Unemployment entry, exit and Okun's law: An analysis with Australian data

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Abstract

This paper sets out a new approach to understanding Okun's law and the evolution of the unemployment rate in Australia. Okun's law can be expressed in terms of a relationship between first differences in the unemployment rate and the growth rate of real GDP while changes in the unemployment rate in turn can be expressed in terms of flows into and out of unemployment. Having established that Australian data is consistent with the 'change' version of Okun's Law we then examine the unemployment entry and exit rates to determine the extent to which the variations in one or both of these rates can be explained by variations in GDP growth. It would appear that the asymmetry in the relationship reflects a greater impact of changes in GDP growth on the entry rate and not the exit rate.

Keywords: Labour market flows; Okun's law; Equilibrium unemployment rate; Australia
JEL Codes: J640; E240; E320

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Introduction

In this paper we present a new approach to understanding the Okun relationship for Australia. Specifically, we aim to examine variations in the rates of entry into and exits from unemployment to determine the extent to which variations in one or both of these rates can be explained by variations in GDP growth. We are especially interested in identifying which flows are the source of the asymmetry in the relationship between GDP growth and changes in the unemployment rate.

Okun's law is commonly expressed in terms of a relationship between deviations from trend in the unemployment rate and deviations from trend in the level of real GDP, or alternatively, in terms of a relationship between first differences in the unemployment rate and the growth rate of real GDP. In this paper we examine the second version of Okun's law. This is because it is changes in the unemployment rate that can be expressed in terms of unemployment entry and exit and so it is the change version of Okun 's law that leads directly to an examination of the relationship between unemployment entry and exit rates on the one hand and GDP growth on the other. While logic dictates that the Okun relationship must reflect the impact of changes in the rate of economic growth on flows into and/or out of unemployment we cannot say a priori whether it is one or both of the flows which react to changes in the growth rate or know the direction and relative size of the reactions. These are issues that can only be addressed empirically.

The structure of the paper and some of the important conclusions reached in each section are as follows:

In section 2 we examine the relationship between changes in the unemployment rate and the rate of economic growth. After a very brief literature survey we estimate a 'change' version of Okun's law using Australian data over the period 1979Q4 – 2023Q4. Amongst other things, we show that we can reject the hypothesis that variations in the growth rate do not Ganger cause variations in the unemployment rate. We also see that there is asymmetry in the relationship such that the extent of the change in the unemployment rate which results from a change in the rate of economic growth varies depending upon whether the economy is in a recession period (which we define as a period when quarterly growth rates are below the trend growth rate) or not. As mentioned above one of the aims of this paper is to determine the 'source' of the asymmetry using data on unemployment inflow and outflow.

Key elements of the relationship between the unemployment rate and flows into and out of unemployment are presented in Section 3. We find (as do others who research in this area) that inflow and outflow are cointegrated with a cointegrating vector of (1, -1), implying that, if there is a 'step' increase in inflow, sooner or later the outflow will rise by an amount equal to the rise in the inflow. We then examine the flow from unemployment to employment and show that, strange as it may seem, more unemployed people find jobs in recessions than in booms and we explain why this is so. In section 4 of the paper we examine the relationship between the unemployment entry and exit rates and the equilibrium unemployment rate and also the relationship between the equilibrium unemployment rate and the actual unemployment rate. We show that there is a very close relationship between these two rates such that the equilibrium rate of unemployment (and this the relative size of the entry and exit rates) is a very good predictor of the actual rate of unemployment and we show why this is so.

In section 2 of the paper we establish that there is a relationship between changes in the unemployment rate and GDP growth while in sections 3 and 4 of the paper, we show that changes in the unemployment rate reflect the relative size of flows into and out of the unemployment 'pool'. Clearly, taken together, these findings imply that there must be an empirical relationship between GDP growth and one or both of the flows in to and out of unemployment. We examine this in section 5 using Vector AutoRegression (VAR). While both entry and exit rates respond to variations in the GDP growth rate, we find that the presence of asymmetry in the relationship is a reflection of the way in which entry into unemployment responds to changes in the growth rate and that it does not appear to reflect the responsiveness of exits from unemployment to changes in the growth rate.

In the following section of the paper we begin our analysis by looking at recent evidence for the 'change' version of Okun's Law for Australia, that is, evidence for a relationship between the change in the unemployment rate and GDP growth. In all of our empirical work we use Australian data over the period 1979Q4 – 2023Q4 downloaded from the ABS website.[1]

The 'changes version' of Okun's Law

Since our ultimate aim is to examine the relationship between unemployment entry and exit rates and GDP growth in order to throw light on the 'Okun' relationship between the change in unemployment and GDP growth (Okun, 1962), it is necessary for us to first establish that there actually is a relationship between the change in the unemployment rate and GDP growth.

An important aside: In what follows we refer to the coefficient measuring the effect of a change in the GDP growth rate on the change in the unemployment rate (or on unemployment entry and exit rates) as "the Okun coefficient".

1 Quarterly real GDP data are taken from the *Australian National Accounts: National Income, Expenditure and Product* releases. Labour force measures such as the unemployment rate and flows in to and out of unemployment are taken from *Labour Force, Australia* releases. The monthly gross flows have been made stock consistent. For an explanation of the method used and the reasons why it is important to use stockconsistent figures see Frazis *et al.* (2005) and Dixon *et al.* (2007). The flows data are seasonally adjusted using Census X13 and the quarterly observations are averages of the monthly flows.

Research undertaken by Guisinger and Sinclair (2015)[2], Valadkhani (2015)[3] and Ball *et al.* (2017[4] and 2019[5]) suggests that there is such a relationship for Australia. Since none of these studies could be said to be using 'recent' data we begin by examining the empirical relationship between GDP growth and changes in the unemployment rate for persons in Australia over the period 1979:4 – 2023:4. We use the 'quarter on quarter before' as our measure of change (rather than (say) annual changes or comparing each quarter with the value for four quarters before) as changes in unemployment and in the flows in the labour market, especially in recessions, can occur quickly and turning points eg trough to peak unemployment can occur in a period less than a year.

The first two data columns in Table 1 report descriptive statistics for the first differences in the unemployment rate and the GDP growth rate. Amongst other things, we see that both variables are I(0).

2 Guisinger and Sinclair (2015) estimate an equation where the annual change in the unemployment rate is regressed on the annual growth rate of GDP (no lags are included and there is no allowance for asymmetry). The data set covers the years 1989 – 2011. Australia is one of the countries they examine. They find a statistically significant Okun coefficient of -0.50.

3 Valadkhani (2015) estimates a number of models of Okun's law involving four-quarter changes in the variables. The sample period is 1980Q3 – 2014Q1. In a model with a fixed coefficient and with lags at -1, -4, -5 and -6, the estimated short-run value of the Okun coefficient is -0.131 while the long-run value is estimated to be -0.420. The author also tests for asymmetry in the Okun coefficient and finds that the coefficient becomes more negative in recessions.

4 Ball *et al.* (2017, p. 1439) write that Okun's law "… is strong and stable by the standards of macroeconomics". Australia is one of the countries they examine. For quarterly data over the period 1980Q1 – 2013Q4 they find an Okun coefficient of -0.410.

5 Ball *et al.* (2019, p 856) find an Okun coefficient of -0.508 for annual data for Australia over the period 1980-2015.

Table 1. Descriptive Statistics (quarterly averages of monthly seasonally adjusted data): 1979:4 – 2023:4 (%) – First-differences and the GDP growth rate

	ΔUnemployment rate	GDP growth rate	Δln (Entry rate)	Δln (Exit rate)
Mean	-0.0131	0.7461	-0.00178	0.00072
Std. deviation	0.3311	1.0095	0.05913	0.04117
Unit Root test (ADF) p-value*	-7.1800 0.0000	-12.8215 0.0000	-14.4270 0.0000	-15.8124 0.0000
Contemporaneous Correlations				
ΔUnemployment rate	1.000			
GDP growth rate	-0.475	1.000		
Δln (Entry rate)	0.666	-0.465	1.000	
Δln (Exit rate)	-0.477	0.084	0.096	1.000

* The null is that the variable has a unit root.

The results of a simple OLS regression with (seasonally adjusted) quarterly data for the period 1980Q4 – 2023Q4 of the quarter on the quarter before change in the unemployment rate as the dependent variable on (i) the quarter on the quarter before growth rate of real GDP, (ii) a slope dummy to test for asymmetry in relation to recession periods[6] and (iii) the lagged change in the unemployment rate, are given in the first 'data' column of Table 2 below.[7]

As expected we find that there is a negative relationship between the change in the unemployment rate and GDP growth.[8] It would also seem that there is asymmetry in the relationship and specifically that the Okun coefficient is more negative in recessions (which we define as periods of negative deviations of the actual growth rate from the Hodrick-Prescott trend growth rate) than it is in other periods. The long run value of the Okun coefficient outside of recessions is estimated to be -0.183 while in recessions the long run value is estimated to be -0.434.

6 We test for this by using a slope dummy which is 1 when there is a negative deviation of the rate of GDP growth from the Hodrick-Prescott trend in GDP growth rates (quarter on quarter before) and 0 in all other periods.

7 If a shift recession dummy is included in the equation the p-value on the coefficient is 0.3685. As a result we drop the shift dummy but retain the slope dummy.

8 Granger causality tests indicate that we cannot reject the null that changes in the unemployment rate do not Granger cause the GDP growth rate while we can reject the null that the growth rate does not Granger cause changes in the unemployment rate.

Table 2. Estimated coefficients (p-values in parentheses)

Estimation method	OLS (HAC)*	VAR	
Dependent variable	Δ*UR*	Δln (*en*)	Δln (*ex*)
C	0.0751 (0.0083)	0.0127 (0.0070)	-0.0042 (0.2034)
GDP growth rate	-0.0936 (0.0017)	-0.0156 (0.0005)	0.0062 (0.0491)
Slope dummy for Recessions	-0.1286 (0.0001)	-0.0359 (0.0000)	-0.0070 (0.3120)
Lagged dependent variable	0.4880 (0.0000)	–	–
Number of lags on the variable in the VAR	–	5	5

* OLS (HAC) is Heteroskedasticity and Autocorrelation Consistent (Newey-West) estimation.

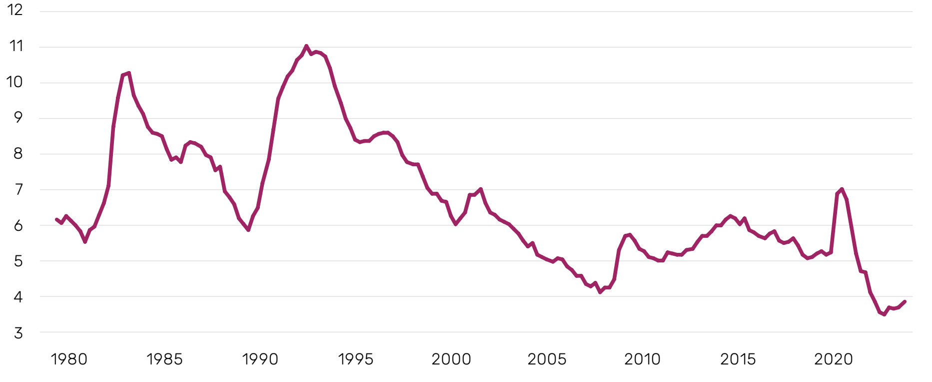
To summarise: there is a good deal of evidence for Australian data covering different periods that the 'change version' of Okun's Law is a reasonable description of variations in the unemployment rate in Australia. In what follows we will take this as 'a given'. Now, clearly the change in the unemployment rate reflects the balance of flows into and out of unemployment within any period and so it is natural to look at the Okun relationship as 'merely' being the refection of a relationship between output growth and one or more labour market flows. The justification for focusing on the flows is that we will see in the sections which follow: (i) that the actual rate of unemployment follows the (stochastic) equilibrium rate very closely (and we will also see why this is), (ii) that movements in the equilibrium rate depend upon movements in the entry and/or exit rates and, (iii) since the unemployment rate varies with the GDP growth rate it follows that one or both of the entry and exit rates must be varying with the growth rate of real GDP.

In the next section of the paper we examine the relationship between changes in the unemployment rate and flows into and out of unemployment.

Dynamics of Unemployment: Inflow and Outflow[9]

The main characteristics of the evolution of the unemployment rate are depicted in Figure 1 which shows quarterly averages of seasonally adjusted monthly values for the unemployment rate for persons over the period 1979Q4 – 2023Q4. Notable are the two 'major' recession episodes of 1981-1983 and 1990-1993 together with increasing unemployment following the GFC in 2008-2009 and the COVID-19 related rise in 2020. We also see the long, slow, recovery from the recession of the early nineties and the sharp fall in unemployment following the lifting of the COVID-19 restrictions.

Figure 1. Time Series of Unemployment Rate for persons (seasonally adjusted) (%): 1979:4 – 2023:4



The unemployment rate is defined as the ratio of the number unemployed (*U*) to the total labour force (*LF*). Allowing for both *U* and *LF* to vary over time, the change in the unemployment rate (*UR*) can be expressed as:[10]

$$\Delta(UR_t) = \frac{U_t}{LF_t} - \frac{U_{t-1}}{LF_{t-1}} = \frac{\Delta U_t}{LF_t} - \left(\frac{U_{t-1}}{LF_t}\right)\left(\frac{\Delta LF_t}{LF_{t-1}}\right) \qquad (1)$$

9 This section draws upon Dixon *et al*. (2007).

10 We are using monthly flows data based on matched records. Here, the subscript 't-1' on a stock variable refers to its value at the beginning of the month while the subscript 't' refers to its value at the end of the month. For a flow variable the subscript 't' refers to the flow during the month while the subscript 't-1' refers to the flow during the previous month.

where Δ represents a discrete change operator.

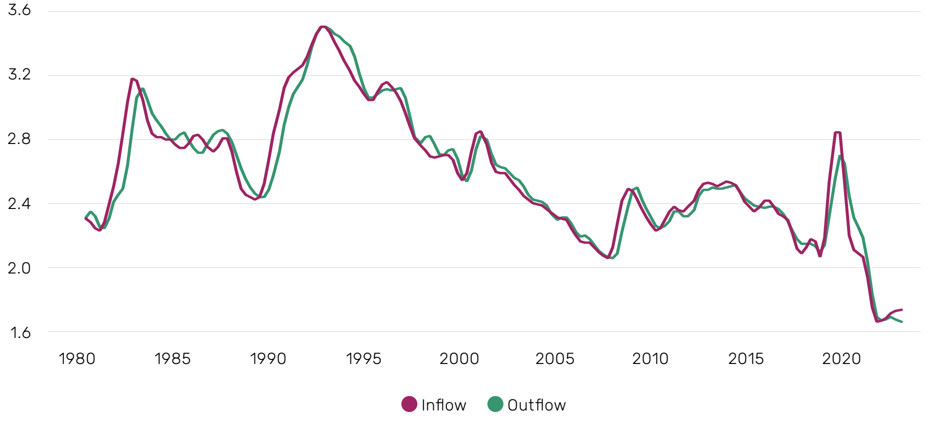
Changes in the number unemployed over time (Δ*U*) reflect the balance between two flows, an inflow into unemployment (*IN*) and an outflow from unemployment (*OUT*). Given this equation (1) may be written as:

$$\Delta(UR_t) = \frac{(IN_t - OUT_t) - U_{t-1}\left(\Delta LF_t / LF_{t-1}\right)}{LF_t} \tag{2}$$

Since the change in the labour force over a 'short' discrete period, like a month, is likely to be small,[11] it follows that both Δ*LF/LF* and especially $(U_{t-1} / LF_t)\,(\Delta LF_t / LF_{t-1})$ are likely to be quite small (both in absolute terms as well as relative to the other component in the equation), hence we will follow other researchers and throughout treat

$$\Delta\left(UR_t\right) \approx \left(\Delta U_t / LF_t\right) = (IN_t - OUT_t)/LF_t \tag{3}$$

Figure 2. Unemployment Inflow (blue line) and Outflow (brown line) rates as a percentage of the labour force (seasonally adjusted and smoothed data): 1980:3-2023:4



11 The average monthly values of the relevant variables expressed as percentages of the labour force are: *IN/LF* = 2.572%, *OUT/LF* = 2.577%, Δ*LF/LF* = 0.052% and (*U/LF*)*(Δ*LF/LF*) = 0.004%.

The evolution of inflow and outflow rates over time in Australia is depicted in the two inter-twined series in Figure 2.[12] The inflow rate (*INR*) is defined as the sum of the flows from employment and from not in the labour force into unemployment over the month expressed as a proportion of the labour force (ie *INR* = *IN/LF*). The outflow rate (*OUTR*) is defined as the sum of the flows from unemployment to employment and to not in the labour force over the month, also expressed as a proportion of the labour force (ie *OUTR* = *OUT/LF*). Granger causality tests show that while we cannot reject the hypothesis that *OUTR* does not Granger cause *INR*, we can reject the hypothesis that INR does not Granger cause OUTR. Tests show that *INR* and *OUTR* are both I(1). Fitting a Vector Error Correction model to the two series we find that INR is exogenous[13] and that the two series are cointegrated with a cointegrating vector of approximately (1, -1), implying that, if, following a sustained exogenous shock, the inflow rate increases, sooner or later, the outflow rate will rise by an amount equal to the rise in the inflow rate. This is not a feature of Australian data alone – Balakrishnan and Michelacci (2001) find that Inflow and Outflow Rates for the US, UK, Germany, France and Spain also have cointegrating vectors of (1, -1). Yashiv (2007) looked at a number of US data sets and found that "job finding and separation into unemployment move together along a 45-degree line" (p 796).[14]

An implication of our finding that *INR* and *OUTR* are cointegrated with a cointegrating vector of approximately (1, -1) is that, paradoxically as it would seem, we would expect to observe that more unemployed people find jobs in a recession than in

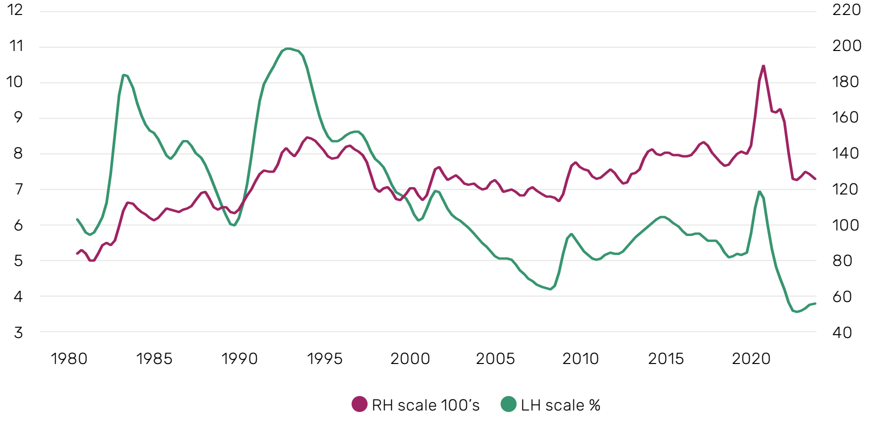
12 So as to better display the underlying movement, the series depicted in Figures 2–5 are based on quarterly averages of monthly rates which have been seasonally adjusted and smoothed using a 7-period Henderson moving average (see Henderson (1916) and Gray and Thomson (1996) for a description). This is because monthly and quarterly flows data, even when seasonally adjusted, is very noisy. In the statistical and econometric work which underpins results reported in this paper we use seasonally adjusted, but not smoothed, quarterly averages of monthly data. In all of our econometric work we use the Akaike information criterion (AIC) to determine the number of lags to include in the model. EViews is used throughout.

13 This result is not surprising. Balakrishnan and Michelacci (2001) find the same for the US, UK, Germany, France and Spain over the period 1972:3 – 1989:4. Burgess and Turon (2005, p 433) also find this for UK claimant count data over the period 1967:1 – 1998:4 while Dixon and Mahmood (2006) find that this is also true for UK claimant count data over the period 1989:1 – 2003:4. Fujita and Ramey (2009) find this for US data over the period 1976:1 – 2005:4 while Bryson (2024) finds this for US data for the period 1979:4 – 2019:4. Elsby *et al*. (2013) find this for fourteen OECD countries (and they also draw attention on p 544 to a number of earlier papers using US data who have also found this). It should be noted that they conclude that "these findings for worker flows are a *stylized fact* of modern labor markets" (p 547, our emphasis).

14 This relationship was also reported for Australian data over the period 1979Q3 – 2007Q3 by Dixon *et al*. (2007, p 209) and for UK data by Burgess and Turon (2005, p 440).

a boom![15] (We would also expect to observe that more unemployed people move out of the labour force in a recession than in a boom and this is indeed the case, but unlike our finding for the number moving from unemployment to employment, this is not surprising.) Figure 3 shows the unemployment rate (as a percentage) and also the number of people (in thousands) who were classified as unemployed at the beginning of each month but who were classified as employed at the end of the month.[16] Clearly, while the job finding probability might fall in a recession, the expansion in the number unemployed more than offsets this with the result that the absolute number of unemployed finding employment increases during recession episodes. Burgess and Turon (2005) argue that one of the factors responsible for the induced rise in outflow is related to hirer's preference for people who have not been unemployed for long periods. They assume that the probability that an individual will receive a job offer "declines over duration [and, as a result of this,] the average measured outflow rate depends on the duration structure of the unemployment stock and this, in turn, depends on the movement in the inflow. As the economy turns down, more people flow in, the ratio of newly unemployed increases and hence so does the average outflow rate" (p 437f).

Figure 3. The flow from unemployment to employment and the unemployment rate, seasonally adjusted and smoothed data: 1980:3-2023:4



15 See Dixon *et al*. (2007, passim), Borland (2009, p 238f) and Evans (2018, p 478f) for both a demonstration and a more extensive discussion of this in the context of Australian data. Mercan *et al*. (2024) find that "the fact holds across OECD countries" (p 245 and Appendix A.5). It has also been documented in papers by Blanchard and Diamond (1990), Burda and Wyplosz (1994), Fujita and Ramey (2009) and Elsby *et al*. (2013).

16 Recall that we are working with quarterly averages of monthly figures.

A parsimonious model of unemployment rate equilibrium and short-run dynamics

Although flows between three labour market states – employed, unemployed and 'not in the labour force' – are involved when modelling changes in unemployment, it is common in the literature to model unemployment dynamics in a parsimonious fashion with the aid of only a single entry rate to unemployment and a single exit rate from unemployment.

By definition:

$$\Delta U_t = \left(\frac{IN_t}{E_{t-1}}\right)E_{t-1} - \left(\frac{OUT_t}{U_{t-1}}\right)U_{t-1} = en_t E_{t-1} - ex_t U_{t-1} \tag{4}$$

where *en* is the "entry rate" into unemployment defined as *en(=IN/E)* and *ex* is the "exit rate" from unemployment defined as *ex(=OUT/U); E* is the total number employed and *U* is the total number unemployed. Notice that *en* includes flows from both employment and not-in-the-labour force to unemployment while *ex* includes flows from unemployment to both employment and not-in-the-labour force.

Dividing both sides of (4) by the labour force *(LF = E + U)* yields an expression for the evolution over time of the unemployment rate:

$$UR_t - UR_{t-1} \approx \frac{\Delta U_t}{LF_{t-1}} = en_t - (en_t + ex_t)UR_{t-1} \tag{5}$$

As we shall see the data in the 'levels' are not stationary, and so it is not particularly meaningful to compute a single 'natural' or 'equilibrium' rate as clearly there is no meanreversion behaviour.[17] Instead, we propose to work with a time-varying 'equilibrium unemployment rate'. Given (5), the unemployment rate associated with 'flow equilibrium' (in the sense of $\Delta U_t = 0 \, \forall \, t$), or what Hall calls the "stochastic equilibrium unemployment rate" (UR^*_t) will be:[18]

$$UR_t^* = \frac{en_t}{en_t + ex_t} = \frac{1}{1 + (ex_t / en_t)} \tag{6}$$

The main advantage of this framework is that we can study the behaviour of an unobservable variable (the equilibrium rate of unemployment) by studying the behaviour

17 I am grateful to Guay Lim for pointing this out to me.

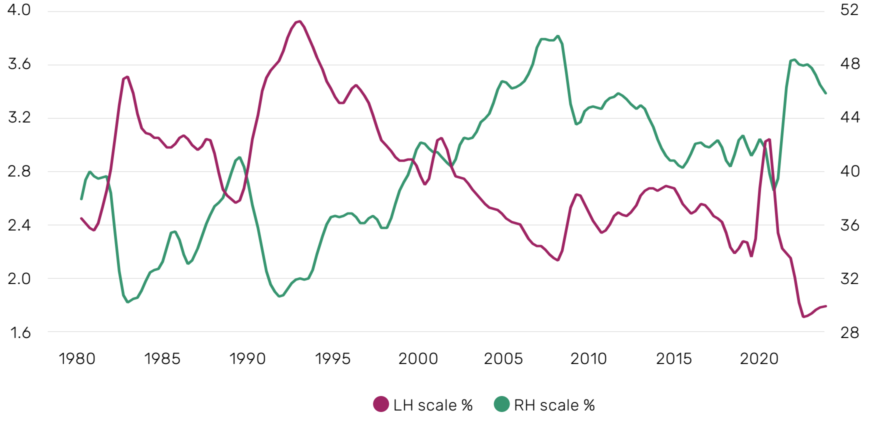
18 See Hall (2003, p 147f and 2005, p 398f). Hall also uses the term "stochastic stationary state". Elsby and Smith (2010, p R32) use the term "flow steady state value" for this concept while Mercan *et al.* (2024, p242) use the term "steady state unemployment rate".

of observed variables (entry and exit rates). Fortunately, as we shall see, the dynamics of the actual rate around the equilibrium rate also depends upon *en* and *ex*.

Figure 4 shows the evolution of the entry (*en*) and exit (*ex*) rates over the period 1979:4- 2023:4.[19] Both rates are highly variable but are clearly inversely related.[20] The entry to unemployment rate, *en*, rose sharply in the recessions of 1981-83 and 1990-92 and then fell slowly in the period between the two. It rose at the time of the GFC and also at the time of the pandemic-related lockdowns in 2020. The exit from unemployment rate, *ex*, fell during the recession periods and increased during the recovery phases following the two recessions and also as restrictions were eased towards the end of the pandemic.[21]

Table 3 presents some descriptive statistics for the levels of the entry and exit rates and the unemployment rate. Not surprisingly, the unemployment rate is positively correlated with the entry rate and is negatively correlated with the exit rate. We also see that the exit rate is negatively correlated with the entry rate. Notice, in passing, that all of these variables in 'the levels' are I(1).[22]

Figure 4. Entry and Exit Rates (seasonally adjusted and smoothed data): 1980:3-2023:4



19 Again, we have plotted the seasonally adjusted (and smoothed) entry and exit rates and again, the numbers are quarterly averages of monthly data.

20 As will be seen in Table 3 the contemporaneous correlation coefficient between the two is -0.815.

21 Other authors observe similar cyclical variations in the entry and exit rates as we find here – see for example Burgess and Turon (2005) and Elsby and Smith (2010).

22 The first differences of all of the variables is, as expected, I(0).

Table 3. Descriptive Statistics (quarterly averages of monthly seasonally adjusted data): 1979:4 – 2023:4 - Levels

	Entry rate (%)	*Exit rate* (%)	*Unemployment rate* (%)
Mean	2.765	40.089	6.642
Std. deviation	0.484	5.195	1.830
Unit Root test (ADF) p-value*	-1.915 0.325	-1.604 0.478	-2.005 0.285
Contemporaneous Correlations			
Entry rate	1.000		
Exit rate	-0.815	1.000	
Unemployment rate	0.954	-0.928	1.000

* The null is that the variable has a unit root.

Insights about the dynamics of the observed unemployment rate can be obtained by combining (6) and (5) to give a partial adjustment model:

$$UR_t - UR_{t-1} = \left(en_t + ex_t\right)\left(UR^* - UR_{t-1}\right) \tag{7}$$

Equation (7) shows that the higher is ($en + ex$) the faster is the adjustment in the event of any disequilibrium. Amongst other things, this shows that the determinants of the equilibrium rate and the determinants of the short-run dynamics, and especially the 'persistence' of the unemployment rate, are interrelated. In particular, changes in the equilibrium rate are *necessarily* accompanied by changes in the rate of adjustment and thus in persistence.

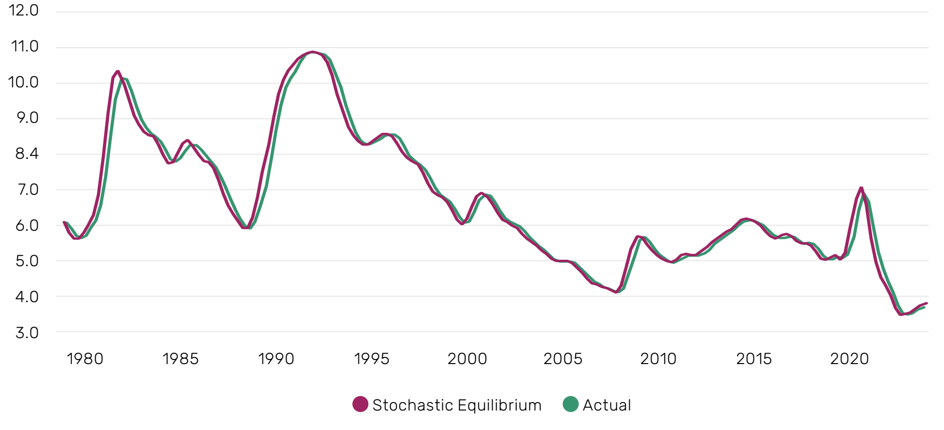
Figure 5 compares the stochastic equilibrium unemployment rate UR^*_t (computed using equation (6) and the observed values of en_t and ex_t in each period) with the observed unemployment rate.[23] The two series are clearly closely related with a contemporaneous correlation coefficient of 0.995. It is also clear that the equilibrium rate leads the actual rate.[24] The mean absolute deviation of the observed unemployment rate from the equilibrium rate is 0.126 per cent, which is very small when compared with

23 In Figure 5 we display seasonally adjusted and smoothed rates. The correlation coefficient and the measures of the difference between the equilibrium and actual rates are computed using seasonally adjusted but not smoothed entry and exit rates.

24 And so the equilibrium rate might be useful for forecasting, see Barnichon and Nekarda (2012).

the mean value of the observed unemployment rate of 6.643 per cent. As Hall (2005, p 398), Burgess and Turon (2005, p 430), Petrongolo and Pissarides (2008, p 257f), Fujita and Ramey (2009, p 88), Shimer (2012, p 132) and others have noted, the close correlation between the actual and stochastic equilibrium rate suggests that it may be safe when modelling unemployment, to initially neglect 'turnover dynamics' and focus on the stochastic equilibrium rate and its determinants.

Figure 5. Actual and Stochastic Equilibrium Unemployment Rates (seasonally adjusted and smoothed data) 1980:3-2023:4



To see why the stochastic equilibrium and actual unemployment rates are closely related we rearrange (7) to obtain an expression for the gap between the observed rate of unemployment and the equilibrium rate. It is:

$$UR_t - UR_t^* = \left(en_t + ex_t - 1\right)\left(\frac{en_t}{en_t + ex_t} - UR_{t-1}\right) \tag{8}$$

It follows that if $(en_t + ex_t)$ is high and/or shocks to *en* and *ex* are small, the actual unemployment rate in any period would be close to the stochastic equilibrium rate. In fact, the average value of $(en + ex)$ is 43 per cent per month implying that on average around 82 per cent of the adjustment will take place within one quarter.

In relation to the dynamics of the system, we have already noted the rate of adjustment of the observed unemployment rate to the equilibrium rate is given by *the sum* of *en* and *ex*. For our data set the value of the sum of *en* and *ex* is (as we would expect) negatively correlated with both the observed unemployment rate and with the stochastic equilibrium rate (UR^*), with correlation coefficients of -0.906 and -0.905

respectively. This implies that if the (equilibrium) unemployment rate is low the speed of adjustment will be high, and vice-versa.

We have seen the role of the entry and exit rates in determining the stochastic equilibrium unemployment rate and we have also seen that the actual unemployment rates follows closely movements in the (stochastic) equilibrium rate. Our most fundamental proposition in this paper is that, if there is a relationship between the growth of real GDP on the one hand and changes in the unemployment rate on the other (as set out in Okun's law), then there must be a relationship between the growth of real GDP on the one hand and changes in one or both of the rates at which people flow into and out of unemployment on the other. Whether it is one or both of the rates is an empirical question and cannot be determined a priori.

The relationship between changes in the entry and exit rates and GDP growth

In this section of the paper we focus on to the relationship between changes in the unemployment entry and exit rates and GDP growth.[25] We are especially interested (inter alia) in these questions: (i) What is the relationship between variations in the entry and exit rates and GDP growth? and (ii) What appears to be the source of the asymmetry in the Okun relationship? Is it the entry rate, the exit rate or both?

Before proceeding any further, we note that the unemployment rate (*UR*) and the ratio of the number unemployed to the number employed (*U/E*) are monotonically related. By definition:

$$UR = \frac{U}{LF} = \frac{1}{1+\left(E/U\right)} = \frac{1}{1+\left(1/\left(U/E\right)\right)} \qquad (9)$$

which implies that we can explain the behaviour of the unemployment rate by explaining the behaviour of the ratio of the number unemployed to the number employed (and vice versa). As in the earlier case, if we had flows equilibrium at the prevailing entry and exit rates, that is inflow ($en \times E$) equals outflow ($ex \times U$), we can solve for the 'stochastic equilibrium' ratio of the number unemployed to the number employed at any moment in time:

25 Lim *et al*. (2021) also takes a 'flows approach' to Okun's law but that paper uses US data and the focus is on the relationship between changes in GDP and the *net flows* between *all* labour market states and not on the relationship between changes in GDP and the unemployment entry and exit rates.

$$\left(U/E\right)_t^* = \frac{en_t}{ex_t} \qquad (10)$$

which is to say that movements in the ratio of unemployment to employment (and thus movements in the ratio of unemployment to the labour force) reflect *relative* levels of the entry and exit rates including the impact of a shock to GDP growth on the relative proportionate changes in the entry and exit rates. The advantage of looking at the ratio of the number unemployed to the number employed (*U/E*), rather than the unemployment rate (*U/LF*) is that, while the equilibrium unemployment rate is related in a non-linear fashion to the entry and exit rates, equation (10) implies that there will be a simple linear relationship between the logarithm of the ratio of unemployment to employment in any period and the logarithms of the entry and exit rates and the same may be said the of the logarithms of the first-differences. For convenience of exposition, we call the RHS of equation (10) the 'stochastic equilibrium unemployment ratio' to distinguish it from the 'stochastic equilibrium unemployment rate' (given by (7) above). Clearly, in exploring Okun's law our focus must be on the *relative* movements in entry and exit following a shock to GDP growth.

The last two columns of Table 1 provide descriptive statistics for the first-differences in the logarithms of the entry and exit rates, together with the GDP growth rate. As expected, we see that the GDP growth rate is positively correlated with changes in the (logarithm of the) entry rate and negatively correlated with changes in the (logarithm of the) exit rate.

Since all three variables we are interested in (the change in the logarithm of the entry rate, the change in the logarithm of the exit rate and the GDP growth rate) are I(0) and given also that we want to allow for possible interactions between entry and exit rates[26] with GDP growth treated as exogenous, the appropriate way to approach the data is by using Vector Autoregression (VAR).[27] We again include a slope dummy to allow for asymmetry.[28]

The results of the VAR are set out in the second and third data columns of Table 2. In an attempt to provide an efficient description of the results we will focus our attention on estimated coefficients that have a p-value ≤ 0.10 (estimated coefficients with a p-value greater than 0.10 will be treated as having a 'true' value of zero).

What insights into Okun's law and the labour market in Australia result the equations for the first difference in the logarithms of entry and exit rates? To answer this question we will consider two scenarios. The first scenario involves an increase in the (positive) rate of GDP growth when the economy is not in a recession (obviously consequences of a decrease in the rate of GDP growth when the economy is not in a

26 We saw earlier that inflow and outflow rates are interdependent.

27 The AIC criterion has been used to determine the appropriate lag lengths.

28 Including a shift dummy for recession periods yields coefficients on the dummy which have very high pvalues. As a result, we drop the shift dummy (but retain the slope dummy).

recession simply involves changing the signs in what follows). The second scenario involves a further decline in the rate of GDP growth when the economy is in a recession (obviously consequences of an increase in the rate of GDP growth when the economy in a recession simply involves again changing the signs in what follows). In each scenario we will focus on what it is about the effect of economic growth on the entry and exit rates that results in the unemployment rate changing in the direction consistent with Okun's law.

An increase in the rate of GDP growth when the economy is not in a recession

The entry in the first column of the second row (labelled "GDP growth rate") of Table 2 tells us, not unexpectedly, that the increase in the growth rate leads to a fall in the unemployment rate. What must be happening to unemployment entry and exit to bring this about? The third and fourth columns of the second row give us that information. We see that in response to an increase in the growth rate, the entry rate falls, thus tending to lower the ratio of unemployment to employment and the unemployment rate below what it would otherwise be. We also see that in response to a higher rate of economic growth the exit rate rises and this will also be tending to lower the ratio of unemployment to employment and thus the unemployment rate below what it would otherwise be. Taken together these results are consistent with a rise in the rate of economic growth resulting in a lower rate of job separations and a higher rate of job finding than would otherwise be the case.

A decrease in the rate of GDP growth when the economy is in a recession

The entry in the first column of the third row (labelled "Slope dummy for recession") of Table 2 tells us that the Okun coefficient varies, depending upon the state of the economy and specifically that, if the economy is growing below the trend rate, the effect of a given change in the growth rate upon unemployment rate will be greater (more negative) than if the economy is growing at or above the trend rate. What must be happening to unemployment entry and exit to bring this about? Again, the third and fourth columns of the third row give us that information. Notice that in recessions we estimate that the impact of a change in the growth rate on the change in the entry rate is larger (specifically, more negative) than at other times, while there appears to be no significant impact of a change in the growth rate in recessions on the exit rate. In short, the asymmetry in the response of the unemployment rate to changes in the GDP growth rate is likely due to factors which effect the rate at which job separations occur. How can we explain the presence of asymmetry? Some time ago Axel Leijonhufvud (1973) introduced the idea of a 'corridor' "by which he meant that when shocks are small, an economy functions relatively smoothly "within a corridor", but large shocks can generate instability and change the dynamics completely" (Farmer, 2022).[29] The large shocks which he refers to are failures of effective demand of such a magnitude that agents are constrained in their actions and their hopes (expectations) of a return to 'normalcy' in the short-run are dashed. In relation to employment this results in a situation where firms will not simply reduce hours in the belief that a reduction in sales is firm or industry specific and/or only temporary but will instead reduce the number of employees.

Returning to the empirical results reported in Table 2 we notice that the consequences for unemployment of a shock to GDP are greater in the second case discussed above (a decrease in the rate of GDP growth when the economy is in a recession) than in the first case (an increase in the rate of GDP growth when the economy is not in a recession). If we use the point estimates of coefficients where the p-value is less than 0.10 we see that a downturn involving a 1 per cent fall in the growth rate will result in a rise in the ratio of unemployment to employment of 0.0577 per cent (*en* rises by 0.0156 per cent + 0.0359 per cent while *ex* falls by 0.0062 per cent) per period while an upturn involving a 1 per cent rise in the growth rate will result in a fall in the ratio of unemployment to employment of 0.0218 per cent (*en* falls by 0.0156 per cent while *ex* falls by 0.0062 per cent) per period. Clearly the behavior of the entry and exit rates are such that in the downturn (cet par) the unemployment ratio rises relatively 'fast' while during the recovery (cet par) the unemployment ratio falls relatively slowly. One possible explanation for this could be in terms of the age profile of firms. During the downturn one would expect firms with relatively high labour costs (in the context of a 'vintage model' one would expect these to be the oldest firms in the industry) to shed labour at a higher rate per unit of output than the labour hiring rate per unit of output of the (likely newer and thus lower labour cost) firms which survive and expand in the recovery.

Concluding remarks

Logic dictates that, if the unemployment rate changes in a systematic way in response to variations in the rate of economic growth, then at least one of the unemployment entry and exit rates must change in a systematic way in response to variations in the rate of

29 Leijonhufvud envisages a world in which the economy "is likely to behave differently for large than for moderate displacements from the "full coordination" time-path. Within some range from the path (referred to as "the corridor" for brevity), the system's homeostatic mechanisms work well, and deviation-counteracting tendencies increase in strength. Outside that range these tendencies become weaker as the system becomes increasingly subject to "effective demand failures" (Leijonhufvud, 1973, p 32).

economic growth. We have seen that this is indeed the case and that the unemployment entry and exit rates appear to respond in ways that make sense in the light of economic theory. We have also found that the asymmetry in the relationship between GDP growth and the unemployment rate reflects the impact of changes in GDP growth on the entry rate and not the exit rate.

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