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Source: *Oxford Economic Papers*, New Series, Vol. 34, No. 1 (Mar., 1982), pp. 98-107

Published by: Oxford University Press

Stable URL: <http://www.jstor.org/stable/2662741>

Accessed: 10/08/2009 17:07

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RELATIONSHIP BETWEEN UNEMPLOYMENT AND VACANCIES IN THE UNITED KINGDOM: A MIMIC APPROACH¹

By A. PARIKH and F. ALLEN

I

Introduction

It has been widely recognized that there has been a shift in the relationship between unemployment and vacancies in Great Britain since late 1966. There have been a number of attempts to explain this.

Sleeper (1970) argued that it occurred because the introduction of Selective Employment Tax in September 1966 resulted in a reduction in employment in service industries.

Gujarati (1972) argued that because of the introduction of redundancy payments in December 1965 and earnings-related unemployment benefit in September 1966, people chose to remain unemployed for longer and this resulted in a shift in the *UV* relationship.

Taylor (1972) suggested that towards the end of 1966, there was a deliberate shake-out of labour, resulting from a change in the employment policy of firms because of pessimism about the future, and that because of redundancy payments this was not resisted by the unions as much as before.

Foster (1974) put forward the explanation that the shift in late 1966 could be attributed to two main factors: (a) the abnormal demographic increase in young inexperienced labour and (b) the introduction of redundancy payments legislation which encouraged employers to shake out older, less efficient workers. Furthermore, the legislation on redundancy payments was that it biased redundancies towards very young and very old employees. It was concluded by Foster (1974) that the introduction of earnings related benefits is of minor importance in explaining the *UV* shift.

Evans (1977) looked at the problem afresh and broke down the shift in the *UV* relationship for males and females. The curve showing the *UV* relationship seems to have shifted outward for males in 1966–68, but did not shift or shifted slightly inwards for females. Thus it is argued that the shift in the curve for males is unlikely to be due to an increase in the number of young inexperienced workers, due to the rise in the birth-rate twenty years ago, since this would have affected females equally; similarly the shift is unlikely to be due to increased redundancies in manufacturing or service industries. He compares data on unemployment from the censuses of 1961, 1966 and 1971 with registered unemployment and shows that a large number of unemployed males and females may be unregistered and that the

¹ The authors would like to thank Mr. S. Mosley for his competent statistical assistance, and the referee of the journal for suggesting revisions which have improved the model formulations.

proportion that is registered varies considerably both between regions and over time. He largely attributes the shift to the introduction of earnings-related unemployment benefits which increased the propensity to register because of the greater rewards for doing so; true employment may not necessarily have changed.

The problem appears to be that the usual measurement of unemployment is subject to different and significant errors in observation from one phase of the cycle to another. A similar observation can be made about vacancies. If the economy moves from a recession to an upswing, the number of vacancies may be expected to rise immediately, though the percentage unemployed may remain quite high, owing to the unwillingness of the labour force to move either between occupations or between regions. There is also a strong possibility of reporting bias for two variables. The unemployment rate has a definite lower limit of zero, whilst the excess demand for labour or vacancy rate has no defined upper limit. (Parikh, 1977). There is no legal obligation for firms to record vacancies, and in periods of high demand for labour, strong discouragement effects may result in serious underestimates of their numbers.

As both unemployment and vacancies are subject to errors in variables, the ordinary least squares estimates of α and β from a single equation relationship such as

$$\log U_t = \alpha + \beta \log V_t + \varepsilon_t \quad \beta < 0 \quad (1.1)$$

are biased and inconsistent. Recently, Zellner (1970) and Goldberger (1972a) have suggested an approach through which the consistent estimation of a simultaneous equation model with errors in variables is possible if the model is identified. This approach was used in another paper (Parikh-Allen, 1977).

We propose four different models to analyse the relationship between unemployment and vacancies as measures of excess demand for the United Kingdom economy.² We adopt an approach used by McCallum (1974) and cast the excess supply of labour (that is the difference between the supply of labour and the demand for labour divided by the supply of labour) in a neoclassical framework and use the underlying theory to explain the observed variation in unemployment rate. We have also used excess demand as measured by the vacancy rate as the dependent variable in the same model and instead of relating it directly to unemployment rate, we have used instruments such as real wage rate and productivity for the true unobserved measure of excess demand/supply on the labour market.

In Section II, we formulate the models. In Section III, we summarize the results based on four estimated models, to support or reject a number of

² Parikh and Raj (1979) have made use of unemployment-vacancy relationships in wage-price equations for the United Kingdom using a random coefficients regression framework to account for the shifts in the relationships.

null hypotheses. The models proposed in this paper are multiple-indicator-multiple-cause (MIMIC) models. MIMIC model blends econometric and psychometric themes (Goldberger, 1974).

II

Models with unobservable variables

In the introduction, a brief summary was given of the various explanations that have been put forward to explain the *UV* shift. The purpose here is not to pinpoint one of these causes. It is accepted that the observed *UV* relationship has changed due to one or several reasons and we conduct the empirical analysis based on this hypothesis. Given the various explanations, it is possible to postulate a statistical relationship between unemployment and vacancies such as (1.1) treating both as observed variables. This log-linear specification is estimated by Bowers, Cheshire and Webb (1970).

There are a number of problems with this direct relationship. Both unemployment and vacancies are endogenously determined rendering the interpretation invalid. Though apparently meaningful results may be obtained, there is a strong possibility of deriving misleading conclusions from such a misspecified relationship. We propose four alternative models which are estimated in Section III. Both unemployment and vacancies are proxies measuring excess demand for labour, and true measure of excess demand on the labour market is unobserved. It is proposed to derive a true (unobserved) excess demand (X_t^*) equation using a very simple neoclassical framework based on McCallum (1974).

Let Q denote aggregate output and $w = W/P$ the real wage rate. The quantity of labour demanded in period t , L_t^d is then assumed to be given by:

$$\frac{L_t^d}{Q_t} = f(w_t, t), \quad \frac{\partial f}{\partial w} < 0 \quad \frac{\partial f}{\partial t} < 0 \quad (2.1)$$

where the trend variable t enters to account for technical progress. On the supply side, an equally simple relationship is postulated.

$$\frac{L_t^s}{N_t} = g(w_t, t), \quad \frac{\partial g}{\partial w} > 0 \quad (2.2)$$

where N is a population measure and t is designed to capture the influence of gradually changing tastes for employment and other institutional factors. The signs of the partial derivatives are presumed to be as indicated although this is not definite. Letting $q = Q/N$ and assuming log-linear relationships for (2.1) and (2.2) we obtain

$$\log L_t^d - \log L_t^s = b_1 \log q_t + b_2 \log w_t + b_3 t.$$

Using the approximation formula, $(x - z)/z = \log x - \log z$, this becomes

$$(L_t^d - L_t^s)/L_t^s = b_1 \log q_t + b_2 \log w_t + b_3 t. \quad (2.3)$$

McCallum then postulates a wage adjustment relation and substitutes the relationship on the right hand side of (2.3) to derive an operational wage adjustment equation. We adopt a different approach however and make use of (2.3), the unobserved excess demand equation of the labour market, in the unemployment and vacancy relationships. In the models presented below, we have excluded time-trend variable in the first model but have introduced it in the third model.

Model A:

$$U_t = \alpha_0 + \alpha_1 X_t^* + \alpha_2 Z_t + \varepsilon_{1t} \quad (\text{A.1})$$

$$V_t = \beta_0 + \beta_1 X_t^* + \beta_2 Z_t + \varepsilon_{2t} \quad (\text{A.2})$$

$$X_t^* = \gamma_1 \log q_t + \gamma_2 \log w_t + \varepsilon_{3t} \quad (\text{A.3})$$

and

$$\Sigma = E(\varepsilon\varepsilon') = \begin{bmatrix} \sigma_{11} & \sigma_{12} & 0 \\ \sigma_{12} & \sigma_{22} & 0 \\ 0 & 0 & \sigma_{33} \end{bmatrix}$$

where U_t = the observed unemployment rate

V_t = the observed vacancy rate

Z_t = a shift dummy; 0 before 1966 (3) and 1 thereafter

W_t = wages (index number)

P_t = Prices (Retail Price Index)

$w_t = W_t/P_t$ = Real Wages

Q_t = gross domestic product

N_t = a measure of the working population obtained by interpolating the annual figures for those aged between 20 and 65

$q_t = Q_t/N_t$ = productivity variable

H_t = Index of normal hours worked (seasonally adjusted)

X_t^* = Unobserved measure of excess demand for labour.

In the model A, the equation (A.3) can be substituted in (A.1) and (A.2) and reduced-form equations are obtained. The unobservable variable disappears from the estimating equations. We obtain:

$$U_t = \alpha_0 + \alpha_1 \gamma_1 \log q_t + \alpha_1 \gamma_2 \log w_t + \alpha_2 Z_t + \varepsilon_{1t} + \alpha_1 \varepsilon_{3t} \quad (\text{A.4})$$

$$V_t = \beta_0 + \beta_1 \gamma_1 \log q_t + \beta_1 \gamma_2 \log w_t + \beta_2 Z_t + \varepsilon_{2t} + \beta_1 \varepsilon_{3t}. \quad (\text{A.5})$$

There is an overidentifying restriction $\alpha_1 \gamma_1 / \beta_1 \gamma_1 = \alpha_1 \gamma_2 / \beta_1 \gamma_2$, and from the reduced-form disturbance variance-covariance matrix, σ_{ij} can be recovered under the assumption that $\sigma_{33} = 1$ (standardised). The overidentifying restriction (Goldberger, 1973) and the hypothesis $\alpha_2 = \beta_2 = 0$ can be tested after estimating restricted and unrestricted versions of model A which is presented in Section 3.

The second model postulated is:

Model B:

$$U_t = \alpha_0 + \alpha_1 X_t^* + \varepsilon_{1t} \quad (\text{B.1})$$

$$V_t = \beta_0 + \beta_1 X_t^* + \varepsilon_{2t} \quad (\text{B.2})$$

$$X_t^* = \gamma_1 \log q_t + \gamma_2 \log w_t + \gamma_3 Z_t + \varepsilon_{3t}. \quad (\text{B.3})$$

In this model, the unobserved measure of excess demand in the labour market has shifted and shift dummy is used in (B.3) instead of in (B.1) and (B.2). This model has one more overidentifying restriction since the reduced-forms yield

$$\frac{\alpha_1 \gamma_1}{\beta_1 \gamma_1} = \frac{\alpha_1 \gamma_2}{\beta_1 \gamma_2} = \frac{\alpha_1 \gamma_3}{\beta_1 \gamma_3} = \mu,$$

and this can be tested after estimation. The assumptions regarding variance-covariance matrix of stochastic disturbances are as before.

Model C:

In both models A and B, the trend variable is not used although the measure of excess demand for labour derived in (2.3) explicitly contains time trend variable. We, therefore, decided to make use of this variable in X_t^* relationship.

$$U_t = \alpha_0 + \alpha_1 X_t^* + \alpha_2 Z_t + \varepsilon_{1t} \quad (\text{C.1})$$

$$V_t = \beta_0 + \beta_1 X_t^* + \beta_2 Z_t + \varepsilon_{2t} \quad (\text{C.2})$$

$$X_t^* = \gamma_1 \log q_t + \gamma_2 \log w_t + \gamma_3 t + \varepsilon_{3t}. \quad (\text{C.3})$$

In this model, there is an additional overidentifying restriction as model B and this can be tested. Our restriction is

$$\frac{\alpha_1 \gamma_1}{\beta_1 \gamma_1} = \frac{\alpha_1 \gamma_2}{\beta_1 \gamma_2} = \frac{\alpha_1 \gamma_3}{\beta_1 \gamma_3} = \mu$$

and the hypothesis of shift in unemployment or vacancy relationship can be tested as in model A.

In model D, the shift in unemployment or vacancy relationship is explained after testing the null hypothesis of shift in U or V equation. The variable Z_t is eliminated from model C and the index of normal hours worked is used as a shift variable in one of the relationships. Because of the redundancy payments act and other reasons discussed in Section 1, the observed higher unemployment rate for a given level of excess demand might be reflected in index of normal hours worked variable. We expect the

sign $\partial U_t/\partial H_t > 0$ indicating that when normal hours worked rises, the unemployment increases. Our model is:

Model D:

$$U_t = \alpha_0 + \alpha_1 X_t^* + \alpha_2 H_t + \varepsilon_{1t} \quad (\text{D.1})$$

$$V_t = \beta_0 + \beta_1 X_t^* + \varepsilon_{2t} \quad (\text{D.2})$$

$$X_t^* = \gamma_1 \log q_t + \gamma_2 \log w_t + \gamma_{3t} + \varepsilon_{3t} \quad (\text{D.3})$$

and the hypothesis of a priori restrictions and the null hypothesis $\alpha_2 = 0$, can be tested.

III

Data, estimation and results:

The data on which the study is based was collected from appropriate volumes of Economic Trends, DEP Gazettes, CSO National Income and Expenditure and Monthly Digest of Statistics. All data are seasonally adjusted and therefore seasonal dummies have not been used in any of the models.

In Table 1, we give Full-Information Maximum Likelihood Estimates of parameters of four models A, B, C and D proposed in Section II. In model A, we have shift variable explicitly introduced in equations A.1 and A.2. There is one parametric restriction (overidentifying) and using this restriction in the FIML procedure, estimates are obtained. Any increase in real wage rate increases unemployment and a per cent increase in real wage is associated with 4.71 per cent increase in unemployment rate. The productivity variable does not play any significant role. Any increase in real wage rate increases vacancy rate although the coefficient is not statistically significant when asymptotic t -test is used. We also estimated a model without any restrictions on the coefficients of $\log q$ and $\log w$ of the vacancy relationship and we find that our a priori restrictions in the form of $\alpha_1 \gamma_1 / \beta_1 \gamma_1 = \alpha_1 \gamma_2 / \beta_1 \gamma_2$ is not rejected.³ χ^2 test conducted using the likelihood values suggested that restricted and unrestricted models produce similar estimates. The validity of the model is tested and if we take the restricted model as a valid model, more efficient estimates are obtained. The null hypothesis that $\alpha_2 = \beta_2 = 0$ is tested and we find that there is a significant coefficient with respect to Z_t (dummy) variable in unemployment relationship. This confirms that the relationship between unemployment, the observed measure of excess demand for labour, and true (unobserved) measure of excess demand in the labour market has shifted since 1966(III). This shift may be due to any

³ Goldberger (1973) suggests that if the validity of the model is in doubt, the restrictions may be used to test the model.

TABLE 1
Full Information Maximum Likelihood Estimates, t-ratios, of Unemployment-Vacancy Model: Restricted and Unrestricted Forms

Model Name	Dependent Variable	Coefficients with Respect to						Variance of Residuals	log likelihood	χ^2
		Constant	log Q	log w	Z _t	time-trend	H _t			
A-Restricted	U _t	0.7762 (1.1768)	-0.3164 (0.7772)	4.7121* (4.0851)	0.3921* (2.3374)		0.23760	16.4503	0.0000	
A-Restricted	V _t	0.5913* (2.5728)	-0.1053 (0.7651)	1.5686 (0.0778)	-0.1052 (0.0778)		0.05277	—	—	
A-Unrestricted	U _t	0.7777 (0.3121)	-0.3155 (0.1987)	4.7111* (2.4375)	0.3929 (1.6262)		0.23760	16.4503	—	
A-Unrestricted	V _t	0.5906 (0.5029)	-0.1058 (0.1413)	1.5686 (1.7221)	-0.1051 (0.9230)		0.05277	—	—	
B-Restricted	U _t	0.5958 (0.7210)	-0.4062 (0.7839)	6.0492* (6.7239)	0.1389 (1.7379)		0.24540	15.0859	0.7288	
B-Restricted	V _t	0.6807* (4.6735)	-0.6080 (0.7581)	0.8946 (0.7581)	0.0208 (0.7581)		0.05470	—	—	
C-Restricted	U _t	3.8104* (2.8645)	1.5254 (1.8056)	4.2791* (3.4276)	0.4959* (2.9639)	-0.0128* (2.1809)	0.25460	18.7842	25.4852	
C-Restricted	V _t	1.9364* (3.0644)	0.7390 (1.8473)	2.0731 (1.8473)	-0.1328 (1.7931)	-0.0062 (1.7931)	0.04940	—	—	
C-Unrestricted	U _t	-20.4700* (4.0398)	-13.4347* (4.2679)	2.2094 (1.2359)	0.2548 (1.1841)	0.0943* (4.6541)	0.18940	31.5268	—	
C-Unrestricted	V _t	12.5832* (5.6297)	7.2989* (5.2566)	7.2989* (3.7797)	-0.0271 (0.2859)	-0.0532* (5.9551)	0.03591	—	—	
D-Restricted	U _t	-5.9743 (1.9227)	2.2106 (1.7707)	3.4276 (1.0381)	0.1071* (3.6858)	0.0136 (1.4121)	0.24230	19.3502	34.3236	
D-Restricted	V _t	1.0456* (6.6514)	0.1603 (1.4408)	0.2485 (1.4408)	0.0009 (1.4408)	0.0009 (1.4408)	0.05640	—	—	
D-Unrestricted	U _t	-29.1698* (5.5398)	-11.4530* (3.9274)	-2.4224 (1.3248)	0.1181* (4.0513)	0.1223* (6.1767)	0.16300	36.5120	—	
D-Unrestricted	V _t	12.4668* (5.6696)	7.2222* (5.2987)	3.0634* (4.1738)	-0.5356* (6.0492)	-0.5356* (6.0492)	0.03600	—	—	

1 For model B, the unrestricted model is the same as unrestricted model A.

2 * denotes that asymptotic t-ratios are greater than 2.

3 t-ratios for derived coefficients can be obtained from the authors.

one or more reasons mentioned in Section 1. When the Z_t variable is dropped from vacancy relationship, the same estimates are obtained.

Model B uses the shift dummy in the unobserved measure of excess demand for labour equation and when we obtain reduced-forms of model B, we find that there are two overidentifying restrictions. Once again, the validity of this model is tested using χ^2 test which reject the restrictions since the obtained χ^2 value is greater than $\chi^2_{0.05}$ for 2 degrees of freedom.⁴ In this case, the restricted model is rejected. The results of this model are similar to model A as far as signs of the coefficients are concerned.

In Model C, time-trend variable is used in the unobserved measure of excess demand for labour as obtained in expression (2.3). We can test the validity of the model through overidentifying restrictions and the shift parameter, $\alpha_2 = \beta_2 = 0$. The χ^2 test reveals that the overidentifying restrictions are rejected and unrestricted model is a much better fit to the data since likelihood values are relatively very high. In the unrestricted version, increase in productivity decreases unemployment while it contributes to the increase in vacancy. A rise in short-run productivity seems to be associated with increased capacity utilization leading to an increase in employment which increases demand for labour and hence the vacancy rate. With the restricted version, we have obtained incorrect sign with respect to technical progress variable while the unrestricted version suggests that technological progress increases unemployment rate and reduces vacancy rate. An increase in real wage raises the vacancy rate and this may be due to the employers bidding up wages to fill up the vacancies.

In Model D, instead of using the shift dummy, we make use of index of normal hours worked in the observed unemployment relationship because the coefficient of Z_t is significant in this relationship as indicated by model A. The size of α_2 in unemployment relationship suggests that the shift arises on the supply side and the response to this shift by employers or unions may be captured in the index of normal hours worked⁵ variable. When output cyclically expanded after 1966, firms perhaps relied more upon increasing hours of work and less upon recruitment of new employees. There are two a priori restrictions and the test reveals that the restricted version is rejected. Signs of most of the coefficients of the unrestricted version are as expected. We have not postulated unrestricted model and it should be considered as a statistical model alternative to restricted model. The coefficient of normal hours worked variable seems to explain the shift in unemployment relationship and increases the likelihood value for both restricted and unrestricted

⁴ The unrestricted model B is equivalent to the unrestricted model for A and likelihood ratio test is constructed on the basis of log of likelihood values $-2[\log L(R) - \log L(UR)]$ follows a χ^2 distribution with degrees of freedom equivalent to number of restrictions. The $\log L(R)$ and $\log L(UR)$ refers to corresponding likelihood values for restricted and unrestricted models. The lower is the χ^2 value, the better is the fit.

⁵ When index of normal hours falls, employees may be available for overtime if their preference for work is greater than leisure.

versions. An increase in normal hours increases unemployment as expected.⁶

However, the model D is rejected empirically and among the four models studied, the model A is acceptable while models B, C and D are not. In models B, C and D, the unobserved measure of excess demand for labour introduces shift dummies in a symmetrical manner in both the unemployment and vacancy relationships. These models (B, C and D) assume that a structural shift in the labour market is accounted for in terms of a variable which affects both excess supply and excess demand variables symmetrically. Our econometric tests reject this hypothesis.

Summary and conclusions

In this section, we summarize some of the tentative conclusions derived on the basis of four postulated models for studying the observed unemployment and vacancy rates on the true measure of excess demand on the labour market, which is derived using McCallam's (1974) neoclassical theory of demand. Each of the models was tested against the unrestricted version since the parameters of regression provide more than enough information to determine the structural parameters which are known as overidentifying restrictions. If the validity of the model was confirmed, the restrictions could be exploited to obtain more efficient estimates.

We found that one of the four models satisfied the restrictions and this version confirms that the shift in unemployment relationship has taken place since 1966 (III) and this shift may be due to redundancy payments act, earnings-related unemployment benefit, selective employment tax and abnormal demographic increase in young inexperienced labour and increased propensity to register as unemployed since 1966.

The estimated coefficients of Model A where the shift dummies are included directly in the unemployment and vacancies relationships indicate that the shift in unemployment is greater than in vacancies and this rejects the model versions B, C and D in which shift variables appear through unobserved measure of excess demand for labour (X_t^*).

It may be concluded that there has been a structural shift in the $U-V$ locus and this is not accounted for in terms of a variable which affects both sides of the labour market symmetrically. The model results favour the hypothesis that the shift in unemployment is greater than the shift in vacancies.

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⁶ The index of normal hours worked (seasonally adjusted) shows a sharp decline until 1965, and since 1968, it is almost constant while the longer *average* hours worked in 1967-68 indicates that firms were employing existing underutilised stock of labour on overtime basis during cyclical growth. It is probable that any further decline in normal hours worked has a strong influence on unemployment rate.

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