would like unilaterally. Different solutions have been proposed along this curve (although we must move off it when strikes occur intermittently). For example the Nash cooperative solution is equivalent to the maximisation of the product of profit and utility (net of fallback threat positions). In general, any particular solution typically involves the intersection of two conditions: the positively sloped efficient contract curve and a negatively sloped power or equity locus. Clearly, as the union gains more bargaining power the power locus shifts up, and the equilibrium yields more employment and a higher wage. What would happen in a cyclical boom? The power locus shifts out as unions become able to push for a better deal. However the isoprofit contours shift right (in the employment axis) taking the efficient contract curve along with it. Employment definitely rises in the boom, but the real wage might possibly fall on account of the efficiency effect. Thus bargaining models give an ambiguous answer to the real wage cyclicity question, although in contrast to the symmetric information Implicit Contract models (see below), they do predict significant employment procyclicity. The real wage will be procyclical if the "power effect" dominates the "efficiency effect".

1.2c Observability of Marginal Product

The third micro explanation has one trivial interpretation and is based on the fact that it is virtually impossible to observe or measure marginal product. This explanation would suggest that real wages should be randomly distributed about the true marginal product, and precludes gradual error correction. Thus we might expect acyclicity.

A more substantial interpretation is one version of the Efficiency Wage hypothesis: because workers' marginal product is costly to observe, there is an incentive to shirk, rather than work. It will be cheaper for a firm to pay a wage in excess of the market-clearing one so that the expected losses from detection are greater than the benefits from shirking (for example, see Shapiro and Stiglitz (1984)). In the aggregate, the wage premium creates a pool of unemployed that validates the net benefit of working⁴. The 'no shirking condition' in this model acts like an effective upward-sloping labour supply curve. Demand variations will establish equilibria along this condition thus implying procyclicity. However this effective supply curve will also shift down as unemployment (and the expected cost of shirking) increases leading to even stronger procyclicity.

Another version of the Efficiency Wage hypothesis is the labour turnover model. Here firms draw from a labour force with heterogenous skills not readily observable and which invariably requires firm specific training. Firms do better if they can attract, keep and motivate trained quality workers. By paying an efficiency wage in excess of marginal product, a firm can reduce the incentive to search for better opportunities elsewhere. In aggregate, the implied unemployment pool will deliver the search disincentive. Once again the efficient wage locus acts like a supply curve and the real wage will be procyclical.

1.2c Risk and Insurance

The third general microeconomic explanation for wage and price inertia is based on the Implicit Contract model. Firms are patently more reluctant to adjust real wages than to vary employment when faced with random demand fluctuations. The Implicit Contract model explains this by suggesting that firms are less averse than workers to the income risks of these fluctuations. Given the unavailability of external market insurance for these risks, an implicit internal market will develop between firms and their employees. If firms are risk neutral and all information is public, they will offer workers income insurance by paying an average wage that does not vary over different states (for example see Azariadis (1975)). However it has long been recognised that the firm could also provide an even lower insured wage plus employment insurance over the cycle. Further, the same employment would occur as in a spot market for labour. So it is not clear that the theory can explain why wages are less variable than employment and output.

If we abandon the assumption of risk neutral firms, we get a modification to the internal insurance equilibrium outcome. Over longer terms it is doubtful that firms have sufficient access to capital markets to adequately finance rigid wages and also there are macroeconomic shocks which cannot be diversified away by individual shareholders. This suggests that firms will be risk averse. In this event, expected utility will be equalised across states and the contract wage will be state-dependent, higher in boom states and lower in bust states. This is because risks must now be shared by both workers and firms.

Asymmetric information with optimal contracting generate complicated wage contracts contingent on all realised states⁵ (see Grossman and Hart (1983)). If workers cannot observe states while risk averse employers can, there is an incentive for employers to lie about the state. This incentive cannot exist in

equilibrium, and so the optimal contract will have to be made conditional on observables, such as employment. For example, to get the appropriate risk sharing (with risk averse workers and firms), employment can be tied in a rule to wages and will then have to vary more than in the symmetric information or in the risk neutral case. Thus asymmetric information will introduce more employment variation and unemployment with marginal product in excess of the reservation wage.

Contract models are equally applicable in goods markets. For many types of goods firms choose to maintain their posted prices after transitory shocks have been realised. Instead quantity adjustment takes place ex-post. This casts doubt on the stylised fact that wages are more variable than prices.

What have these Contracting models to say about real wages and business cycles? With risk averse firms, nominal wages will be procyclical, and especially so under asymmetric information. If inflation indexation is also built into the contracts, the real wage will also be procyclical. In general though, the real wage can move either way, depending upon which of nominal wages or prices has the stronger insurance component.

1.2e Compositional Effects of Employment

The evidence on real wage cyclicality in different economies is very mixed. One explanation has been offered by Barsky and Solon (1989). The aggregate real wage may easily display procyclicality even if industry-specific wages are acyclical. This may occur if the employment share of high wage earners is procyclical. During booms, when labour is relatively scarce, quality standards for filling particular jobs fall and internal promotions become more frequent. Thus labour will migrate to better internal jobs and to higher wage industries. The actual wage for each job in each industry need not change, nor need the

average wage in each industry. However if higher wage industries expand more than lower wage ones, the compositional effect can lead to a higher aggregate real wage. In general then, if the distribution of employment across industries with different wage structures is sufficiently procyclical, then the aggregate real wage can be procyclical even if industry-specific wages happened to be countercyclical.

Another reason for procyclical real wages is that booms lead to overtime payments that are usually 150% of basic wages. Indeed an employment boom may even have been engineered in part by declines in the base wage and yet overall wages may go up. However Barsky and Solon (1989) test this hypothesis with US data and conclude that overtime payments are unimportant.

SECTION 2 Empirical Methodology

The objective of this paper is to isolate the unobservable stationary (or cyclical) component of a set of macroeconomic series and to see how these components may be related. In general, we shall be considering time series models of an observable y_t that can be broken down into the following components

$$y_t = \mu_t + \chi_t + \Sigma_t + \delta Z_t + \epsilon_t \quad (1)$$

TREND CYCLE SEASONAL EXOGENOUS IRREGULAR

The last four together comprise a stationary component, while the first is by definition non-stationary.

The irregular term is an uncorrelated white noise process with mean 0 and variance σ_ϵ^2 . The exogenous component involves a vector of statistically

exogenous variables, Z_t . These may include intervention variables which can be used to see whether an exogenous intervention had any effect on the model. In particular we will be interested to see whether the Hawke-Keating Accords with the trade union movement represented a significant intervention.

The stochastic cycle will be a stationary ARIMA(2,0,1) process restricted to a trigonometric form centred around a frequency λ_c (in radians) and involving a damping factor $\rho < 1$ (see Harvey and Souza (1985)) i.e.

$$\chi_t = \rho \cos \lambda_c \chi_{t-1} + \rho \sin \lambda_c \chi_{t-1}^* + \tau_t \quad (2a)$$

$$\chi_t^* = \rho \sin \lambda_c \chi_{t-1} + \rho \cos \lambda_c \chi_{t-1}^* + \tau_t^* \quad (2b)$$

where τ and τ^* are serially uncorrelated white noise processes with a common variance σ_τ^2 (necessary for identification purpose). Stationarity demands that $\rho < 1$. In the spectral domain, this stochastic cycle has a peak in its power spectrum which becomes sharper as ρ increases. If the common variance of the cycle is zero, the deterministic cycle becomes

$$\chi_t = 2\rho \cos \lambda_c \chi_{t-1} - \rho^2 \chi_{t-2}$$

which has characteristic roots $\rho(\cos \lambda_c \pm i \sin \lambda_c)$.

The stochastic seasonal component is modelled as the sum of seasonal terms as in (2) with ρ set to one, λ_c set to the appropriate seasonal frequency and the common variance given by σ_s^2 for all seasonal frequencies (see Harvey (1984)).

The non-stationary trend component can be modelled in a number of ways. If stationarity can be obtained by a regression on time, then the variable is

said to be time-stationary (or TS). If stationarity can only be achieved by differencing the series, then it is difference-stationary (or DS). This distinction was made by Nelson and Plosser (1982). In the TS case, shocks are always transitory, while in the DS one, shocks become permanently embodied in the trend component. If the variable is treated as a deterministic function of time and it is in fact stochastic, or if it is modelled as, say, an ad-hoc moving average, inferences based on subsequently detrended data can be very unreliable (see Nelson and Kang (1984)). To test which of the two applies, a single unit root test from the following regression (for sample sizes from quarterly data of less than 150) has been suggested by Said and Dickey (1984) and supported by Schwert (1987):

$$y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^4 \delta_i \Delta y_{t-i} + e_t \quad (3)$$

Under the hypothesis that $\gamma=1$, the t ratio is not distributed as the Studentized t and the correct distributions are given in Dickey and Fuller (1979). If we cannot reject the single unit root hypothesis, then we can conclude that the series is difference stationary of (at least) the first order. An alternative definition to DS, widely used, is that the series is integrated (at least) of order 1 or I(1). A stationary series would be I(0). Thus if the stochastic trend is an I(1) process or DS, it becomes

$$\mu_t = \mu_{t-1} + \beta_t + \eta_t \quad (4)$$

which is a random walk plus drift, β_t , and with η having a mean 0 and variance σ_η^2 . If β_t is constant, then this trend component is an ARIMA(0,1,1) process.

One possibility is that the slope β_t is not constant, and itself follows a random walk :

$$\beta_t = \beta_{t-1} + \zeta_t \quad (5)$$

If the variance of ζ_t is non-zero, then the trend model is equivalent to an ARIMA(0,2,1) process. One further possibility is that there is a stationary cycle in the trend equation (4), in which case the trend component contributes an ARIMA(p,1,q) process.

A number of I(1) series may cointegrate (see Engle and Granger (1987)). That is, in a linear regression of these variables, the residual may be found to be stationary. If true, it suggests that a long run relationship exists between the series. Of course in the short run, the model will require a more complex dynamic structure

Various methods have been proposed for the extraction of I(1) trend components. The competing methods are observationally equivalent (see Stock and Watson (1988) for a comparison of longrun forecast properties) and depend on the assumption made about the correlation of the noise in the trend and in the (composite) stationary component. Beveridge and Nelson (1981) assume perfect correlation and show that any ARIMA(p,1,q) process can be represented as a random walk stochastic trend - that is, the series can be decomposed into a permanent and a stationary cyclical component whose innovations are perfectly correlated. With this assumption Box-Jenkins estimation methods are all that is required⁶.

An alternative assumption is zero correlation of the trend and stationary components. Zero correlation has plausibility if the theoretical explanations of the permanent and the transitory innovations are quite different. The former may involve fundamental technological invention while the latter might be related to the weather. This assumption gives rise to unobserved component ARIMA models which require different techniques. In the subsequent empirical work, we use this methodology which has been labelled Structural Time Series Modelling and dates back to Muth (1960).

Estimation of the parameters of very general Structural Time Series Models can be based on the Kalman filter after putting the models into state-space form e.g. (1)-(5) (ignoring seasonals) can be written compactly as

$$y_t = z'A_t + \varepsilon_t \quad (6a)$$

$$A_t = TA_{t-1} + v_t \quad (6b)$$

where (ignoring time subscripts) $A=(\mu,\beta,\chi,\chi^*)'$, $z=(1,0,1,0)$, $v_t = (\eta,\zeta,\tau,\tau^*)$ and

$$T = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \rho\cos\lambda_c & \rho\sin\lambda_c \\ 0 & 0 & -\rho\sin\lambda_c & -\rho\cos\lambda_c \end{bmatrix}$$

(6a) is the measurement or observation equation while (6b) is the transition or state equation. The unknowns are the component variances and the cyclical parameters - ρ and λ_c - while the only observed variable is y_t . Assuming initial values of the unknown parameters, there is clearly a signal extraction problem involved while observations on y_t are accumulated. The Kalman filter provides the optimal updating of the state estimates and yields the likelihood function in

terms of the prediction error decomposition. This can be maximised with respect to the unknown parameters to give maximum likelihood estimates. Once the ML estimates have been found, optimal smoothed estimates of the unobserved components over the whole sample can be obtained by using all the information available at the end of the sample (see Harvey (1981) for a full explanation).

SECTION 3 Empirical Results

The question of real wage cyclicity was tested on a quarterly data sample for Australia from 1972q2 to 1989q1. The series⁷ used were wages and salaries per employee in the non-farm sector deflated by the gross non-farm domestic product deflator - denoted RW⁸ gross domestic product deflated by its deflator - denoted RGDP, and the terms of trade - denoted TOT. All of the data was not deseasonalised and was transformed into logarithms. The reason for selecting TOT and RGDP is that the former could represent an important external source of a cyclical force, while the latter picks up internal sources.

At the first stage, we have to decide how to detrend the series so that we can observe the contemporaneous correlations of their stationary components. As explained above, we check to see whether the variables are trend-stationary or difference-stationary processes. In Table 1 we report the Said-Dickey tests for a unit root in each series⁹. Note that fixed seasonals were included in these regressions and their regression estimates suppressed.

We see from the marginal significance level (based on the Dickey-Fuller distribution) of the first lag given in the column LAG1 in Table 1 that the test on real wage data cannot reject a unit root (at 5%), whereas real output cannot at 10%. Their equations perform adequately with regard to normality (NORM),

heteroscedasticity (HET) and functional form (FNFRM) diagnostic tests. Thus we shall conclude that both the real wage and output are difference stationary. The existence of significant differenced regressors for RGDP in Table 1 suggests that there are important dynamics which may be captured by a stochastic cycle. The own lagged differences of the real wage are significantly different from zero, and yet are extremely small. Nevertheless this significance suggests that the real wage may perform better if another variable displaying persistence was used as a regressor. Indeed, we shall see below that the stationary components of output and the terms of trade will be able to contribute in this role.

The terms of trade appears to be a borderline case, although given that the residuals appear to be heteroscedastic, an appropriately adjusted consistent estimate of the standard error (see White (1982)) gives a "t test" statistic for the unit root as 3.00 which means that the null cannot be rejected at 5%. The terms of trade will therefore be treated as difference stationary.

A test for cointegration of these three I(1) series was then conducted - the unit root test of the autoregressive coefficient of the residuals of the linear regression of (logarithms of) RW on RGDP and TOT had a "t statistic" of 3.4. From the Dickey-Fuller tables, we can reject the unit root at 5%, and conclude that there will be a long run relationship between the level of the real wage and output and the terms of trade.

The third step in our procedure is to apply univariate Structural Time Series modelling¹⁰ to our three series. The previous step suggests that the non-stationary components of RW, GDP and TOT can be modelled as random walk processes. A slightly longer data sample for GDP and TOT - 1971q1 to 1989q1 - was taken because the component extraction process wastes the first 5 observations. The general structural model was tested (without any exogenous variables) and the results reported in Table 2.

Consistent with the results reported in Table 1, the RW data had to be modelled as having a variable level but a fixed slope for the trend component; the underlying annual rate of growth was just under 1%. No cycle could be estimated for the real wage, although there was a significant non-stochastic seasonal. The equation did pass the diagnostic tests. For output and the terms of trade, we see that the variance of the trend processes are insignificantly different from zero. This implies that the model of RGDP and TOT are effectively first difference models, thus supporting the conclusions obtained in Table 1. The cyclical hyperparameters are highly significant in both cases and the implied period ($2\pi/\lambda_c$) of the output data is 22.34 quarters while the terms of trade appears to have a period of 14.37 quarters. Unfortunately the TOT results suffer from non-normal errors (particularly kurtosis) which means that robust estimation methods are needed. The reason for this is that there were massive gyrations in the first three years of the sample. Thus any of our subsequent conclusions about the effect of the terms of trade (adjusted for the trend and seasonal component) will be weakened by this feature. In Figures 1 and 2, graphs of the series and their estimated smoothed components are shown.

For the final stage of the this empirical research the original series were adjusted by deducting their trend and seasonal components. The adjusted series shall be denoted as RGDPA and TOTA respectively.

Three explanatory variables are now added to the real wage model. These three are

- 1) RGDPA
- 2) TOTA
- 3) ACCORD

where ACCORD is an intervention variable which has the value zero for all time periods prior to the fourth quarter 1983, and a value of one in the rest. With this variable, we shall be able to see whether the Labor government's wages policy

had any effect on the level of real wages. A Chow test was also conducted to see whether the overall parametric structure differed significantly after 1983q3.

Real Wage Procyclicality

The results in Table 3 provide the empirical answer to the question posed in this paper. We cannot reject the hypothesis (at 5%) that the real wage is procyclical. A contemporaneous increase in the stationary component of real GDP will lead (*ceteris paribus*) to 29% increase in the real wage.

Wage Reduction from the Accords

The effect of the Accord intervention is seen to be significant in a negative direction. The Accord can be seen as a mechanism that reduced the real wage level beyond what might have been necessary during the downcycle from 1986q4 to 1988q2.

However estimating the same equation until 1983q3 and then performing a Chow test on the forecast thereafter gave a test statistic of .8277 (distributed as $F(22,38)$) which has a marginal significance level greater than 50%. We must conclude that the Hawke government had no impact on the underlying economic relationships; it was simply able to use its offices to persuade the trade union movement to take a wage cut.

Terms of Trade reduce Real Wages

Finally, Table 3 shows that the stationary terms of trade component had a significant negative contemporaneous impact on the real wage. We mentioned earlier that the estimates from the TOT equation were somewhat unreliable because the residuals were significantly non-normal. If that problem was not too serious, we would still have to rationalise the negative sign. One explanation

could be that an improved terms of trade which comes about when import prices fall leads to competitive pressures in the non-farm import-substitution and non-traded sectors thus reducing union power and encouraging wage reductions. Similarly higher export prices of farm commodities cause the real exchange rate to appreciate making non-farm exporters less competitive and thus putting pressure on their trade unions. This is of course the Dutch Disease explanation.

CONCLUDING COMMENTS

Despite having observed that the real wage is only weakly cyclical, we have been able to establish a firm procyclical aggregate real wage result for the non-farm sector in Australia in the 1970's and 1980's. From our survey in Section 1 of theories that predict on this cyclicity question, we may be tempted to rule out all those that would have us believe in countercyclicality or acyclicity - eg Keynesianism, Monetarism, Staggered Contracting. This leaves us with a fair set of competing hypotheses such as Real Business Cycle models, Imperfect Competition models, Trade Union models with bargaining, Efficiency Wage models and some Implicit Contract models

However before jumping to such a conclusion, it is important to be aware of the warning given in the compositional hypothesis. Results with aggregate data can be potentially misleading. The real wage in individual sectors may behave countercyclically and yet give rise to a procyclical aggregate result. However Barsky and Solon (1989) have shown that individual sectors in the USA are in fact procyclical. Nevertheless it is essential that a disaggregated analysis be done for Australia before ruling on some our cherished macroeconomic paradigms.

These results should not be interpreted as proof of the total invalidity of, say, the Keynesian sticky nominal wage story that would require an inverse correlation between real wages and employment in response to demand shocks. Rather they suggest that over the twenty year sample, such episodes and occurrences were not of great importance.

If the strong procyclicality is a robust result for Australia, it means that her highly institutionalised structure of wage determination has not managed to provide real wage insurance over the business cycle. Although in this paper there has been no attempt to select amongst the competing procyclical alternatives, the bargaining model where the cycle of power dominates the cycle of efficiency is certainly compelling in the Australian case.

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FOOTNOTES

1. A first order difference equation can give rise to an oscillatory process. The simplest example is $y_t = \alpha y_{t-1}$ with $\alpha < 0$ where y_t alternates from being positive and negative when not 0. More complicated non-linear first order systems (such as $y_t = \alpha y_{t-1} (1 - y_{t-1})$) can generate chaotic periodic cycles depending on parameter values and/or initial conditions (see Baumol and Benhabib (1989) for an excellent survey on chaos in economics). In this paper, these pathological cases are not considered.

2. Zarnovitz (1989) provides a detailed analysis of imperfect competition and price and wage stickiness.

3. The union/non-union wage differential is not necessarily independent of demand. In more complicated models (for example where the utility weights attached to the union/non-union wage varied with the cycle), dependence is not likely to alter the cyclical conclusion.

4. While the posting of bonds by workers could eliminate the wage premium, the possible costs of litigation may prohibit this possibility. Similarly seniority wages could be a substitute for the premium, implying a life-cycle in the pattern of wages.

5. States of the world involve nominal and real shocks. Indexation for inflation in contracts does resolve one of the contingencies (albeit imperfectly with lags). Real contingencies are practically much more difficult to index and generally missing from real world contracts. Inflation indexation on its own can easily exacerbate the costs of non-adjustment to real shocks.

6. Box-Jenkins estimation methods are not without their own problems e.g. that of ensuring the invertibility of the MA process, and of the somewhat subjective methods of model selection.

7. The data was collected from the National Accounts series in the TSS set from the dX database marketed by EconData Pty Ltd.

8. The use of total wages and salaries per employee will mean that the results are influenced by overtime payments and part-time employment. The results of Barsky and Solon (1989) suggest that conditioning for overtime makes little difference. The same conclusion is expected for part-time variations. Non-farm series were used because the number of owner-occupied businesses in the farm sector is disproportionately large. The real product wage, rather than the consumption wage was chosen because the former is the more common construct across the theories considered.

9. The econometric program MICROFIT written by H Pesaran and B Pesaran and marketed by Oxford University Press was used in these tests.

10 For this purpose we have used STAMP which is a software package written by A Harvey and S Peters, and distributed by the LSE Computing Centre.

TABLE 1

Tests for Difference or Trend Stationarity

	LAG1	TREND	D1	D2	D3	D4	\bar{R}^2	HET	NORM	SERCOR	FNFRM
RW	.70 [.7%]	.0004 [<10%]	.000 (.173)	.000 (1.88)	.000 (.596)	.000 (.981)	.92	[>10%]	[>50%]	[>10%]	[5%]
RGDP	.769 [>10%]	.0015 [<10%]	-.29 (1.82)	-.08 (.47)	.11 (.71)	.32 (2.46)	.98	[>10%]	[>10%]	[>25%]	[>10%]
TOT	.72 [<5%]	-.001 [<1%]	.21 (2.02)	.34 (3.51)	.34 (3.36)	.26 (2.51)	.95	[<1%]	[50%]	[2.5%]	[>5%]

Marginal significance levels are reported in [.] and t ratios in (...).
 LAG1 is the first lag of the dependent variable
 D1 to D4 are first to fourth lagged differences of the dependent variable
 HET, NORM, SER COR and FNFRM are Lagrange multiplier tests for heteroscedasticity, non-normality, serial correlation and non-linearities in the functional form

TABLE 2

Univariate Structural Time Series Models

	σ_η^2	σ_ζ^2	σ_τ^2	σ_ξ^2	σ_ϵ^2	ρ	λ_c	TREND	\bar{R}^2	HET	NORM	SERCOR
RW	.0001 (2.44)	-	-	.0000 (.00)	.00009 (2.56)	-	-	.00227 (1.81)	.99	[>10%]	[>25%]	[>25%]
RGDP	.00 (.00)	.00 (.00)	.00004 (.86)	.00 (.00)	.00015 (3.25)	.895 (9.71)	.28 (2.50)	-	.99	[>10%]	[>25%]	[>25%]
TOT	.00 (.00)	.00007 (1.74)	.0001 (1.38)	.00 (.00)	.0001 (1.88)	.954 (23.7)	.44 (9.2)	-	.99	[>10%]	[<1%]	[>10%]

The σ_η^2 are the estimated variances of the unobserved components
 ρ and λ_c are estimated parameters of the cyclical component

TABLE 3

Exogenous Variables and the Real Wage

	σ_η^2	σ_ξ^2	σ_ϵ^2	TREND	RGDPA	TOTA	ACCORD	R^2	HET	NORM	SERCOR
RW	.0001 (2.82)	.00 (.00)	.00002 (.88)	.0028 (2.28)	.291 (2.99)	-.309 (3.79)	-.023 (1.85)	.94	[>10%]	[>25%]	[>25%]

FIGURE 1
 REAL WAGE

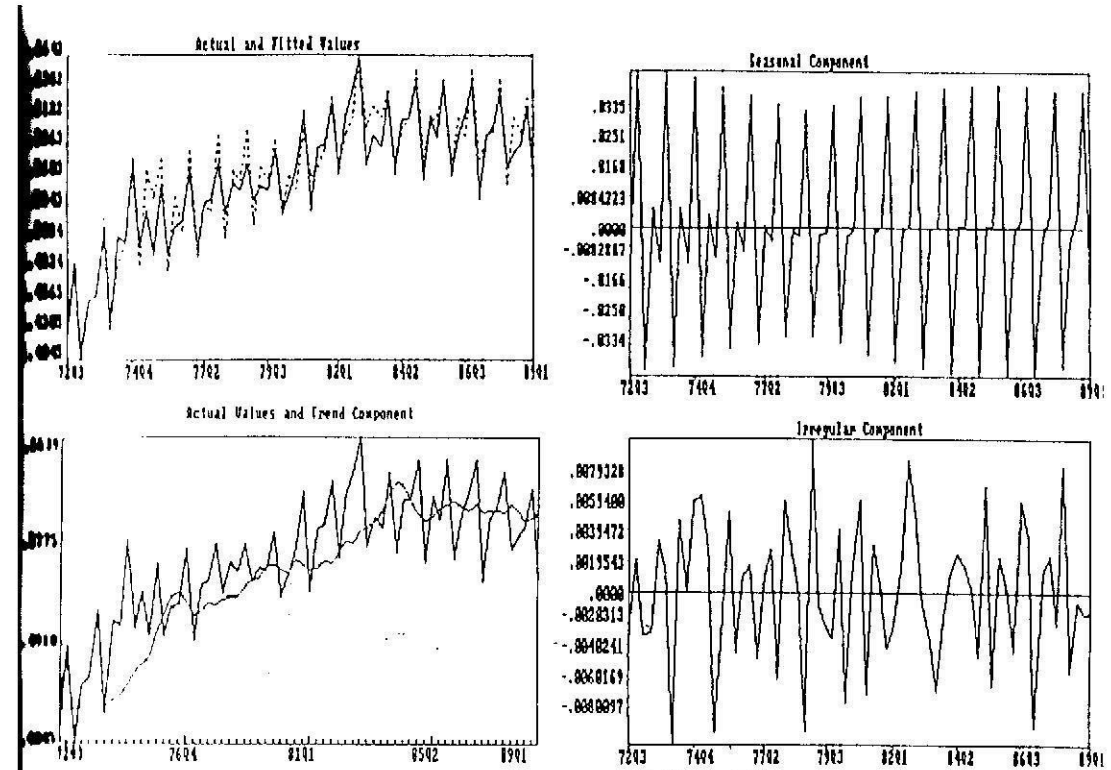


FIGURE 2
REAL GROSS DOMESTIC PRODUCT

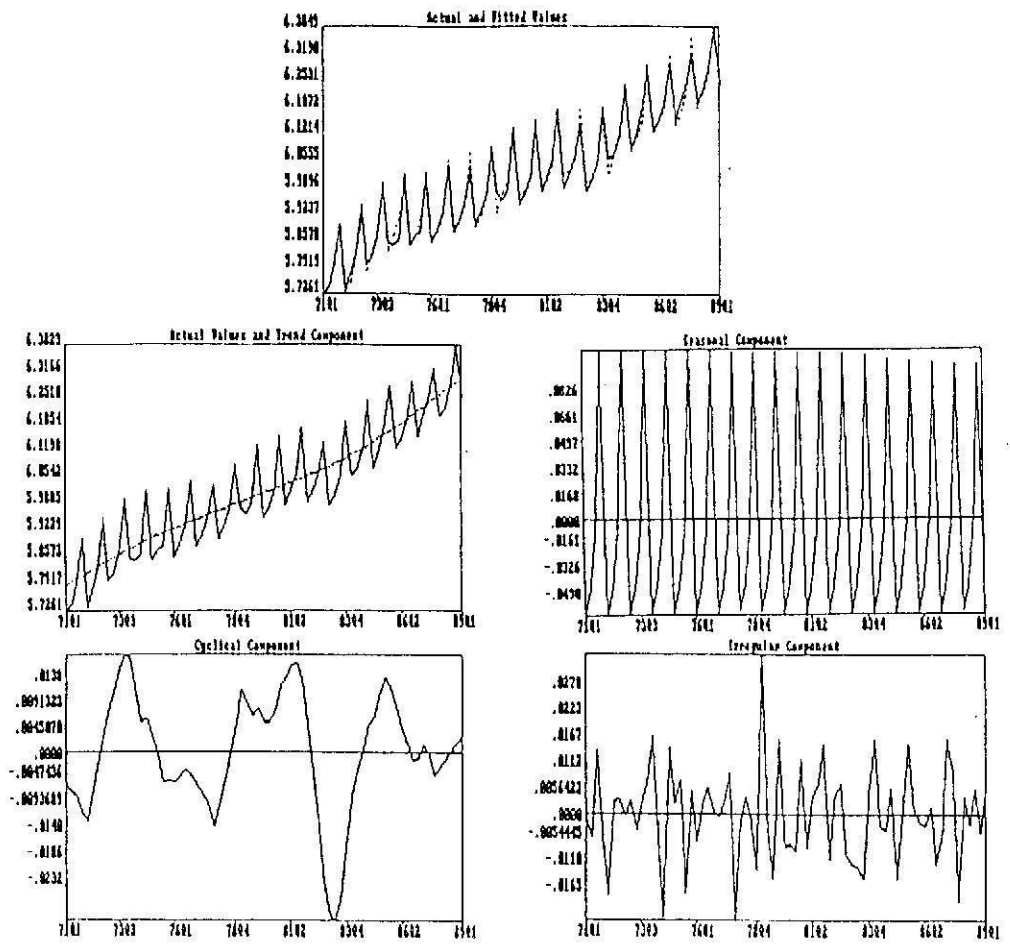
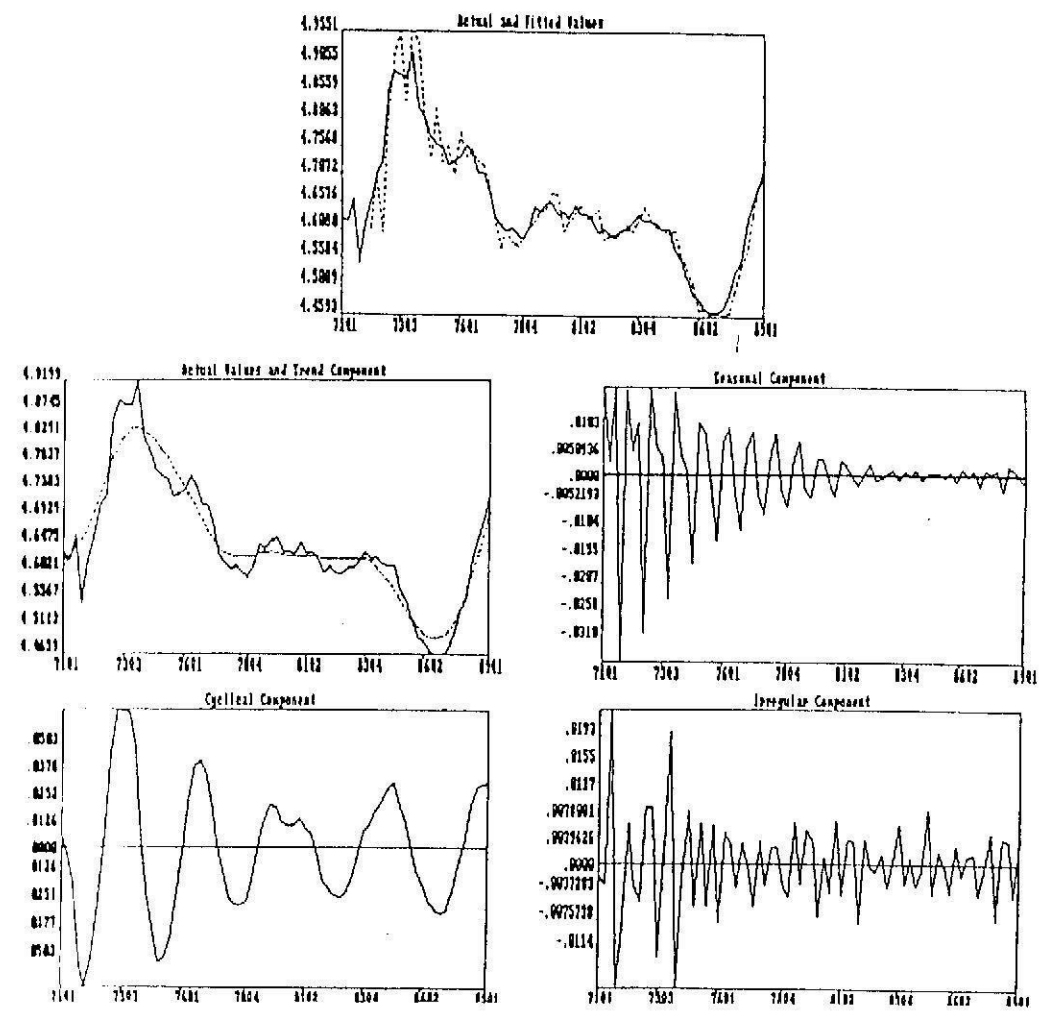


FIGURE 3
TERMS OF TRADE



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