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A DISAGGREGATED MODEL OF WAGE DETERMINATION

by

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1. INTRODUCTION

The ORANI module of the IMPACT medium term model of the Australian economy provides, for a given set of exogenously specified conditions, projections of demands for labour by industry and occupation.[1,2] When fully operational the BACHUROO module will enable projections of labour supply by occupation. As these ex-ante demands for and supplies of labour are formulated in initially unconnected modules representing different sets of decision makers, whose behaviour is affected by different sets of exogenous variables, there is no reason to expect equality between supply and demand, either in the aggregate, or in particular occupations. An important issue for IMPACT is whether there is some mechanism which operates to drive labour supply and demand towards equality.

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1. For a description of the IMPACT medium term model, see Powell (1977).

2. The main industry grouping for IMPACT is the input-output classification. For a description of the IMPACT occupational classification, see McIntosh (1976).

In practice there can be only one amount of labour transacted in each occupation and industry; hence to close the interface between BACHUROO and ORANI it will be necessary to specify how this transacted quantity and the accompanying wages and unemployment rates, are determined. Two extreme hypotheses are :

(i) wages adjust sufficiently in a single period (year) to equate supply and demand for labour in all occupations and industries (i.e., equilibrium prevails in the labour market) ;

(ii) no single period adjustments in wages occur in response to initial differences between ex ante supply and demand and hence these differences are fully reflected in unemployment or labour shortages.

The most likely occurrence is that for most occupations and industries there will be a solution lying between these extremes.

An important feature of IMPACT is the disaggregation of labour inputs into a number of categories based on skill. It recognizes that labour is not a single homogeneous input, but rather consists of a number of quite distinctive skill groups which present employers with various substitution possibilities. This approach means that there will not be a single aggregate wage rate paid to all labour but instead implies a wage structure (relativities) among occupations and it is on this issue that the present paper focuses. The occupations used are Professional White Collar, Skilled White Collar, Unskilled White Collar, Skilled Blue Collar and Unskilled Blue Collar.[1]

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1. For a detailed enumeration of these groups, see McIntosh (1976).

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Two possible approaches are apparent using the suite of programs developed by C.R. Wymer.[1] His ASIMUL package is designed to compute Full Information Maximum Likelihood (FIML) estimates of the parameters of systems like the above, which are non-linear in the variables as well as in the parameters. An alternative approach, less expensive in terms of computer time, is to use Wymer's RESIMUL package after appropriate Taylor series linearization of the non-linearities in the predetermined variables of the final estimating form.[2] RESIMUL computes FIML parameter estimates for simultaneous equations systems which are linear in the variables. Both approaches will be explored in the empirical phase of this work.

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1. See Wymer (1977).
2. This approach is followed in McAleer et. al. (1979).

In general the possibilities for labour mobility are greater within these groups than they are between them and hence we expect wage rates to be less diverse within them than between them. The industry grouping employed in this study is an eighteen industry Australian Bureau of Statistics classification used in the Earnings and Hours Survey.[1]

The purpose of this paper is to develop and estimate a disaggregated model of the wage determination process to allow specification of the wage adjustment mechanism which operates when ex ante labour supplies and demands are not equivalent at initial wage rates. The model is developed in two stages and is similar in flavour to the more aggregative model presented in McGuire and Rapping (1968). Firstly, the concept of equilibrium wages at which demands and supplies of labour would be equated is developed in Section Two. Supply and demand factors are assumed to affect actual wages through their influence on these equilibrium wages. In Section Three consideration is given to possible specifications of the actual wage determination process involving combinations of the equilibrium wage, key wage settlements and previous period's wages. The estimation of the resulting reduced form model, along with a number of parameter restrictions which assist in this estimation and in identifying the structural form parameters of the model, is examined in Section Four.

It should be noted that the data currently available to estimate the model consist of only four annual observations (May 1974-1977) on weekly wages and hours worked for the above industry by occupation groups. This limited data base placed restrictions on the development of the model outlined below.

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1. See Australian Bureau of Statistics (Ref. 6306.0). This classification excludes agricultural industries and domestic service.

2. THE EQUILIBRIUM MODEL

While observation of the Australian labour market clearly indicates the absence of short or medium term equilibrium behaviour, the concept of equilibrium wages is an attractive one for considering the influence of economic variables on wages. It is with this in mind that we develop a model of a disaggregated labour market in equilibrium and focus in particular on the reduced form wage equations of this system.

In developing the model an industry is treated as if it were a single very large firm. It is expected that the resulting model will be similar to that obtained by aggregating the individual behaviour of a large number of separate firms, but will avoid the intractable mathematical complications involved in following the aggregation approach. This simplification allows us to apply to the industry the familiar profit maximization requirement of equality between a factor's marginal revenue product and its marginal factor cost.

The total cost of industry j is[1] :

$$TC_j = \sum_{i=1}^{n} L_{ij} W_{ij} + K_j R_j + \text{(cost of materials)} ; \qquad (1)$$

where

L_{ij} = labour of type i used in industry j ,

W_{ij} = average wage of labour type i in industry j ,

K_j = capital used in industry j ,

R_j = average cost of capital for industry j .

1. For convenience time subscripts are omitted when developing the industry's labour demand function. All variables relate to the current time period.

r^{th} coefficient $(\Gamma_{rg}^{(j)})$ of the reduced form wage equation for occupation g in industry j will be a function of various structural parameters;[1] viz;

$$\Gamma_{rg}^{(j)} = f\,[\,\phi_{rg}^{(j)}, \varepsilon_{rj}, \eta_j, \alpha_{1r}, \alpha_{2r}, \alpha_{3r}, \alpha_{4r}, \alpha_{5r}, \lambda_g\,] . \qquad (27)$$

Because industry specific effects are all embodied in ε_{rj}, η_j and the industry specific part of $\phi_{rg}^{(j)}$ (from (23) this is L_{gj}/L_g), each of which we may specify a priori, variations across industries at a given point in time may be used in conjunction with time series variations, to estimate the occupation specific elements of $\Gamma_{rg}^{(j)}$. The estimation problem has been reduced to one of determining occupational effects alone.

4.3 Proposed Estimation Procedure

To obtain a typical equation in the final form of the system for estimation, one substitutes (14) into (18) into (20). The resultant equations are to be estimated subject to the restrictions discussed in the last section.

The most straight forward approach to the estimation of these dynamic wage equations involves the assumption that they are subject to normally distributed white noise errors. The substantial non-linearity of the final form both in the parameters and the predetermined variables, places the estimation problem in the rather complicated class requiring advanced software for estimation.

1. There will be n of these $\Gamma_{rg}^{(j)}$ for each occupation in each industry. The $(n+1)^{th}$ coefficient in each equation will be the relevant $(1 - \lambda_g)$.

The first of these effects is allowed for by our respecification of $\phi^{(j)}$ in (23). The second type of effect is an argument for some zero elements in the all industries wage elasticities matrix (Φ). However, as noted above this matrix does not appear in the coefficients of the reduced form wage equation. Hence zero restrictions on single elements of Φ will not be transmitted through to the reduced form coefficients.

However, if all of the off diagonal elements of $D^{(j)}$ are less than one in absolute value, then $C^{(j)-1}$ can be approximated by[1]

$$C^{(j)-1} = (I + D^{(j)})^{-1} \approx I - D \quad . \qquad (26)$$

This approximation to $C^{(j)-1}$ will both allow zero restrictions on elements of Φ to be transmitted as zero restrictions on the values of relevant reduced form coefficients <u>and</u> enable the definition of $\phi^{(j)}$ in (25) (along with the other adjustments outlined in Section 4.1) to lead to implementable restrictions on reduced form coefficients across industries.

The effect of the above parameter restrictions is to allow us to treat that portion of the reduced form parameters remaining to be estimated, as the same for all industries. From equation (21) we can see that after imposing the approximation of $C^{(j)-1}$ in (26), the

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1. In the demand literature, the equivalent approximation for the inverse of a utility Hessian is motivated by Barten's concept of 'almost additive preferences'; see Powell (1974), pp. 31-32.

The marginal cost to industry j of a small increase in its use of labour type i, with other inputs held constant, is[1,2]:

$$MFCL_{ij} = \sum_{\ell=1}^{n} \frac{\partial W_{\ell j}}{\partial L_{ij}} L_{\ell j} + W_{ij} \quad , \qquad (2)$$

$$= \sum_{\ell=1}^{n} \left(\frac{\partial W_{\ell j}}{\partial L_{ij}} \frac{L_{\ell j}}{W_{\ell j}} + \delta_{\ell i} \right) W_{\ell j} \quad , \qquad (3)$$

where

$$\delta_{\ell i} = 1 \text{ for } i = \ell \; ;$$
$$= 0 \text{ otherwise} \; .$$

With the aid of some additional notation, (3) may be expressed as

$$MFCL_{ij} = \sum_{\ell=1}^{n} \left(\phi_{\ell i}^{(j)} \frac{L_{\ell j}}{L_{ij}} + \delta_{\ell i} \right) W_{\ell j} \quad . \qquad (4)$$

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1. It is assumed that in the short run (less than 1 year) capital is fixed and changes in an industry's labour usage do not affect its cost of capital. However, using more of occupation i could, by increasing wages for that occupation, lead to substitution in all industries towards other occupations and thereby change their wage rates. This accounts for the presence of the $\frac{\partial W_{\ell j}}{\partial L_{ij}}$ $(\ell \neq i)$ terms in (2).

2. Notice that (2) implies that labour inputs can be varied without <u>necessarily</u> changing inputs of materials. If it is considered more realistic that, at fixed K_j, an increase in L_{ij} involves a proportional increase in materials, then the right hand term should be deleted from (1), and W_{ij} reinterpreted as the cost of labour inclusive of complementary materials inputs.

The $\phi_{\ell i}^{(j)}$ terms $\left(\phi_{\ell i}^{(j)} = \frac{\partial W_{\ell j}}{\partial L_{ij}} \frac{L_{ij}}{W_{\ell j}}\right)$ are elasticities (flexibilities) of wages in occupation ℓ in industry j with respect to changes in L_{ij}. There will be n of these elasticities for each type of labour in a given industry.

The total revenue of industry j is product price (P_j) times gross output (Q_j) :

$$R_j = Q_j P_j = G_j(L_{1j}, L_{2j}, \ldots, L_{nj}; K_j; \text{materials}) P_j . \quad (5)$$

Hence the marginal revenue product from a small increase in the use of labour type i in industry j is :

$$MRPL_{ij} = \frac{\partial R_j}{\partial L_{ij}} = P_j \frac{\partial Q_j}{\partial L_{ij}} + Q_j \frac{\partial P_j}{\partial L_{ij}} , \quad (6)$$

$$= P_j \frac{\partial Q_j}{\partial L_{ij}} + \frac{Q_j}{P_j} \frac{\partial P_j}{\partial L_{ij}} P_j . \quad (7)$$

Rearranging (7) and multiplying and dividing by Q_j/L_{ij} gives :

$$MRPL_{ij} = \frac{Q_j}{L_{ij}} P_j \varepsilon_{ij} \left(1 + \frac{1}{n_j}\right) , \quad (8)$$

where

$$n_j = \frac{\partial Q_j}{\partial P_j} \frac{P_j}{Q_j}$$

is the elasticity of demand for the output of industry j , and

equality of reduced form coefficients between industries. However, under certain plausible conditions, there is an approximation to $C^{(j)-1}$ available which will allow us to develop reduced form coefficients which are approximately equal. This is now discussed in Section 4.2.

4.2 Zero Restrictions on Reduced Form Parameters

For the purpose of estimating equation (21) a particularly useful *a priori* parameter specification is setting reduced form parameters equal to zero. To achieve this we need to argue that certain structural parameters are zero and be able to carry these restrictions through to the reduced form. The most obvious candidates for such restrictions are the wage elasticities.

In their industry specific form there are two reasons why we might consider that a small percentage change in the use of one type of labour (i) by a particular industry (j) may have virtually no effect on the wage that industry pays for another type of labour (ℓ) (i.e., zero $\phi_{\ell i}^{(j)}$) .

(a) Industry j's use of labour type i is small relative to the use of i by all industries, and hence a small percentage change in that input will have little effect on the market for other types of labour.

(b) There is little relationship between labour types ℓ and i either in terms of substitutability in the production process *or* in the wage determination system.

$$C^{(j)} = \begin{bmatrix} \left(\frac{L_{1j}}{L_1}\phi_{11} + 1\right) & \frac{L_{2j}}{L_1}\phi_{21} & \cdot & \cdot & \frac{L_{nj}}{L_1}\phi_{n1} \\ \cdot & & & & \\ \cdot & & & & \\ \frac{L_{1j}}{L_n}\phi_{1n} & \cdot & \cdot & \cdot & \left(\frac{L_{nj}}{L_n}\phi_{nn} + 1\right) \end{bmatrix} . \quad (24)$$

This can be written as

$$C^{(j)} = \hat{L}_i^{-1} \phi \hat{L}_{ij} + I = D^{(j)} + I , \quad (25)$$

where

$$\hat{L}_i^{-1} = \begin{bmatrix} \frac{1}{L_1} & & 0 \\ & \ddots & \\ 0 & & \frac{1}{L_n} \end{bmatrix} ; \quad \text{and} \quad \hat{L}_{ij} = \begin{bmatrix} L_{1j} & & 0 \\ & \ddots & \\ 0 & & L_{nj} \end{bmatrix} .$$

Now as the separate elements of the $C^{(j)}$ matrix as defined in (25) are not recoverable from $C^{(j)-1}$, the development of the industry wage elasticities matrix (ϕ) does not appear to be of use in creating

$$\varepsilon_{ij} = \frac{\partial Q_j}{\partial L_{ij}} \frac{L_{ij}}{Q_j}$$

is the marginal physical product of labour type i in industry j divided by its average physical product. This is the partial elasticity of production (i.e., with all other factors held constant) with respect to changes in L_{ij} . Solving (8) for L_{ij} we have :

$$L_{ij} = \frac{Q_j\, P_j\, \varepsilon_{ij}\left(1 + \frac{1}{n_j}\right)}{MRPL_{ij}} . \quad (9)$$

Now imposing the profit maximizing condition of $MRPL_{ij} = MFCL_{ij}$, substitution of (4) into (9) gives us the industry's demand function for labour type i :

$$L^D_{ij} = \frac{Q_j\, P_j\, \varepsilon_{ij}\left(1 + \frac{1}{n_j}\right)}{\sum_{\ell=1}^{n}\left(\phi^{(j)}_{\ell i} \frac{L_{\ell j}}{L_{ij}} + \delta_{\ell i}\right) W_{\ell j}} . \quad (10)$$

For every industry there will be n of these labour demand equations, one for each type of labour.

A more ad hoc approach is adopted in specifying the supply of labour function as the theoretical basis of the individual's labour supply decision is not as well developed in the literature as labour demand behaviour.[1] The supply of labour type i to industry j (L^S_{ij}) is viewed as the total labour supply of type i (L^S_i) multiplied by the share of this going to industry j (S_{ij}) .

1. Of course, the BACHUROO model is concerned with a detailed elaboration of the supply side. Hopefully the stylized model developed here will serve as a synopsis of the more important features relevant to wage determination.

Total supply of labour to occupation i is treated as a multiplicative function of the stock (H_{it}) of persons capable of undertaking occupation i in year t , the average after tax wages paid in occupation i in period (t - 1) and the average after tax wages paid in all other occupations in (t - 1) :

$$L_{it}^{s} = H_{it}^{\alpha_{1i}} \tilde{W}_{i,t-1}^{\alpha_{2i}} \tilde{W}_{.i,t-1}^{\alpha_{3i}} . \tag{11}$$

This specification implies the following :

(a) Current wages do not influence labour supply in the current period. It is assumed that labour supply does not react immediately to changes in wage rates. The single period lag specified in (11) is assumed to be due to delays in the diffusion of labour market information and to inertia on the part of labour suppliers in absorbing the information and in reacting to it.

This assumption seems reasonable for an annual model and avoids some of the problems of non-linearities which would be involved in solving for W_{ijt} if current wages were included in the labour supply function.

(b) Labour supply depends on after tax wages (i.e., the money actually received by employees). This specification is of particular relevance in times of rapidly increasing money wages when progressive tax rates can significantly alter relative take home wages.

where

$$\hat{T}_j = \begin{bmatrix} \frac{L_{1j}}{L_1} & & 0 \\ & \ddots & \\ 0 & & \frac{L_{nj}}{L_n} \end{bmatrix} ; \qquad \Phi = \begin{bmatrix} \phi_{11} & \cdots & \phi_{n1} \\ \vdots & & \vdots \\ \phi_{1n} & \cdots & \phi_{nn} \end{bmatrix}$$

and

L_i is the employment (man-hours) of labour type i in all industries. A typical wage elasticity will be

$$\phi_{\ell i}^{(j)} = \phi_{\ell i} \frac{L_{ij}}{L_i} . \tag{23}$$

Equation (23) states that the elasticity of average wages paid by industry j for occupation ℓ with respect to a change in the use of labour type i by industry j , is the all industry elasticity multiplied by industry j's share of employment of labour type i .[1]

The above adjustments account for all of the structural parameters which differ between industries for a given occupation. However, because of the way the wage elasticity parameters enter the reduced form wage equation (21), this will not ensure the equality of the reduced form coefficients. The $\phi_{\ell i}^{(j)}$ coefficients are included in the $C^{(j)}$ matrix of equation (16). It is the elements of the inverse of this $C^{(j)}$ matrix which appear as coefficients in equation (21). After making the assumption about the form of $\phi^{(j)}$ suggested in (22) the $C^{(j)}$ matrix will be :

1. While the model does not explicitly specify how actual employment is determined, L_{ij} and L_i are not strictly exogenous variables. In order to avoid having quasi endogenous variables as data in the reduced form system, it is intended to use the base period values of L_{ij} and L_i in estimation work.

This leaves the wage elasticity parameters. These measure the percentage response in average wages paid by an industry for labour of a particular occupation as a result of a small percentage change in that industry's use of another (or the same) type of labour. Clearly the mechanisms through which such wage responses occur are complex, and this makes the prior specification of the industry variation in them a difficult task. The one factor that will systematically affect the $\phi_{\ell i}^{(j)}$, causing them to vary between industries, is the importance of the industry in the type of labour whose usage is being changed. If an industry employs ten per cent of the unskilled white collar labour force, we would expect a given percentage change in its use of that type of labour to have a greater impact on wages in <u>all occupations</u> than the same percentage change in employment in an industry with only one per cent of the unskilled white collar workforce.

Hence it is hypothesized that each industry's wage elasticities matrix $(\Phi^{(j)})$ is made up of two components :

(i) an all industry elasticities matrix (Φ) determined by the technical and labour market relationships between different occupations ; and

(ii) an industry specific set of weights based on the industry's importance in the employment of various occupations $(\hat{T}_j)$.

Thus we have

$$\Phi^{(j)} = \hat{T}_j \Phi \quad , \tag{22}$$

(c) The influence of wages in other occupations on the supply of labour of type i is reflected in a single composite wage variable. Hence the effect on L_i^s of changes in wages in a particular occupation will be related to that occupation's importance in total employment. Ideally we should allow separately for the different influences of wages in each occupation on L_i^s . However the $(n - 1)$ additional parameters implied would place too great a strain on the available data.

(d) The α_2 and α_3 parameters can be interpreted as partial elasticities of labour supply with respect to the wage variables concerned.

The share S_{ij} of L_i^s going to industry j is treated as a function of average after tax wages paid to occupation i in industry j and average after tax wages paid in all other industries to occupation i , in the previous period

$$S_{ij} = \alpha_{4i} \ \ell n \ \tilde{W}_{ij,t-1} + \alpha_{5i} \ \ell n \ \tilde{W}_{i,.j,t-1} \ . \tag{12}$$

This specification is based on the assumption that the <u>percentage point</u> change in an industry's share of labour supply of a particular occupation, as a result of a given percentage change in that industry's lagged wage $(\tilde{W}_{ij,t-1})$ or in all other industries' lagged wages $(\tilde{W}_{i,.j,t-1})$, is the same for all industries.[1] Therefore the percentage change in an

1. Hence if the retail industry increases the wage it offers for unskilled white collar workers by 10 per cent and in the next year this leads to its <u>share</u> in the total supply of these workers rising by one <u>percentage point</u> (from say 5 to 6 per cent), then we expect a similar wage increase in (say) the transport and storage industry to have the same effect on that industry's share of the supply of these workers (from say 3 to 4 per cent).

industry's occupation share will be in inverse proportion to its existing labour supply. This requirement is met by equation (12) where :

$$\frac{\partial S_{ij}}{\partial \tilde{W}_{ij,t-1}} \frac{\tilde{W}_{ij,t-1}}{S_{ij}} = \frac{\alpha_{4i}}{S_{ij}} \quad \text{and} \quad \frac{\partial S_{ij}}{\partial \tilde{W}_{i,.j,t-1}} \frac{\tilde{W}_{i,.j,t-1}}{S_{ij}} = \frac{\alpha_{5i}}{S_{ij}} .$$

As we shall see in Section 4 the equality of occupation share parameters $(\alpha_{4i}$ and $\alpha_{5i})$ across industries implied by this specification will be most useful in estimating the reduced form wage equations of our model.

Again the specification of a single composite other industry wage variable $(\tilde{W}_{i,.j})$ in (12) avoids the additional parameters and considerable multicollinearity between explanators which would ensue if separate W_{ik} variables were included for wages in each of the other $(m - 1)$ industries.

From (11) and (12) the total supply of labour type i to industry j is :

$$L^S_{ij} = H^{\alpha_{1i}}_{it} \tilde{W}^{\alpha_{2i}}_{i,t-1} \tilde{W}^{\alpha_{3i}}_{.i,t-1} (\alpha_{4i} \ln \tilde{W}_{ij,t-1} + \alpha_{5i} \ln \tilde{W}_{i,.j,t-1}) . \qquad (13)$$

Equating L^S_{ij} and L^D_{ij} (i.e., equations (10) and (13)) and solving for current wages $(W^E_{ijt}$, say), gives the wages which will clear the market for labour type i in industry j in year t :

4.1 Restrictions on Coefficients Across Equations

In order to justify restrictions placed on the coefficients of the reduced form wage equations, we need to examine the various structural form parameters involved.

As a result of the specification of the model, certain structural form parameters are the same for a single occupation across all industries. These are the occupation labour supply elasticities $(\alpha_{2i}$ and $\alpha_{3i})$ and the occupation stock elasticities (α_{1i}). We have already argued that the industry share labour supply parameters $(\alpha_{4i}$ and $\alpha_{5i})$ and the wage adjustment parameters (λ_i) are equal between industries. However, there is no reason to expect a priori that any of the other structural form parameters are equal for all industries. Hence to be able to restrict reduced form coefficients across equations the relationship between these other structural parameters must be specified a priori.

If we assume that the industry production functions are all Cobb-Douglas,

$$Q_j = a K^{\Theta_j} \prod_{i=1}^{n} L_{ij}^{\varepsilon_{ij}} \times \text{(function of materials usage)} ,$$

and that constant returns to scale prevail with factors receiving their marginal revenue products, then the partial production elasticities will be equivalent to factor shares in gross revenue. This approach enables the prespecification of the ε_{ij} parameters. Prior estimates of the price elasticities of demand for the products of industries (η_j) are derivable from parameters estimated for the ORANI module.[1]

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1. Dixon, et al. (1977)

(b) Partial production elasticities with respect to labour inputs (ε_{ij}) ;

(c) Price elasticities of demand for outputs of industries (η_j) ;

(d) Occupational labour supply elasticities with respect to wages $(\alpha_{2i}$ and $\alpha_{3i})$;

(e) Industry share labour supply parameters $(\alpha_{4i}$ and $\alpha_{5i})$;

(f) Elasticities of occupational labour supply with respect to the stock of qualified personnel (α_{1i}) ;

(g) Wage adjustment parameters (λ_i) .

The focus of the model developed above is on the process by which wages are determined at a <u>disaggregated level</u>. Hence primarily we are interested in the set of reduced form equations (21), which explain the level of actual wages by industry and occupation. Restrictions which assist in estimating the n.m equations like (21) are those which set reduced form coefficients equal to (or related to) a particular value. These values may be either (a) another coefficient of the reduced form model, typically in our model the coefficient associated with the equivalent variable in the equation for the same occupation, in another industry, or (b) some number determined either <u>a priori</u> or by estimation outside the model. These possibilities are explored below.

$$\sum_{\ell=1}^{n} \left(\phi_{\ell i}^{(j)} \frac{L_{\ell jt}}{L_{ijt}} + \delta_{\ell i} \right) W_{ijt}^{E} = \tag{14}$$

$$\frac{Q_{jt}\, P_{jt}\, \varepsilon_{ij}\, (1 + \frac{1}{\eta_j})}{H_{it}^{\alpha_{1i}}\, W_{i,t-1}^{-\alpha_{2i}}\, W_{.i,t-1}^{-\alpha_{3i}}\, (\alpha_{4i}\, \ell n\, \tilde{W}_{ij,t-1} + \alpha_{5i}\, \ell n\, \tilde{W}_{i,.j,t-1})} = Z_{ijt} \,.$$

For each industry there will be n equations like (14) and this system can be written in matrix form as

$$\begin{bmatrix} (\phi_{11}^{(j)} + 1) & \phi_{21}^{(j)} \frac{L_{2j}}{L_{1j}} & \cdots & \phi_{n1}^{(j)} \frac{L_{nj}}{L_{1j}} \\ \vdots & (\phi_{22}^{(j)} + 1) & \cdots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \phi_{1n}^{(j)} \frac{L_{1j}}{L_{nj}} & \cdots & \cdots & (\phi_{nn}^{(j)} + 1) \end{bmatrix} \begin{bmatrix} W_{1jt}^{E} \\ \vdots \\ W_{ijt}^{E} \\ \vdots \\ W_{njt}^{E} \end{bmatrix} = \begin{bmatrix} Z_{1jt} \\ \vdots \\ Z_{ijt} \\ \vdots \\ Z_{njt} \end{bmatrix} \tag{15}$$

In shorthand we have :

$$C^{(j)}\, W_{.jt}^{E} = Z_{.jt} \,, \tag{16}$$

yielding

$$W^E_{.jt} = [C^{(j)}]^{-1} Z_{.jt} \; , \tag{17}$$

where $W^E_{.jt}$ is the vector of equilibrium wages in year t for industry j. A typical equation in this system is

$$W^E_{ijt} = C^{(j)^{-1}}_{i1} Z_{1jt} + \ldots + C^{(j)^{-1}}_{in} Z_{njt} \; , \tag{18}$$

where $C^{(j)^{-1}}_{im}$ is the i^{th} row, m^{th} column element of $[C^{(j)}]^{-1}$.

Each of the endogenous W^E_{ijt} variables depend on all of the exogenous variables, the parameters of the relationships being related to the parameters of equations (10) and (14). As we shall see in Section 4 a number of reasonable a priori restrictions might be placed on the structural form parameters in order to facilitate estimation of the reduced form model.

4. RESTRICTIONS ON STRUCTURAL FORM PARAMETERS

Only four years data are currently available for estimating the $n + 1$ coefficients of each of the reduced form wage equations represented by (21) and for identifying the parameters of the underlying structural model.[1] Not surprisingly this cannot be achieved for any meaningful n (number of occupations) with the model as it stands. One means of helping to solve both of these problems is to place restrictions on the parameters of the structural model.

Firstly, it is necessary to decide the variables on which to parameterize the structural model. Clearly these decisions must be somewhat arbitrary as it is often possible to claim that a particular parameter should in fact be treated as a variable of the model.[2] However, at some stage certain elements of the model have to be treated as fixed parameters. This choice is determined by the focus of the model concerned, and the factors that are considered to be relatively stable over time or about whose determination we can, or wish to say little.

Those factors being treated as parameters of the structural model are :

(a) Elasticities of wages with respect to changes in labour demand $(\phi^{(j)}_{\ell i})$;

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1. Data on actual wages are available for a consistently defined set of industries over a ten year period (1963-72) but only for the occupations non-managerial and managerial (see ABS Survey of Weekly Earnings and Hours, Reference No. 6.1). The heterogeneous nature of these groups limits their usefulness for studying wage determination at a disaggregated level.

2. For example, the elasticity of demand for an industry's output (η_j) will be treated as a parameter of the model. However, it could be argued that these elasticities vary over time (e.g., with the business cycle) and hence should be explained within the model.

individual influences are assumed to cancel each other out leaving each λ_i constant over time. The existence of only three data points in time precludes allowing for changing λ_i.

Thirdly, for projection purposes a model containing an exogenous national wage case variable will require projections of this variable. While the ORANI and BACHUROO modules endogenize the variables exogenous to the market wage model developed so far, they do not attempt to explain national wage decisions and this is a drawback of including this variable. Clearly such considerations cannot justify an incorrect model specification, but given the two above points, they do add weight to the argument for excluding a national wage decision variable from our model.

Substituting the expression for equilibrium wage from equation (18) into equation (20) we obtain an expression for the actual wage of occupation i in industry j in period t

$$W^A_{ijt} = \lambda_i C^{(j)-1}_{i1} Z_{1j} + \ldots + \lambda_i C^{(j)-1}_{in} Z_{nj} + (1 - \lambda_i) W^A_{ij,t-1} \quad . \tag{21}$$

This is a typical one of the n.m reduced form actual wage equations resulting from the structural model made up of equations (4), (8), (11), (12) and (20) and the closing conditions that firms equate $MRPL_{ij}$ and $MFCL_{ij}$ and that equilibrium wages occur where $L^D_{ij} = L^S_{ij}$.

3. THE MARKET WAGE MODEL

For a number of reasons it is not expected that actual (i.e., observed) wages in all industries and occupations will adjust to equilibrium in a single year.[1]

(a) Labour market institutions tend to slow or prevent the wage adjustments (either in absolute or relative wages) needed to achieve equilibrium in all sectors of the labour market. For example, unions often attempt to maintain fairly rigid relativities of their members' wages to those in certain other occupations and industries. Equity objectives have meant that the Arbitration Commission has set minimum wages which may well be too high to allow full employment of unskilled and junior workers.

(b) The considerable time necessary to alter the stock of people capable of undertaking certain occupations means that quantity adjustments on the supply side will be limited in the short run[2] (i.e., the short run supply curve is relatively inelastic). Hence the wage adjustments needed to achieve short run equilibrium may be quite substantial in periods of rapid economic change

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1. Some subsections of the labour market may remain in almost permanent disequilibrium. For example, the market for seamen is a high wage, excess supply situation maintained by a strong union, willing to accept high disguised unemployment in the coastal shipping industry, and by government regulations restricting overseas competition.

2. The equilibrium model has assumed a perfectly inelastic supply curve with respect to current wages. However, it is also expected that even over longer periods (say three years) labour supply by occupation will be fairly inelastic (although the shares going to particular industries should be quite responsive to relative wage changes).

and, particularly in view of the institutional constraints mentioned above, these adjustments may not occur within a single year.

(c) A particular set of equilibrium wages only applies for a given level of final demand for output. Changes in actual wages, however, will affect the level of output demand and prices and hence result in a new equilibrium wage matrix. Ideally we would like to model prices and output endogenously. However the restrictions of the available data strictly limits the size and complexity of the structural form model if we are to be able to identify the structural form parameters.

McGuire and Rapping (1968) suggest two mechanisms by which actual wages will differ from equilibrium wages. Firstly there is expected to be a lag in wages adjusting from their previous period's level to the new equilibrium. Hence last year's wages are expected to influence current wages.[1] If we believe our supply and demand equations are correctly specified then this adjustment lag must be the result of institutional barriers. However, there may also be some short run variations in the labour demand function from that implied by short run profit maximizing behaviour (e.g., the practice of labour hoarding during a slump) which are reflected in slow adjustment of actual wages and employment to their equilibrium levels.

1. This effect will be in addition to their influence on current wages through the labour supply function in the model.

model the majority of the Commission's indexation judgments provided less than full indexation, reflecting the Commission's awareness of the prevailing depressed economic conditions.[1] Therefore we would argue that, in general, national wage cases have been influenced by the economic variables determining the all (industry/occupation) groups equilibrium wage. Clearly this concordance will be far from perfect due to the incomplete and varying importance placed on economic factors in reaching national wage decisions. Furthermore at the individual industry/occupation level, particular equilibrium wages are likely to be changing at different rates and possibly even in different directions. Hence while we argue that at the aggregate level the equilibrium model will already reflect some of the forces influencing the national wage, there remains a significant independent element in its effects on disaggregated actual wages.

Therefore secondly we hypothesise that the independent (i.e., non-equilibrium) influence of the national wage case will tend to slow down the adjustment from previous wages to equilibrium wages. Hence the rate of adjustment parameters (λ_i) in equation (20) will be affected by Arbitration Commission wage policies. No explicit allowance is made for this sort of influence but rather it is treated implicitly as one of a number of factors determining the λ_i parameters. Changes in these

1. Six of these decisions have given full compensation for the previous quarter's CPI increase while seven have given partial indexation, five of these involving smaller percentage rises for higher wage earners. This latter trend could be seen as a particularly disequilibriating influence of national wage decisions as unemployment rates for skilled workers are lower than those for the unskilled, suggesting that wider wage differentials were appropriate on economic grounds.

Until recent years the most obvious candidate for an Australian key bargain settlement of the McGuire and Rapping type was the Metal Trades Award which flowed on in varying degrees and with varying rapidity to a wide range of other awards. Some of these influences were purely institutional (i.e., full automatic flow on through the Arbitration Commission) while others resulted from bargaining in awards involving labour both functionally related and unrelated to the metal trades. However, since 1973 this flow on process has been largely averted and over the period of estimation for our model there existed no clear key bargain settlement.

A key bargain of a different type to that envisaged by McGuire and Rapping is the national wage case. This single wage decision affects wages in most industries and occupations but not in the spillover sense of one wage settlement imitating another. Rather it is purely an administrative procedure reflecting the wide range of awards covered directly or indirectly (through State and Public Service Awards) by the national wage decision. Unlike spillovers it does not imply the existence of strong unions able to imitate a wage settlement obtained in another sector. Over most of the 1974-77 period the wage indexation system was in operation and a large part of the money wage increases occuring during this time were a direct result of indexation decisions.

Despite the obvious importance of the national wage case, our model will not include any independent allowance for the actions of the Arbitration Commission. Apart from the data limitations mentioned above there are three reasons for this approach. Firstly, it seems reasonable to assume that macroeconomic conditions have played an important role in influencing indexation decisions. Over the estimation period for our

Numerous adjustment mechanisms could be suggested[1] and for our purposes there appear to be few *a priori* grounds on which to choose between a number of these alternatives. Adjustments towards equilibrium could take a number of years and hence in their most general form would require separate variables (and parameters) for each previous year thought to be important in determining current wages. However, the available data strictly limit the types of adjustment mechanisms that can be incorporated into the model. Hence we assume that current actual wages (W^A_{ijt}) are determined within a simple partial adjustment framework, as follows :

$$(W^A_{ijt} - W^A_{ijt-1}) = \lambda_i (W^E_{ijt} - W^A_{ijt-1}) \qquad (0 < \lambda_{ij} < 1 \ \ \forall \text{ i and j}). \quad (19)$$

Rearranging, this becomes :

$$W^A_{ijt} = (1 - \lambda_i)\, W^A_{ijt-1} + \lambda_i\, W^E_{ijt} , \qquad (20)$$

which implies that current wages are a geometric distributed lag of past equilibrium wages.

We have assumed that for any single occupation, the wage adjustment parameters (λ_i) are the same in all industries (i.e., there is no j subscript on λ). This is based on the belief that, at least at the aggregated occupation and industry levels to be used in this study, the adjustment of wages towards equilibrium relies largely on factors peculiar to occupations. Parham and Ryland (1978) have shown that most

1. See Dhrymes (1971).

of the explainable variation in hourly earnings between occupation/industry groups in both 1968/69 and 1973/74 is accounted for by occupation.[1] This suggests that, by and large, industry of employment does not have a large independent effect on wages, thus providing some empirical justification for assuming that the rate of movement of wages towards equilibrium will also be independent of industry, provided occupation is held constant.

A second mechanism suggested by McGuire and Rapping which accounts for the non-equality of equilibrium and actual wages is the potential influence of key bargains struck elsewhere in the economy. These authors hypothesise that wages in some industries might not be moving towards the equilibrium market clearing wage but rather towards some combination (a geometric mean in their model) of equilibrium and key bargain wages. This view of the influence of the key bargain wage is necessarily a bargaining interpretation. It requires that unions use the key bargain settlement as a basis for their wage claims (and are willing to accept the unemployment implied by wages above equilibrium) and/or that arbitrators and employers use it for making wage settlements.[2]

1. Parham and Ryland investigate the importance of industry and occupational affiliation as explanators in hourly earnings rates. A high percentage of the variation which could be explained jointly by industry and occupation could be explained by occupation alone. The levels of aggregation at which these authors worked (21 industry groups, 5 occupations) is similar to that proposed for the empirical implementation of this paper.
2. The bargaining theory approach to modelling wage determination would suggest including key bargains as influencing both the employers' expectation function concerning the wages they are likely to have to pay to avoid industrial action and unions' wage requirements in order to refrain from industrial action.

There are two other forms in which the key bargain wage settlement may influence wages in other industries and occupations. Firstly, it could enter (lagged one period in our model) the labour supply functions for these groups shifting them to the left thereby raising equilibrium wages. In this role the key bargain will be no different from other wage changes in that its effect on wages for particular industry/occupation groups will be related to the possibilities for labour mobility between them and the key bargain groups.[1] This contrasts with its bargaining influence where linkages in the industrial relations structure will determine its effect on particular groups' wages (for example, as a key bargain it may have less influence on wages of very similar types of labour than it does on wages of fairly unrelated groups).

Secondly, even in an equilibrium wage model key bargains may play an independent role in the process by which equilibrium wages are reached. Traditionally economists have had little to say about the mechanism which moves us from one static equilibrium position to another. In the context of wage setting this process may include certain key bargains acting as signals to employers concerning shifts in wages in general and hence in the labour supply curves facing them. To the extent that those key bargains correctly mirror supply shifts, they will have no more observable importance than expected from their first influence above. However, if they give incorrect signals and within a single period employers either (1) do not realise this, or (2) are not able to adjust their wage offers accordingly, then the influence of key bargains on actual wages will be greater and more diverse than expected.

1. The influence of the key bargain on labour supply of related groups could be somewhat larger or at least more rapid than that of other wage changes because of the greater awareness of this bargain in the labour market.