Unemployment Model

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Introduction

When people become unemployed, it impacts their lifes. The financial impact, given other financial commitments, is often significant. For example, it impacts the ability to pay the mortgage or to consume goods. For similar reasons the unemployment rate is monitored as a significant economic indicator.

People can protect themselves from the risk of becoming unemployed by purchasing financial income protection products. For this type of income protection products, specifically insuring the loss of income through unemployment, the probability for a policyholder becoming unemployed or employed is a relevant and potentially significant factor affecting claims. With respect to loans, as demonstrated during the recent financial crisis, increase in unemployment negatively affects write offs on loan books.

For both income protection products as well as for loans, the probability for a person to become unemployed is a crucial factor in product pricing and credit risk management.

Data directly reflecting the number or percentage of people that historically have transferred from being employed to being unemployed or vice versa is not directly available. However, related, but not necessarily strongly correlated measures are historically available such as unemployment rate, size of labour force and non labour force. The data model behind these publicly available measures implicitly represents a multi-state model implicitly, but not explicitly capturing the percentage of people that historically transferred from being employed to being unemployed and vice versa. Using logic and other publicly available data providing information on the transfers in the multi state model allows us to estimate the historically observed transfers and therefore historically observed probabilities of a person being employed to become unemployed and vice versa (‘unemployment probabilities’).

In section 1 the data model of the applied data is presented. Following we present the model which determines unemployment probabilities. In the third section we present the results and in the fourth section how these can be used in practise.

1. Data

New Zealand Statistics data regarding unemployment is mostly publicly available through the Household Labour Force Survey. The unemployment data, being headcounts, used for this paper is structured according to the following data model:

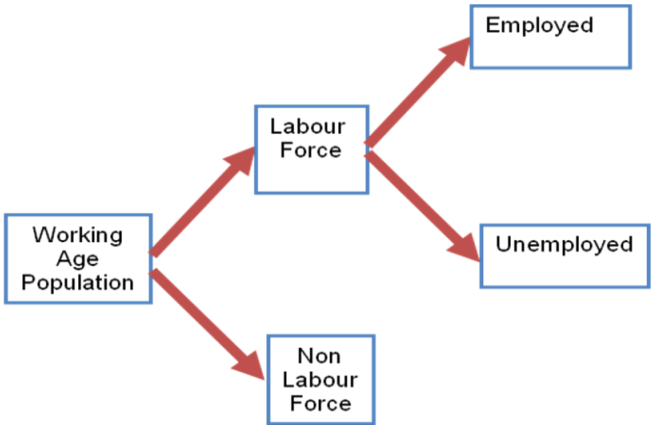

Figure 1: Unemployment data model – source New Zealand Statistics

Unemployment rate = Unemployed / Labour Force

The New Zealand Statistics definitions of each the data elements are provided in appendix A. We will refer to the various data elements in figure 1 as 'unemployment states'.

Historic unemployment data time series according the above data model is available for the following segmentations:-

- Age
- Gender
- Qualification, and
- Region

Most data is available going backwards up to 20 years on a quarterly basis. For the analysis below 20 years data is used starting from June 1990 until September 2009.

2. The unemployment model

The data model provides counts of the number of people in the various unemployment states. The data as such represents a snapshot rather than movements between the various data elements. For example, if there are 100 unemployed people at $t=0$ and 110 at $t=1$ it is unclear from which unemployment states people transferred to unemployment during the period. Or otherwise if at $t=0$ 2000 people are employed and at $t=1$ we observe 2200 employed people, it is uncertain whether these additional 200 people have transferred from either unemployed, non labour force or are a results of a net increase in working age population.

The unemployment rate in any form obviously cannot be considered as a probability for an employed person to become unemployed. For example, a significant rise in unemployment rate can be caused by a large number of people re-entering the labour market without jobs available other than by employed people becoming unemployed.

The data model provides snapshots at fixed points in time, however does not provide information about the transfers during the period. The model described in this section estimates the transfers between unemployment states.

The below diagram displays the possible transfers between unemployment states between two snapshots from the unemployment data model:

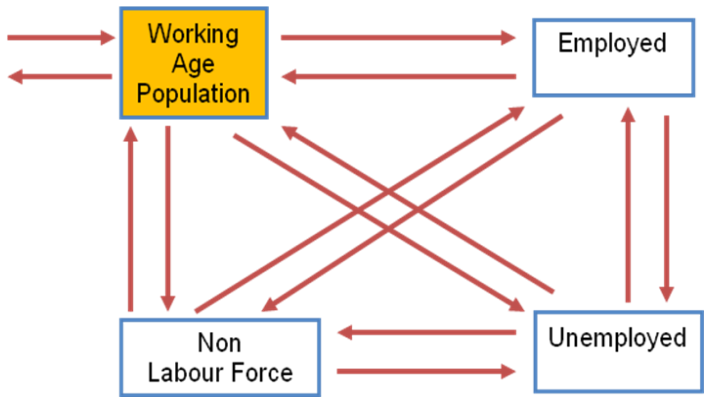

Figure 2: Multi state unemployment model

Please note, labour force is equal to the number of employed and unemployed people and is therefore not a unique unemployment state in figure 2 as it is already captured in the working age population. The number of people in the working age population is equal to sum of the people in the non labour force state, the unemployed state and the employed state. The working age population in this multi state model can be considered as the gateway in and out of multi state model.

The multi state unemployment model can be represented as a set of 8 equations and 16 unknown variables that cannot be solved without either additional data and / or assumptions, i.e. has an endless number of possible solutions. This set of equations represents the unemployment data model at the start of a period, the transfers between the various unemployment states and the resulting unemployment data position at the end of the period.

To solve this set of equations, we have identified 5 assumptions and related publicly available data sets with which we are able to determine a unique solution for the set of equations.

The additional assumptions and data:

Nr	Assumption
1.	The number of people leaving the working age population is equal to the average mortality rate for the population plus net emigration of working age population.
2.	The new people that enter or leave working age population migrate to or from either the various unemployment states according to the proportions measured at the start of the period. For example, suppose there are 100 people in the working age population and 30 (=30%) are in the non labour force state, 60 (=60%) in the employed state and 10 (=10%) in the unemployed state. During next period 10 more people join the working population age and nobody leaves. Then the out of the 10 new people 3 are assumed to move into the non labour force state, 6 are assumed to become employed and 1 is assumed to become unemployed.
3.	If the non labour force decreases in the period then there are no people moving from the employment and unemployment state to the non labour force during the same period.
4.	If non labour force increases during the period then there are no people moving from non labour force to employment and unemployment states during the same period.
5.	The number of people that move from being unemployed to employed is equal to the relative amount of people that have an observed duration of unemployment less than the length of period.

The additional data required to support these assumptions are:-

- Duration of unemployment (New Zealand Statistics - Household of Labour Force Survey)
- Migration statistics (New Zealand Statistics – Subnational Net Migration Estimates), and
- Mortality tables

Assumptions 2, 3 and 4 are supported by historical data showing a very steadily growing participation rate. The participation rate represents the percentage of the working age population that are part of the labour force. Assumptions 1 and 5 are supported by the additional data.

The chosen assumptions and data sets also represent an opportunity to validate results as the model is sensitive to invalid parameters. The assumptions are chosen such that the there is sufficient information to solve the number of people transferring from being employed to unemployed. This is a relatively small number compared to the number of people in each of the unemployment states. If, for example, net migration is incorrectly estimated to be strongly negative and the employment states showing strong growth the set of equations cannot be solved or will lead to practically impossible results.

3. Model Results

3.1. Probability of unemployment

The model estimates quarterly transfers between unemployment and employment over a 20 year period, which enables to estimate the unemployment probabilities. Data analysis on the historic transfers between the unemployment and employment states show these are correlated with the change in unemployment rate.

The estimated historic unemployment probabilities as a function of the change in unemployment rate are presented below:

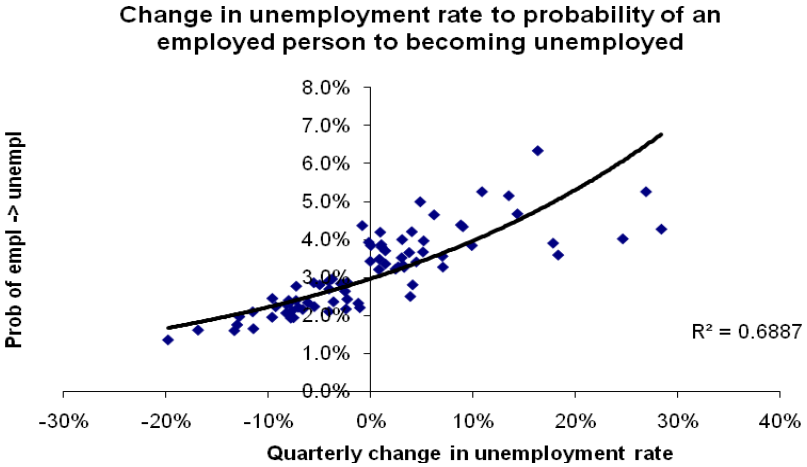

Figure 3: Change in unemployment rate to probability of an employed person becoming unemployed

The natural probability of unemployment for an employed person, given no change in unemployment rate, for an employed person is estimated to be 3%. When unemployment rates increase the chances of becoming unemployed increase as expected. The R^2 of 0.6887 provides good support for this relationship.

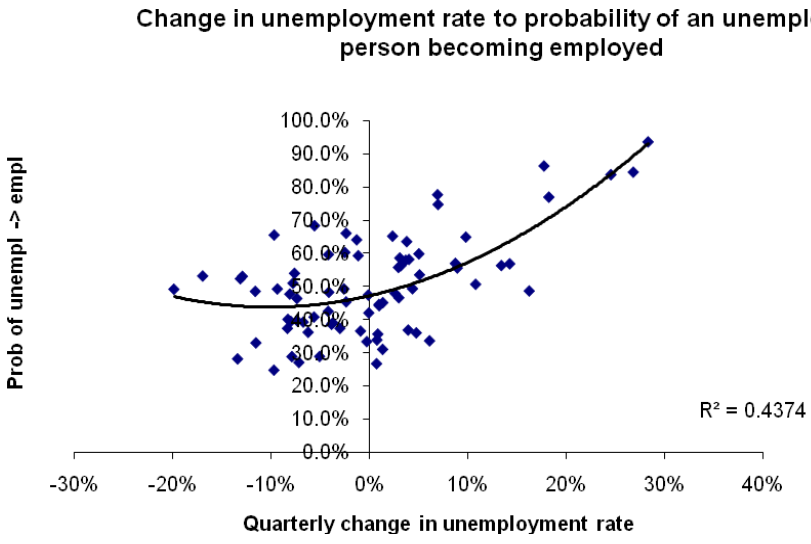

Figure 4: Change in unemployment rate to probability of an unemployed person becoming employed

The natural probability of employment for an unemployed person, given no change in unemployment rate, is estimated to be 50%. The probability of employment increases with absolute changes in unemployment rates being greater than zero. The R^2 shows that there is significant variation around the trend. This relationship between probability of employment and change in employment rate at first sight may present a counterintuitive results. The chance of being (re)employed becomes greater when the unemployment rate is going up (or going down). An explanation could be that when there is no change in unemployment rate the movements on the job market are the smallest. With unemployment rates going up or down activity on the job market increases.

3.2 Segmented unemplomentprobabilities

The model shows similar relations for different segments (age, region, gender and qualification) between the change in unemployment rate and the unemployment probabilities. The estimated probability of unemployment is similarly related to the change in unemployment.

Some examples of the relationship between the probability of unemployment and the change in unemployment rate for various segmentations:-

	Prob of employed to unemployed		Prob of unemployed to employed	
	Mean*	Slope**	Mean	Slope
Total population	3%	9%	50%	93%
Qualification – No Qual	3%	8%	50%	64%
Sample Age – 40 to 44	2%	5%	50%	71%
Gender – Female	3%	9%	50%	81%

*The probability of (un)employment with no change in unemployment rates
** The slope (if assumed to be linear) of the fitted curve with increasing unemployment rates

The means in the above displayed table appear to be stable for the various segments. Please note, duration of unemployment data is publicly available segmented for gender and not for qualification, age or region. The total New Zealand durations of unemployment have been applied instead.

This result does not preclude that the various segments experience different probability of unemployment since the volatility in the unemployment rate is significantly different for different segments. Moreover, the change in unemployment rate for various segments does not appear to be strongly correlated. The probability of unemployment is not strongly correlated between various segments as a result.

3.2. Change in unemployment rate across various segments

Given the unemployment probabilities are correlated with the change in the unemployment rate, we have investigated the correlation between the changes in unemployment rate for the various segments.

The change in unemployment rate for gender is on average 90% correlated to the change in unemployment rate for total New Zealand. However, change in unemployment rate for most regions, age buckets and qualifications appears be uncorrelated between 40% and 70% with total New Zealand over the same 20 year period. As a result the probabilities of unemployment can potentially be quite different for various age, qualification and regional segments.

The unemployment rate for 2007 in Auckland was 3.9% and 4.7% for 2008, which implies an average quarterly increase of 5% in unemployment rate. Over the same period the in the Matawatu - Wanganui region the unemployment rate dropped by an average of 5% per quarter. The model estimates the probability of becoming unemployed for Auckland for one quarter to be 3.5% to 2.6% for the Matawatu - Wanganui region.

4. How these results can be used

The probability of unemployment is relevant for various financial protection and banking products.

Financial protection products can protect the policyholder for the loss of income due to unemployment. The unemployment model can support pricing of this risk by:-

- Estimating the probability of unemployment for various segments
- The estimated duration of unemployment, and
- The probability distribution of duration of unemployment

The probability distribution for duration of unemployment can be estimated given the probability distribution of change in unemployment rate. The unemployment model can also add value with risk modelling or stress testing by calculating future claims for shocked unemployment rates.

The model can be also be used with (structured) retail credit risk models. Unemployment rate is generally viewed as one the significant variables in estimating credit risk, more specifically in estimating the probability of default and loss given default for home loans. During the GFC the impairments on home loans increased significantly amongst other factors as a result of increased number of people becoming unemployed.

Unemployment rate is often regarded as a significant factor in macroeconomic forecasting models. The estimated transfers between the different employment states capture more granular information that solely the unemployment rate and could potentially add value to the forecasting power of macroeconomic models.

Appendix A

Definitions of unemployment states as used in the Labour Force Household Survey

Working-age population
The usually resident, non-institutionalised, civilian population of New Zealand aged 15 years and over.

This definition is commented on the New Zealand statistics website:
"This is a crude definition as some people aged 65 years and over may be in the workforce, while some people aged 15–64 years may not be in the workforce."

Source: http://www2.stats.govt.nz/domino/external/omni/omni.nsf/wwwglsry/working-age+population

Labour force
Members of the working-age population who during their survey reference week were classified as 'employed' or 'unemployed'.

Employed
All persons in the working-age population who during the reference week:

- Worked for one hour or more for pay or profit in the context of an employee/employer relationship or self-employment; or
- Worked without pay for one hour or more in work which contributed directly to the operation of a farm, business, or professional practice owned or operated by a relative; or
- Had a job but were not at work due to: own illness or injury, personal or family responsibilities, bad weather or mechanical breakdown, direct involvement in an industrial dispute, or leave or holiday.

Unemployed
All persons in the working-age population who during the reference week were without a paid job, available for work, and had either actively sought work in the past four weeks ending with the reference week, or had a new job to start within the next four weeks.

Source: New Zealand Statistics