

Modelling a Regime-Shifting New Zealand Beveridge Curve¹

Richard Dutu, Mark J. Holmes and Brian Silverstone
Economics Department
University of Waikato, Hamilton

Abstract

This paper offers new insights into Beveridge curve analysis by modelling the unemployment-vacancy rate relationship within a Markov regime-switching environment in which the probabilities of curve-shifting are determined endogenously by shift factors. This approach, in sharp contrast to existing Beveridge curve literature, enables regime-specific parameters to be estimated. In addition, a novel feature of our analysis is an assessment of the role played by several factors in influencing the transition probabilities of switching between regimes. These shift factors include the labour force participation rate, GDP growth, net migration and the real interest rate. Using New Zealand data, our evidence suggests that these variables have been responsible, in varying degrees, for shifts in and movements along the Beveridge curve.

1. Introduction

Richard Layard and Charles Bean (1989, p.371) once remarked that ‘macroeconomics was invented to explain the persistence of unemployment’. Some two decades on from this remark - in 2008 - the overall OECD unemployment rate was 5.5 percent with a range from 2.4 percent in Norway, to 3.6 percent in New Zealand, 7.8 percent in France and 10 percent in the Slovak Republic. One could say that these relatively wide outcomes represent different labour market frictions in the sense that some countries are better at matching workers to employment than others. One could also say, given the mixed empirical findings from unemployment models generally, that Layard and Bean’s challenge to ‘explain unemployment’ remains ongoing. (See Blanchard 2006).

Beveridge curve analysis - the relationship between unemployment and vacancies - is one approach to studying labour market frictions. It has links to the Phillips curve (via the excess demand for labour) and derives from a framework that views employment as the outcome of a matching process (M) of vacancy-filling (V) by the unemployed (U), by those already in employment (E) and by those not in the labour force (N), that is, $M = m(U, E, N, V)$. By concentrating on the U - V component of the matching process, one can see immediately that Beveridge curve analysis implies some potentially strong assumptions about the behaviour of the E - V , N - V and E - E (churning) relationships. (See Mumford and Smith 1999).

¹ We are grateful to the ANZ Banking Group, and to Steve Edwards in particular, for providing us with the entire monthly job ads count from 1990 to 2007. The ready availability of the Department of Labour job vacancy data is also appreciated. The usual disclaimer applies.

Despite the misspecification that might arise from these assumptions, and others, there is, nevertheless, an extensive Beveridge curve literature providing useful insights into the employment-matching process. This literature includes the survey articles by Blanchard and Diamond (1989), Petrongolo and Pissarides (2001) and Nickell *et al.* (2003). Themes of particular interest in this literature include the nature, stability and elasticity of the $U-V$ relationship and the associated issues of cyclical and structural influences and, if structural, the likely variables. The ‘cyclical-structural’ issue is of special importance given its potential policy implications. Petrongolo and Pissarides conclude that while there might be empirical support for a range of variables causing the Beveridge curve to shift (such as the participation rate, replacement ratio, real wages and unemployment duration), the microeconomic support for these shifts is tentative only. In addition, the meaning of constant returns to scale in the typical Cobb-Douglas specification and the role of job-to-job and out of the labour force searches are challenges for future work.

The New Zealand literature on the Beveridge curve is relatively modest. It includes Hicks and Chin (1984), Chapple, Harris and Silverstone (1996), Nickell *et al.* (2003), Silverstone (2004) and Razzak (2008). Australian contributions include de Francesco (1999), Webster (1999) and Groenewold (2003). For the period of the ‘reform decade’, 1985-1995, Chapple *et al.* (1996, p.153-154) found - somewhat surprisingly given the scale of change in New Zealand - no significant shifts in the Beveridge curve. On the other hand, Silverstone (2004) found that shift factors (such as the participation rate and regional growth differences) may have influenced the New Zealand Beveridge curve over the period 1990-2004. His contribution also included initial work on calculating a hiring rate and a matching function.

Razzak (2008, p.9), covering a similar period (1990-2006), found that New Zealand’s matching function exhibited decreasing returns to scale rather than the constant returns to scale found in numerous other country studies. ‘Decreasing returns to scale means that New Zealand’s labour market needs to be more than double in size in order to double matching. The matching process in New Zealand has been costly’. Razzak also found some support for shift influences on the matching function including the share of young workers in the labour force, the share of skilled labour in total employment and the replacement ratio.

In Australian work, Groenewold (2003, p.80) found that a co-integration relationship existed between the unemployment and vacancy rates when four shift variables were added: the real wage, the replacement ratio, the proportion of long-term unemployed and the proportion of females in the labour force. He also found that structural changes were of greater importance than aggregate demand shocks in explaining the increase in the Australian unemployment rate over the two-decade period from around 1980.

As noted by Wall and Zoega (2002) and others, Beveridge curve shifts are difficult to detect non-arbitrarily. To isolate and explain them, we offer new insights into Beveridge curve shifting by modelling the unemployment-vacancy rate relationship within a Markov regime-switching environment in which the probabilities of shifting from one curve to another are determined endogenously by the selected shift factors. In this paper, we examine two sets of shift factors. First, we examine variables that unambiguously reflect the degree of job market mismatch, namely, the participation rate and net migration. These factors are expected to have an impact on the position of the Beveridge curve. Secondly, we study the impact of business cycle variables, such as GDP growth and the real interest rate, that are expected to move the economy along rather than shift the curve. Overall, our New Zealand work suggests that these variables have been responsible, in varying degrees, for shifts in and movements along the Beveridge curve.

In what follows, Section 2 is mainly an analysis of our vacancy data while Sections 3 and 4 cover our specification work and estimation results, respectively. Section 5 contains our conclusions.

2. Data Sources

Vacancies

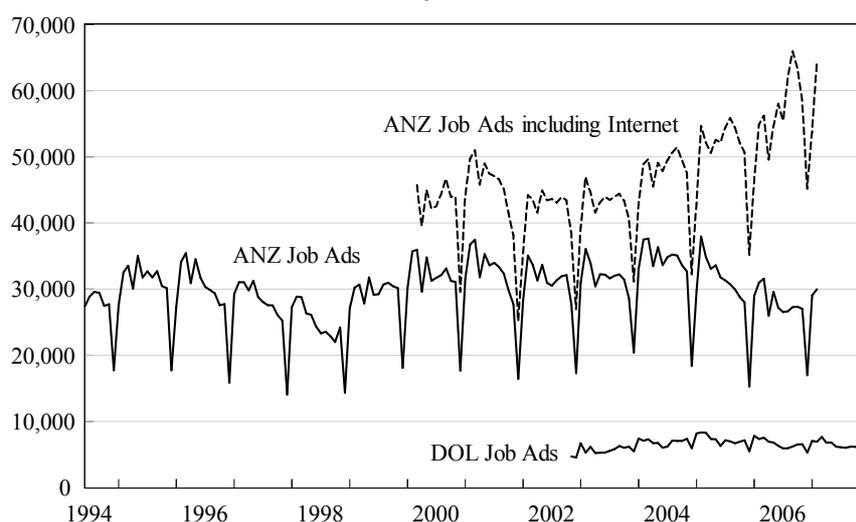
The availability and quality of job vacancy data is a commonly discussed issue in most Beveridge curve studies. New Zealand is no exception. An official vacancy series began in 1955 and ended in 1980 while its successor ceased in 1997. In 1990, the ANZ Banking Group began a monthly count of job advertisements in New Zealand newspapers. The initial coverage of Auckland, Wellington and Christchurch was extended, in 1994, to four other areas (Waikato, Hawke's Bay, Manawatu and Otago). From 2000, the newspaper count was supplemented with a count of internet job advertisements from several major websites.

After some 17 years, the ANZ Bank discontinued their 'help-wanted' series in 2007. There were several reasons for this development. First, the series was a raw rather than individual job count: multiple jobs within one advertisement counted as one job, repeated ads within the same month were included and there was no separation of regional and national job ads within each newspaper. Secondly, from 2002, the Department of Labour (DOL) began publishing and classifying (into 1, 2 and 5-digit occupation groups) a monthly count of individual job advertisements in 25 newspapers. This new series, as Figure 1 shows, avoids the significant duplication arising from raw counting.

Thirdly, the ANZ bank found that 'duplicated job advertising counts from internet-based advertising made the series an unreliable economic indicator' (Steve Edwards, personal communication, 2008). The Department of Labour (2008, p.1) made the related point that in its opinion 'there has not been a fundamental change in employers' decisions to advertise

vacancies in newspapers over the recent past'. As a result, the DOL confined its job vacancy measure mainly to newspaper advertisements, apart from information technology jobs. These two views may be contrasted with Silverstone (2004) who found, from several perspectives, that internet and newspaper job ads combined had a stronger relationship with unemployment, labour constraint and skill shortage indicators than newspaper advertisements alone, at least over the period 2000-2004. Clearly, there are issues to be resolved regarding the integration, or otherwise, of internet and newspaper job advertisements².

Figure 1. Job Advertisements in New Zealand 1994-2007
Monthly, Number



Source: ANZ Banking Group and Department of Labour.

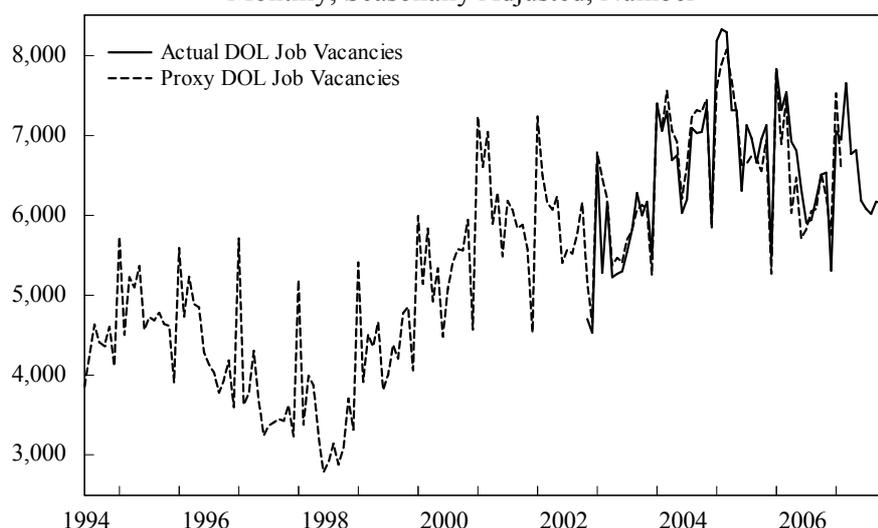
While it is useful to now have some five years of monthly Department of Labour vacancy data (from 2002:11 to 2007:12), it would be even more helpful to have a longer series. After some experimentation, we found that the application of principal components to the ANZ newspaper series produced a relatively good proxy for the DOL newspaper series thereby allowing us to ‘backdate-by-proxy’ the DOL series a further eight years to 1994:06. The proxy series was constructed as follows:

First, all seven ANZ job ad series from 1994:06 to 2007:02 were included (namely, Auckland, Wellington, Christchurch, Waikato, Hawke’s Bay, Manawatu and Otago). The internet series was excluded. We used the principal components default settings in EViews to form the series *anz_pc*. The first principal component, comprising approximately an equal

² In May 2008, the Department of Labour announced it was no longer publishing the monthly Job Vacancy Monitoring (JVM) figures saying that the decision was based ‘on concerns that the JVM figures, which were gathered from newspaper advertisements only, may no longer be a reliable representation of labour market change because of the growth of internet advertising. As soon as a new system is in place, the Department will resume publication of an advertised vacancies series’.

linear combination of all but the Auckland and Canterbury series, accounted for two thirds of the total variance of the seven newspaper series. Two principal components accounted for almost 90 percent of the total variance. Secondly, we regressed the Department of Labour job vacancy series (*dol_jv*) against *pc_anz* and 11 monthly seasonal dummies over their common period 2002:11 to 2007:02. Finally, we ‘backward forecast’ from 2002:10 to 1994:06 to give our proxy *dol_jv* series³. Figure 2 illustrates the outcome of our calculations.

Figure 2. Actual and Proxy Department of Labour Job Vacancies 1994-2007
Monthly, Seasonally Adjusted, Number



Source: ANZ Banking Group and Department of Labour.

Table 1 provides summary statistics on the actual DOL series and the ANZ-based proxy series over their common period 2002:11 to 2007:02. The statistics include a very high correlation (0.92) and ‘acceptable’ differences between actual and proxy maximum and minimum values, standard deviations and related statistics. The mean absolute monthly error of 340 job ads corresponds to just four percent of average monthly DOL job vacancies.

³ It is interesting to note, perhaps, that of the seven newspapers in the ANZ series, Otago and Manawatu have the highest correlations (at 0.81) with the DOL series over the common sample period 2002:11 - 2007:02. This is followed by Canterbury, Hawke’s Bay and Wellington (at 0.66), Waikato (at 0.62) and Auckland a distant seventh (at 0.20).

Table 1. Actual and Proxy Department of Labour Job Vacancy Series
Descriptive Statistics, Common Period 2002:11-2007:02, Number

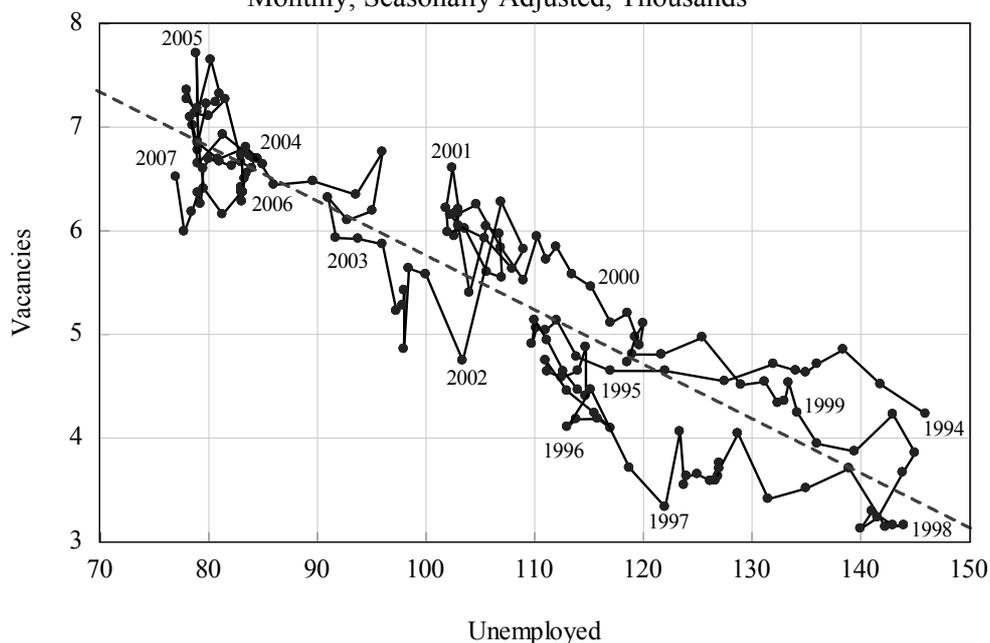
| | Actual | Proxy |
|------------------------------------|--------|-------|
| Median | 6673 | 6577 |
| Maximum | 8330 | 8073 |
| Minimum | 4530 | 4660 |
| Standard Deviation | 883 | 813 |
| Jarque-Bera | 0.55 | 1.40 |
| Mean Absolute Error (actual-proxy) | | 340 |
| Correlation | | 0.92 |

Unemployment

We used an ARIMA process in RATS to interpolate the official quarterly unemployment data to a monthly unemployment rate series. This process was chosen in preference to simple linear interpolation method that would only use information from adjacent quarters.

Figure 3 shows the number of seasonally-adjusted unemployed persons and vacancies between 1994 and 2007. The correlation is -0.91. The series is characterised overall by persistence and by counterclockwise looping around an OLS regression. The ratio of the number of vacancies to unemployed is, on average, 1:20 with a range from 1:10 to 1:45. The 1:20 ratio may be compared, for example, with around 1:3 for the United States 2002-2003 (Shimer 2005) and 1:7 for Australia. Given these comparisons, and the observation that the average quarterly gross flow from unemployment to employment alone over the 1994-2007 was around 25,000 persons, one clear implication of New Zealand's 1:20 ratio is that a relatively high number of vacancies are not advertised in newspapers.

Figure 3. Number of Vacancies and Unemployed Persons 1994-2007
Monthly, Seasonally Adjusted, Thousands



Source: ANZ Banking Group, Department of Labour and Statistics New Zealand.

3. Specification

Labour market activity is typically decentralized, uncoordinated and costly. In this frictional environment, activity between firms and workers could be represented by a matching function. Parallel to the production function, the matching function assumes that the number of successful matches formed in the labour market is the output from a function where the inputs are the number of vacancies (V) posted by firms and the number of unemployed (U) workers looking for a job. Letting M represent the number of matches, this yields:

$$M = Am(U, V) \quad M_U, M_V > 0 \quad (1)$$

where m is the matching function and A represents the efficiency with which inputs are converted into output. Behind the matching function is the idea that the greater the number of unemployed workers or posted vacancies the greater the number of matches. There is supporting evidence (for example, Petrongolo and Pissarides 2001) that matching can be represented by a Cobb-Douglas function with constant returns to scale to give:

$$M = AU^h V^{1-h} \quad (2)$$

In this flow approach to unemployment, the matching function represents the flow out of unemployment. The evolution of the mean level of unemployment is then given by the difference between the flow of workers who enter unemployment and the flow of workers who exit unemployment. In equilibrium, when the two flows are equal, mean unemployment is constant. Specifically, the number of separations (S) is equal to the number of new matches (M) formed given by the matching function so that $S=M$. Dividing both sides of this equality by the size of the workforce (L) gives

$$\frac{M}{L} = \frac{S}{L} = A \left(\frac{U}{L} \right)^h \left(\frac{V}{L} \right)^{1-h} \quad (3)$$

If this steady-state condition holds, then the equilibrium unemployment rate, $u = U/L$, can be expressed as a function of the equilibrium vacancy rate, $v = V/L$. Given the separation rate (s), equation 3 becomes:

$$\ln(u) = a + b \ln(v) \quad (4)$$

where $a = \ln(s) - \ln(A)$ and $b = (h - 1)/h$.

Equation 4 is the Beveridge curve. It is convex to the origin by the properties of the matching function and corresponds to the isoquant of the matching function such that the number of matches formed is just equal to the number of matches destroyed. Given the

separation rate, there exists a unique vacancy rate that keeps the unemployment rate constant. Over the business cycle, assuming the separation rate is unchanged, unemployment and vacancies are negatively related so that the economy moves along the curve. The equilibrium concept behind the Beveridge curve, then, is the equality between the flow in and the flow out of unemployment. It does not correspond to a particular equilibrium level of unemployment or vacancies.

An interesting issue is when the Beveridge curve shifts inwards and outwards. Such shifts have been documented in many countries (see, for example, Jackman *et al.* 1990, Bleakley and Fuhrer, 1997, Wall and Zoega 2002 and Groenewold 2003). From our basic theoretical framework, these shifts have two sources: a change in the separation rate (s) or a shift in the efficiency of the matching process (A). Traditionally, the literature has focused on changes in A as separation rates tend to be constant. For instance, a stable rate of inflow (separation rate) and a falling rate of outflow (a falling A) can explain the increase in UK unemployment from the late 1970s to the mid-1990s (Wall and Zoega 2002). Outward shifts of the Beveridge curve are then associated with a deterioration in the matching process, and vice versa. What, then, causes deterioration or improvement in matching efficiency?

Changes in matching efficiency, A , reflect structural changes in the ability of the unemployed to be matched to vacancies as opposed to cyclical changes which move the unemployed and vacancies along the Beveridge curve. Mismatch is an empirical concept that measures the degree of heterogeneity in the labour market (Pissarides 2000). The list of variables believed to influence matching efficiency is extensive. This long list, as illustrated selectively in Table 2, means that the possibility of specification error is relatively high: might any random group of influences do as well as any other group?

Table 2. Selected List of Conventional Beveridge Curve Shift Influences

| |
|---|
| employment protection |
| unemployment duration |
| replacement rate |
| participation rates (including self-employment) |
| net migration |
| benefit duration |
| active labour market policies |
| educational attainment |
| union density |
| bargaining system |
| tax wedges |
| owner-occupied housing ratio |
| regional mismatch |

In this paper we pursue the search for possible shift factors and offer new insights on the methodology to isolate and explain these shifts. As mentioned in our introduction, shifts in the Beveridge curve are difficult to detect non-arbitrarily. Some rely on simple visual inspection, others on quadratic time trends (Layard, Nickell and Jackman 1991 and Blanchard and Diamond 1989). Albæk and Hansen (2004) examine whether the hiring function has moved at the same time as the Beveridge curve, in which case the shift in the Beveridge curve can be attributed confidently to a change in mismatch rather than separation.

In our paper, we use the Markov-switching approach in which the probabilities of shifting from one curve to another are determined endogenously by the value of selected shift factors.

We examine two sets of shifts factors. First we examine two variables that unambiguously reflect the degree of job market mismatch, namely, the participation rate and net migration. We think of net migration as a measure of international participation in the New Zealand labour market, by contrast to the more traditional (domestic) participation rate. We expect increases in the domestic participation rate to be associated with inward shifts of the Beveridge curve as it is more likely people with qualifications will find the offered wage higher than their reservation wage. Regarding the international participation rate, the outcome depends on whether the average qualification of workers entering the country is greater or smaller than those leaving the country. One advantage of our framework is that it enables us to determine which effect dominates: the increase in qualification due to immigration or the fall in qualification due to migration. In New Zealand's case, we find that positive net migration is associated with an outward shift of the Beveridge Curve, suggesting increased mismatch.

Some argue that the Beveridge curve may shift over the business cycle (Bowden 1980, Baker, Hogan and Ragan 1996, Coles and Smith 1998). We therefore include two business cycle variables - real GDP growth and the real interest rate - to see whether they too can explain shifts in the Beveridge curve. That the real interest rate can shift the Beveridge curve is supported by Phelps (1994) and Blanchard and Wolfers (2000) who attribute a significant impact of the real interest rate on long-term unemployment. It is also supported by the hysteresis effect caused by long spells of unemployment: even though a higher real interest rate first moves the economy down its Beveridge curve (firms' discounted profits are smaller so they offer fewer vacancies), higher unemployment translates into fewer employable workers next period and hence a possible outward shift of the Beveridge curve (Wall and Zoega 2002). This hysteresis effect can be attributed to the deterioration of human capital of the long-term unemployed, or the reluctance by firms to hire them.

4. Estimation

This section explores the possibility that an analysis of the Beveridge curve within a single-regime context is too restrictive. Suppose we initially model the Beveridge curve in a single-regime context such that

$$\ln u_t = a + b \ln v_t + l \Omega_t + \sum_{i=1}^l g_i \ln u_{t-i} + e_t \quad (5)$$

where Ω denotes other variables influencing u (such as the real interest rate, participation rate income growth and net migration in the context of this study) and $e_t \sim i.i.d.N(0, \sigma_e^2)$. The dynamic behavior of u , however, might be subject to regime shifts. If so, it is possible to improve on econometric approaches that make no allowance for such shifts. Suppose a discrete random variable S_t takes two possible values [$S_t = (0,1)$] and serves as an indicator for the state of the labour market at time t . The expected component of u_t , conditional on the value of S_t , is given by equation 6,

$$E(\ln u_t | S_t) = [(1 - S_t)a_0 + S_t a_1] + b \ln v_t + l \Omega_t + \sum_{i=1}^l g_i \ln u_{t-i} + e_t \quad (6)$$

where the unobserved indicator variable S_t , evolves according to the first-order Markov-switching process described in Hamilton (1989),

$$\begin{aligned} P[S_t = 0 | S_{t-1} = 0] &= p = \Phi(d_0) \\ P[S_t = 1 | S_{t-1} = 0] &= 1 - p \\ P[S_t = 1 | S_{t-1} = 1] &= q = \Phi(d_1) \\ P[S_t = 0 | S_{t-1} = 1] &= 1 - q \end{aligned} \quad (7)$$

The fixed transition probabilities of being in Regime 0 or 1 are p and q , respectively, with $0 < p, q < 1$ and $\Phi()$ the cumulative normal distribution function ensuring that the transition probabilities lie in the open interval $(0,1)$. The model defined by equations 6 and 7 can be denoted as Markov-switching Model I. Since β is not regime-varying, this model only allows for shifts in the Beveridge curve intercept between α_0 and α_1 .

Model I features transition probabilities that are fixed. In this study, we are also interested in the extent to which the variables represented by Ω are responsible for pushing the economy into Regime 0 or Regime 1. We can, therefore, extend the fixed two-state Markov-switching chain to allow for the possibility of time-varying transition probabilities. This enables us to specify:

$$\begin{aligned} P[S_t = 0 | S_{t-1} = 0, \Omega_{t-1}, \Omega_{t-2}, \Lambda] &= p_t = \Phi\left(d_0 + \sum_{i=0}^m J_i \Omega_{t-i}\right) \\ P[S_t = 1 | S_{t-1} = 1, \Omega_{t-1}, \Omega_{t-2}, \Lambda] &= q_t = \Phi\left(d_1 + \sum_{i=0}^n k_i \Omega_{t-i}\right) \end{aligned} \quad (8)$$

This specification gives rise to Markov-switching Model II. In this model, a change in Ω can influence u through two channels in u - v space. First, there is a mean equation effect in terms of a movement along a given Beveridge curve. Secondly, there is the possibility of a shift in the Beveridge curve through the impact of Ω on the transition probabilities.

Tables 3a and 3b report results based on the OLS and Markov-switching models, respectively. Having started with a maximum of six lags, the inclusion of two lags on u together with contemporaneous Ω_t (in equations 6 and 8) was found to be acceptable using various model selection procedures. For each of the three variables represented by Ω , the log likelihood values associated with both the OLS estimate and Markov-switching Model II are also reported. In each case, the application of the LR-test proposed by Davies (1987) leads to the rejection of the single-regime OLS model in favour of Markov-switching Model II.

If we initially focus on the estimates that incorporate the participation rate (characterised by the largest log likelihood value), our results indicate the presence of a regime-invariant Beveridge curve slope of $\beta = -0.040$ giving a long-run elasticity of $\beta^L = -0.559$. This estimate can be compared with the Australian study by Groenewold (2003) who obtained long-run Beveridge curve elasticities between -0.35 and -0.64 once shift factors were taken into account. We find evidence of a shifting Beveridge curve characterised by the intercepts $\alpha_0 = 1.467$ in Regime 0 and $\alpha_1 = 1.447$ in Regime 1. The null $\alpha_0 = \alpha_1$ is rejected at the one percent significance level with $c^2(1) = 128.9$. We therefore regard Regime 0 as being characterised by a larger intercept and an ‘outer’ Beveridge curve and Regime 1 as an ‘inner’ Beveridge curve.

While $l < 0$ suggests a direct negative relationship between the participation rate and u in the mean equation, we find that the participation rate influences significantly the transition probabilities of switching between regimes. This is confirmed with $J_0 < 0$ which indicates that an increase (decrease) in the participation rate leads to a reduced (increased) probability of remaining in Regime 0. In a similar vein, $k_0 > 0$ indicates that an increase (decrease) in the participation rate leads to an increased (reduced) probability of remaining in Regime 1. Since $\alpha_0 > \alpha_1$, this evidence is consistent with an inward shift in the Beveridge curve in response to a rise in the female participation rate in particular. This increased participation may be due to more females receiving a wage higher than their reservation wage and to relative opportunities. Given the low average wage in New Zealand, it may be easier for women with a degree to obtain a wage that is higher than their reservation wage.

Figure 4a presents the inferred probability of being in Regime 0 in any month while Figure 4b plots the inferred probabilities of switching from Regime 0 to Regime 1 ($1-p$) superimposed against the log of the participation rate. It is the more recent years that have been associated with a shifting Beveridge curve. This is marked by a sharp fall in the probability of being in Regime 0 (with an ‘outer’ Beveridge curve). This is accompanied by a sharp increase in the probability of shifting to Regime 1 that tracks an increase in labour force participation.

Table 3a. Ordinary Least Squares Results

| | OLS (real interest rate) | OLS (participation rate) | OLS (cyclical GDP) | OLS (net migration) |
|-------|-----------------------------|-----------------------------|-----------------------|------------------------|
| a | 0.003 | 1.487** | -0.000 | -0.055 |
| b | -0.017* | -0.027*** | -0.015* | -0.019** |
| l | 0.001 | -0.348** | -0.008** | 0.000 |
| g_1 | 1.649*** | 1.660*** | 1.657*** | 1.659*** |
| g_2 | -0.667*** | -0.700*** | 0.668*** | -0.674*** |
| LL | 424.799 | 496.819 | 476.527 | 494.507 |

Notes: Estimates are for the single-regime model described by equation 5. The superscripts ***, ** and * denote rejection of the zero null at the 1, 5 and 10 percent significance levels respectively.

Table 3b. Markov-Switching Results

| | MS Model II (real interest rate) | MS Model II (participation rate) | MS Model II (cyclical GDP) | MS Model II (net migration) |
|-----------|-------------------------------------|-------------------------------------|-------------------------------|--------------------------------|
| a_0 | -0.021*** | 1.467*** | -0.003*** | -0.009*** |
| a_1 | 0.006*** | 1.447*** | 0.013*** | 0.007*** |
| b | -0.017*** | -0.040*** | -0.024*** | -0.035*** |
| l | 0.001*** | -0.333*** | -0.015*** | -0.000 |
| g_1 | 1.643*** | 1.511*** | 1.551*** | 1.554*** |
| g_2 | -0.662*** | -0.583*** | -0.571*** | -0.583*** |
| s | 0.0001*** | 0.0001*** | 0.0001*** | 0.0001*** |
| d_0 | -0.019 | 355.312*** | 1.120*** | 1.307*** |
| d_1 | 2.358*** | -235.482*** | 0.235 | 1.563*** |
| J_0 | -0.029 | -84.044*** | -0.050 | -0.003* |
| k_0 | 0.424 | 56.415*** | 2.828*** | -0.000 |
| β^L | -0.899 | -0.559 | -1.160 | -1.184 |
| Null | 35.877 | 128.933 | 76.475 | 68.712 |
| LL | 432.851 | 510.363 | 486.330 | 505.403 |

Notes: Estimates are for the regime-switching model described by equations 6 and 8. The superscripts ***, ** and * denote rejection of the zero null at the 1, 5 and 10 percent significance levels respectively. β^L denotes the long-run Beveridge curve elasticity and is measured by $\beta/(1 - \tau_1 - \tau_2)$. Null refers to the null hypothesis $a_0 = a_1$.

Figure 4a. Inferred Probability of Regime 0

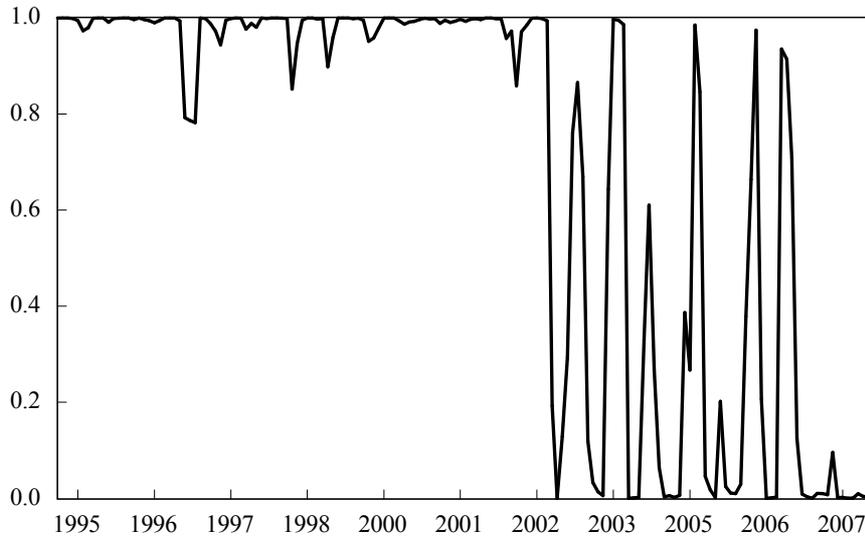
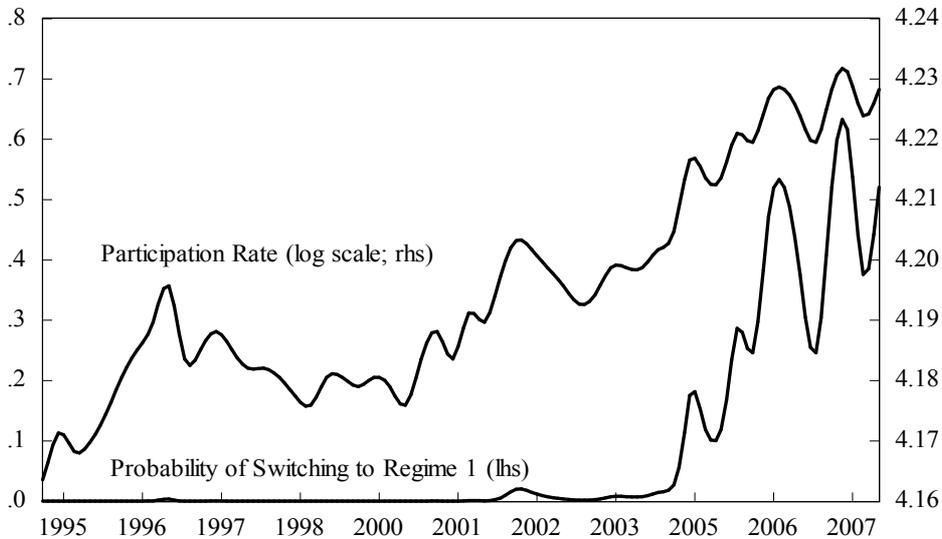


Figure 4b. Probability of Switching to Regime 1 and Participation Rate



We also provide estimates based on the inclusion of the three alternative drivers of Beveridge curve shifts. In each case, we find that $\alpha_0 < \alpha_1$ suggesting that Regime 0 is now characterized by the ‘inner’ Beveridge curve. In the case where Ω represents GDP growth, $k_0 > 0$ suggests an increase (decrease) in GDP growth is associated with an increase (a reduction) in the probability of remaining in Regime 1. This evidence is consistent with the Beveridge curve shifting outwards (inwards) as a result of an increase (a decrease) in GDP growth. This is accompanied by $l < 0$ which suggests a direct negative relationship between the GDP growth and u in the mean equation. While a fall in u might normally be expected from an increase in growth, we find there is also a decrease in matching. Where Ω represents

net migration, we are able marginally to reject the null $J_0 = 0$ at the 10% significance level. One would expect immigration policy to be based on attracting suitably qualified people to join the domestic labour force. However, our finding suggests that an increase in net migration may actually be associated with an outward shift in the Beveridge curve and a reduction in matching. Finally, in the case where Ω represents the real interest rate, we find $J_0, k_0 = 0$ which indicates that changes in the interest rate have no impact in terms of Beveridge curve shifts.

5. Conclusions

Beveridge curve analysis provides useful insights into labour market behaviour. In this study of New Zealand data using a Markov-switching model, we are able confirm the presence of a regime-switching Beveridge curve. We find evidence that increases (decreases) in the participation rate are associated with an inward (outward) shift in the Beveridge curve and therefore an improvement (worsening) in matching. We also find that GDP growth and net migration may also lead to a shifting Beveridge curve. While a rise in the real rate of interest may lead to a rise in the unemployment rate, there is no evidence that the Beveridge curve will shift. Clearly, there are reservations with our investigation: the usage of interpolated data, problems with the measurement of vacancies and the selection of appropriate shift influences including their microfoundations. While addressing these issues constitute an avenue for future research, other directions include an examination of alternative shift factors based on the characteristics of the labour force and the business cycle.

References

- Albæk, Karsten and Henrik Hansen (2004) 'The Rise in Danish Unemployment: Reallocation or Mismatch?' *Oxford Bulletin of Economics and Statistics* 66(4) September, pp.515-536.
- Baker, Simon, Seamus Hogan and Christopher Ragan (1996) 'Is there Compelling Evidence against Increasing Returns to Matching in the Labour Market?' *Canadian Journal of Economics* 29(4) November, pp.976-993.
- Blanchard, Olivier J. (2006) 'European Unemployment: The Evolution of Facts and Ideas' *Economic Policy* 21(45) January, pp.5-59.
- Blanchard, Olivier J. and Peter Diamond (1989) 'The Beveridge Curve' *Brookings Papers on Economic Activity* (1) pp.1-76.
- Blanchard, Olivier J. and Justin Wolfers (2000) 'The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence' *Economic Journal* 110(462) March, pp.1-33.
- Bleakley, Hoyt and Jeffrey C. Fuhrer (1997) 'Shifts in the Beveridge Curve, Job Matching, and Labor Market Dynamics' *New England Economic Review* September/October, pp.3-19.

- Bowden, Roger J. (1980) 'On the Existence and Secular Stability of u - v Loci' *Economica* 47(185) February, pp.35-50.
- Burdett, Kenneth, Shouyong Shi and Randall Wright (2001) 'Pricing and Matching with Frictions' *Journal of Political Economy* 109(5) October, pp.1060-1085.
- Chapple, Simon, Richard Harris and Brian Silverstone (1996) 'Unemployment' in B. Silverstone, A. Bollard and R. Lattimore (eds) *A Study of Economic Reform: The Case of New Zealand*, Amsterdam: Elsevier, pp.139-171.
- Coles, Melvyn G. and Eric Smith (1998) 'Marketplaces and Matching' *International Economic Review* 39(1) February, pp.239-254.
- Davies, Robert B. (1987) 'Tests for Hurst Effect' *Biometrika* 74(1) March, pp.95-101.
- de Francesco, Anthony J. (1999) 'The Relationship between Unemployment and Vacancies in Australia' *Applied Economics* 31(5) July, pp.641-52.
- Department of Labour (2008) 'JVMP Reports: Frequently Asked Questions' Wellington: Department of Labour [www.dol.govt.nz/publications/jvm/job-ad-faq.asp].
- Groenewold, Nicolaas (2003) 'Long-Run Shifts of the Beveridge Curve and the Frictional Unemployment Rate in Australia' *Australian Journal of Labour Economics* 6(1) March, pp.65-82.
- Hamilton, John D. (1989) 'A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle' *Econometrica* 57(2) March, pp.357-384.
- Hicks, John and Fong Mee Chin (1984) 'The Relationship between Unemployment and Vacancies in New Zealand' *Massey Economic Papers* B8405, March.
- Jackman, Richard, Christopher Pissarides and Savvas Savouri (1990) 'Labour Market Policies and Unemployment in the OECD' *Economic Policy* 5(11) October, pp.449-490.
- Lagos, Ricardo (2000) 'An Alternative Approach to Search Frictions' *Journal of Political Economy* 108(5) October, pp.851-873.
- Layard, Richard and Charles Bean (1989) 'Why Does Unemployment Persist?' *Scandinavian Journal of Economics* 91(2) June, pp.371-396.
- Layard, Richard, Stephen Nickell and Richard Jackman (1991) *Unemployment, Macroeconomic Performance and the Labour Market*, Oxford: Oxford University Press.
- Mumford, Karen and Peter N. Smith (1999) 'The Hiring Function Reconsidered: On Closing the Circle' *Oxford Bulletin of Economics and Statistics* 61(3) August, pp.343-364.
- Nickell, Stephen, Luca Nunziata, Wolgan Ochel and Glenda Quintini (2003) 'The Beveridge Curve, Unemployment and Wages in the OECD from the 1960s to the 1990s' in P. Aghion *et al.* (eds) *Knowledge, Information and Expectations in Modern Macroeconomics*, New Jersey: Princeton University Press.
- Petrongolo, Barbara and Christopher A. Pissarides (2001) 'Looking into the Black Box: A Survey of the Matching Function' *Journal of Economic Literature* 39(2) June, pp.390-431.

- Phelps, Edmund (1994) *Structural Slumps. The Modern Equilibrium Theory of Unemployment, Interest and Assets*, Massachusetts: Harvard University Press.
- Pissarides, Christopher A. (2000) *Equilibrium Unemployment Theory*, Massachusetts: MIT Press.
- Razzak, Weshah (2008) 'On the Dynamics of Search, Matching and Productivity in New Zealand and Australia' Wellington: Department of Labour, mimeo, 31pp.
- Stevens, Margaret (2000) 'New Microfoundations for the Aggregate Matching Function' *International Economic Review* 48(3) August, pp.847-868.
- Shimer, Robert (2005) 'The Cyclical Behaviour of Equilibrium Unemployment and Vacancies' *American Economic Review* 95(1) March, pp.25-49.
- Silverstone, Brian (2004) 'Help Wanted in New Zealand: The ANZ Bank Job Advertisement Series' in S.B. Blumenfeld and G. Lafferty (eds) *Labour, Employment and Work in New Zealand*, Proceedings of the 11th Conference 2004, Wellington: Victoria University of Wellington, 2005, pp.125-133. [Also available at: <http://ideas.repec.org/p/wai/econwp/04-03.html>]
- Wall, Howard J. and Gylfi Zoega (2002) 'The British Beveridge Curve: A Tale of Ten Regions' *Oxford Bulletin of Economics and Statistics* 64(3) July, pp.257-276.
- Webster, Elizabeth. (1999) 'Labour Market Programs and the Australian Beveridge Curve: 1978 to 1997' *Economic Record* 75(231) December, pp.405-416.