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An Australian Labour Market Conditions Index

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AN AUSTRALIAN LABOUR MARKET CONDITIONS INDEX

Angelia L. Grant, Wilma Gillies, Ray Harris and Melissa Ljubic¹

Treasury Working Paper²

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- 1 All authors work in the Australian Treasury. The authors would like to thank Jed Armstrong, Christine Barron, Natasha Cassidy, Joshua Chan, Alexandra Heath, John McDermott and Nigel Ray for helpful comments. Correspondence to: Australian Treasury, Langton Crescent, Parkes ACT 2600, Australia. Email: angelia.grant@treasury.gov.au.
 - 2 The views expressed in this paper are those of the authors and do not necessarily reflect those of The Australian Treasury or the Australian Government.



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An Australian Labour Market Conditions Index

Angelia L. Grant, Wilma Gillies, Ray Harris and Melissa Ljubic*

December 2016

Abstract

This paper constructs a labour market conditions index for Australia using principal components analysis with 16 labour market variables. The index is broadly consistent with the business cycle in Australia. It shows that there was a large amount of slack in the Australian labour market during the global financial crisis and it has only recently returned to around average conditions. The index explains between 64 and 87 per cent of the variation in half of the labour market variables used in the analysis. The correlation between wage growth and the labour market conditions index is stronger than the correlation with the unemployment rate alone. In addition, the labour market conditions index appears to be a strong leading indicator of wage growth. The index is not sensitive to the addition of other variables.

Keywords: Principal components analysis, labour market conditions index.

*All authors work in the Australian Treasury. The views expressed in the paper are those of the authors and do not necessarily reflect those of the Treasury or the Australian Government. The authors would like to thank Jed Armstrong, Christine Barron, Natasha Cassidy, Joshua Chan, John Fraser, Alexandra Heath, John McDermott and Nigel Ray for helpful comments. Correspondence to: Australian Treasury, Langton Crescent, Parkes ACT 2600, Australia. Email: angelia.grant@treasury.gov.au.

1 Introduction

Assessing spare capacity in the labour market is important for macroeconomic policymaking, forecasting and a range of other broader policies. It provides an assessment of where an economy is in its business cycle and offers important information for assessing wage and inflation pressures. It is a complex task as there are a number of variables to consider and it can be difficult to obtain a coherent assessment by looking at each of the variables individually. Different variables can at times provide conflicting signals of spare capacity and it can be difficult to know how much weight to put on each of the different variables.

In order to undertake a systematic analysis of a number of variables that is consistent through time and not reliant on judgments made by policymakers, econometric models can be helpful. More specifically, econometric models can be used to combine a range of labour market variables into a summary measure. This ensures that the correlations between a number of variables are assessed using formal methods and the weights placed on the importance of each of the data series are determined completely by the data.

The benefits of combining a number of labour market variables into a summary measure to provide a broader view on labour market conditions has been recognised by a number of government agencies and institutions, including the Board of Governors of the Federal Reserve System and the Reserve Bank of New Zealand (RBNZ). The measure used by the Board of Governors was developed by Chung et al. (2014). It is derived from a dynamic factor model that extracts the common variation from 19 labour market variables. The measure used by the RBNZ was developed by Armstrong et al. (2016). It uses principal components analysis to summarise the common movement in 17 labour market variables. Others have also used principal components analysis. For example, Barnes et al. (2007), Hakkio and Willis (2013) and Zmitrowicz and Khan (2014) develop principal component models of 12, 24, and 8 labour market variables respectively.

This paper constructs a labour market conditions index for Australia using principal components analysis. There are 16 variables used in the analysis, including unemployed persons, employed persons, hours worked and labour force participation. Movements in the index are broadly consistent with the business cycle in Australia. It shows that there was a large amount of slack in the Australian labour market during the global financial crisis and it has only recently returned to around average conditions. The labour market conditions index explains between 64 and 87 per cent of the variation in half of the

variables used in the analysis. The correlation between wage growth and the index is stronger than the correlation with the unemployment rate alone. In addition, the index is a strong leading indicator of wage growth.

The remainder of this paper is organised as follows. Section 2 provides a brief description of principal components analysis, Section 3 details the data used in the analysis and Section 4 reports the labour market conditions index, the correlation with wage growth and the robustness of the index to the addition of other variables. Section 5 concludes.

2 Principal Components Analysis

There are various econometric methods that can be used to determine the common movement in a number of data series. Principal components analysis, as applied by Stock and Watson (2002), is one such method. This section briefly discusses principal components analysis and outlines the steps required to undertake the estimation.

Principal components analysis is a dimension reduction method that reduces a number of observed variables into a smaller number of principal components that account for most of the variability. The components are a linear combination of the variables used in the analysis. Mathematically, computing the principal components amounts to determining the eigenvectors and eigenvalues of the covariance matrix for the variables.

More specifically, the components are functions of the eigenvectors, with the first principal component determined by the eigenvector corresponding to the largest eigenvalue. The first principal component accounts for the maximum amount of common variation in the observed variables. Subsequent components are determined by the eigenvectors corresponding to the descending eigenvalues and account for the maximum amount of common variation that was not accounted for by earlier components. The components are uncorrelated with each other.

Consider the following model that motivates the principal components analysis, where the $n \times 1$ vector of observed variables \mathbf{X}_t depends on a vector of k latent factors \mathbf{f}_t :

$$\mathbf{X}_t = \mathbf{\Lambda} \mathbf{f}_t + \boldsymbol{\varepsilon}_t, \tag{1}$$

and $\mathbf{\Lambda}$ is the $n \times k$ loading matrix.

One estimation method for this model is to find the factor loadings and factors so as to minimise the sum of squared errors:

$$\sum_{t=1}^T (\mathbf{X}_t - \mathbf{\Lambda} \mathbf{f}_t)' (\mathbf{X}_t - \mathbf{\Lambda} \mathbf{f}_t)$$

with respect to $\mathbf{\Lambda}$ and $\mathbf{f}_1, \dots, \mathbf{f}_T$.

This optimisation problem is nonlinear. One method for solving it is to compute the eigenvectors and eigenvalues of the covariance matrix of the data. This can be done with the following steps:

1. Standardise each of the n data series by subtracting the mean and dividing by the standard deviation and construct a $T \times n$ matrix \mathbf{X} by stacking \mathbf{X}_t over $t = 1, \dots, T$.
2. Extract the k largest eigenvalues and eigenvectors of $\mathbf{X}'\mathbf{X}$ and arrange the eigenvectors by descending value of the corresponding eigenvalues (i.e. $\mathbf{v} = (\mathbf{v}_1, \dots, \mathbf{v}_k)$).
3. Estimate the latent factors using $\mathbf{f} = \mathbf{X}\mathbf{v}$ and transform the factors into an index by multiplying by 100 and dividing by n . The latent factors estimated in this way are called principal components.

3 Data

The principal components analysis is based on 16 labour market variables, which are outlined in Table 1.¹

All data, except for job advertisements, are sourced from the Australian Bureau of Statistics labour force survey or the detailed labour force data.² The newspaper job advertisements series is sourced from the ANZ. The frequency of each of the series is

¹ Unlike Chung et al. (2014) and Armstrong et al. (2016), the 16 variables used in the analysis do not include any wage variables. This is a deliberate choice given that one of the purposes of constructing the index is to forecast wage growth.

² The vintage of data used is the June 2016 release. It is noted that annual benchmarking resulted in revisions to the monthly hours worked series in the July 2016 release. These revisions do not have a significant effect on the reported labour market conditions index.

monthly, except for the data on underemployed persons, which is reported quarterly. For this variable, the series is held constant in each month of the quarter. All data, except for the civilian population, persons not in the labour force and short-term and long-term unemployed persons, are seasonally adjusted. The sample period is 1992M2 to 2016M6.

Table 1: Variables used in the labour market conditions index.

	Variable	Transformation
(1)	Employed persons	$\Delta_{12}\ln$
(2)	Full-time employed persons	$\Delta_{12}\ln$
(3)	Employment to population ratio	Δ_{12}
(4)	Unemployed persons	$\Delta_{12}\ln$
(5)	Unemployed persons who looked for full-time work	$\Delta_{12}\ln$
(6)	Unemployment rate	Δ_{12}
(7)	Unemployed persons aged 15 to 24	$\Delta_{12}\ln$
(8)	Short-term unemployed persons (under 26 weeks)	$\Delta_{12}\ln$
(9)	Long-term unemployed persons (52 weeks and over)	$\Delta_{12}\ln$
(10)	Underemployed persons	$\Delta_{12}\ln$
(11)	Labour force participation rate	Δ_{12}
(12)	Persons not in the labour force	$\Delta_{12}\ln$
(13)	Civilian population aged 15 years and over	$\Delta_{12}\ln$
(14)	Monthly hours worked in full-time jobs	$\Delta_{12}\ln$
(15)	Monthly hours worked in part-time jobs	$\Delta_{12}\ln$
(16)	Newspaper job advertisements	$\Delta_{12}\ln$

As mentioned above, principal components analysis reduces a number of observed variables into a smaller number of principal components that account for most of the variability. As such, it relies on the variables being correlated. Tables 2 and 3 report the lower triangular entries of the correlation matrix for the transformed data. That is, the (i, j) entry of the matrix is the correlation coefficient of the i -th and j -th variable.

The correlations between a number of variables are high. For example, the correlation between the annual percentage change in employed persons and the annual percentage change in full-time employed persons is 0.89.

Table 2: Data correlation matrix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	1.00							
(2)	0.89	1.00						
(3)	0.97	0.86	1.00					
(4)	-0.64	-0.69	-0.75	1.00				
(5)	-0.63	-0.69	-0.74	0.97	1.00			
(6)	-0.74	-0.73	-0.82	0.95	0.92	1.00		
(7)	-0.51	-0.57	-0.61	0.89	0.81	0.85	1.00	
(8)	-0.28	-0.32	-0.41	0.78	0.72	0.68	0.75	1.00
(9)	-0.71	-0.73	-0.73	0.66	0.67	0.71	0.54	0.11
(10)	-0.49	-0.56	-0.54	0.67	0.70	0.62	0.59	0.39
(11)	0.83	0.66	0.80	-0.24	-0.26	-0.32	-0.12	0.05
(12)	-0.80	-0.63	-0.83	0.34	0.37	0.41	0.22	0.07
(13)	0.05	0.05	-0.21	0.45	0.46	0.40	0.42	0.45
(14)	0.71	0.80	0.73	-0.67	-0.68	-0.69	-0.60	-0.44
(15)	0.27	-0.12	0.30	-0.08	-0.09	-0.16	-0.02	-0.08
(16)	0.29	0.30	0.46	-0.71	-0.72	-0.66	-0.63	-0.69

Table 3: Data correlation matrix (continued).

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(9)	1.00							
(10)	0.53	1.00						
(11)	-0.46	-0.24	1.00					
(12)	0.48	0.29	-0.95	1.00				
(13)	0.12	0.21	0.07	0.17	1.00			
(14)	-0.52	-0.49	0.49	-0.51	-0.13	1.00		
(15)	-0.05	-0.02	0.34	-0.38	-0.19	0.08	1.00	
(16)	-0.26	-0.49	0.07	-0.24	-0.68	0.51	0.19	1.00

4 Results

4.1 Labour Market Conditions Index

The labour market conditions index, which is the first principal component from the principal components analysis, is shown in Figure 1(a).³ It is a standardised index, so 0 represents average labour market conditions. The index is constructed to be positively correlated with the number of employed persons. Hence, an index that is greater than 0

³ It is usual to focus on the first principal component in this context, given that the interpretation of other principal components is less clear. Moreover, in the application in this paper, the first principal component accounts for the majority of the variation in over half of the variables.

indicates a greater amount of labour market tightness than experienced on average and an index less than 0 indicates more slack in the labour market than on average.

Movements in the labour market conditions index are broadly consistent with the business cycle in Australia, with slack recorded during periods of slowing economic growth. The index suggests that there was a large amount of slack in the Australian labour market during the global financial crisis, which corresponds with a rise in the unemployment rate. While the rate of unemployment did not peak at levels seen during previous economic downturns, and peaked at a level lower than forecast by Treasury at the time, the percentage point rise was steep (see Figure 1(b)). Labour market variables other than those associated with levels of unemployment also provide an indication of significant slack in the labour market during the global financial crisis. For example, there were falls in the labour force participation rate, indicating a discouraged worker effect, and falls in monthly full-time hours worked. In fact, a distinguishing feature of the global financial crisis compared to the early 1990s recession was that employers chose to reduce hours rather than lay off employees (see, e.g., Bishop et al., 2016). Notwithstanding this, the labour market conditions index suggests that the slack in the labour market during the global financial crisis was comparable to that recorded in early 1992.

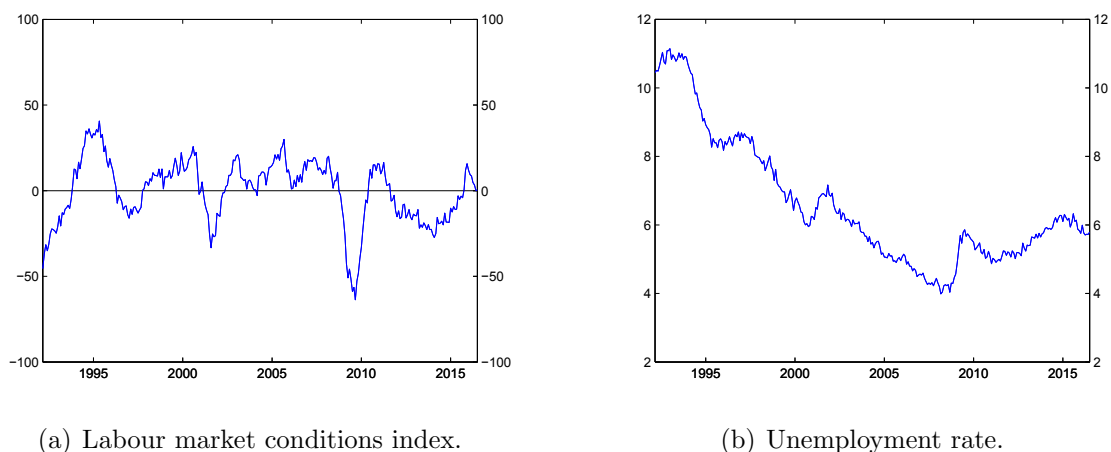
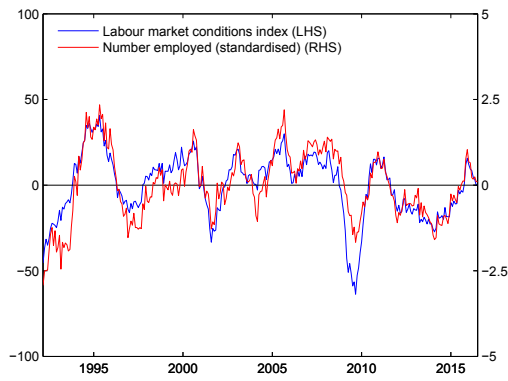


Figure 1: Labour market conditions index and unemployment rate.

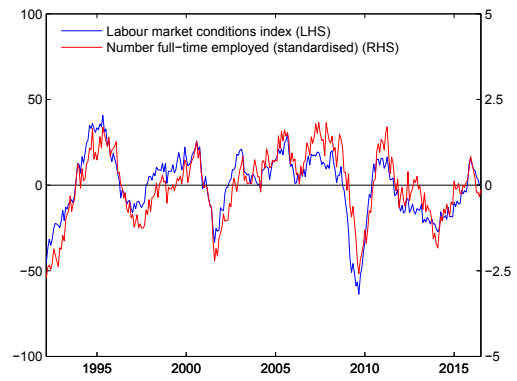
Following the global financial crisis, a large amount of labour market slack remained. In the immediate aftermath of the crisis, conditions in the labour market tightened and the unemployment rate fell as the economy grew strongly. Then as the terms of trade fell and the mining investment boom began to unwind, the unemployment rate drifted up.

Indeed, the length of time that the economy has experienced slack in the labour market is the longest seen over the sample period of 1992M2 to 2016M6. This is consistent with the fact that, after beginning to fall following the worst of the global financial crisis, the unemployment rate rose between 2011 and 2014 and has only fallen slightly since then.

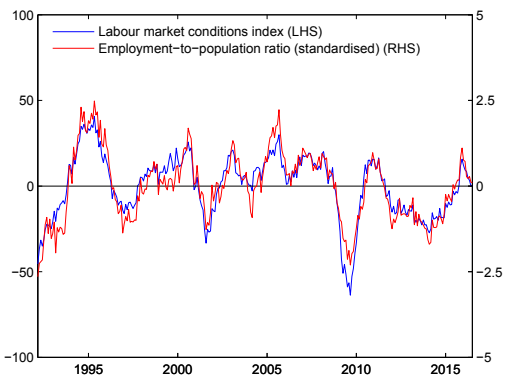
Figures 2, 3 and 4 show the labour market conditions index and each of the variables used in the construction of the index. The series that are inverted are those with a negative factor loading. As expected, a number of the variables are closely related to the labour market conditions index, but differences can be seen over some time periods. For example, the number of employed persons is closely correlated with the index, but did not fall as significantly as the index during the global financial crisis. This highlights the advantage of constructing an index from a large number of variables, rather than monitoring a single variable. In addition, the labour market conditions index is more persistent and less volatile than most of the labour market variables. This is another advantage of pooling information from a large dataset of variables.



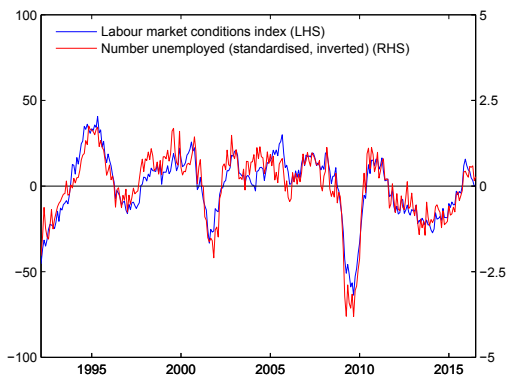
(a)



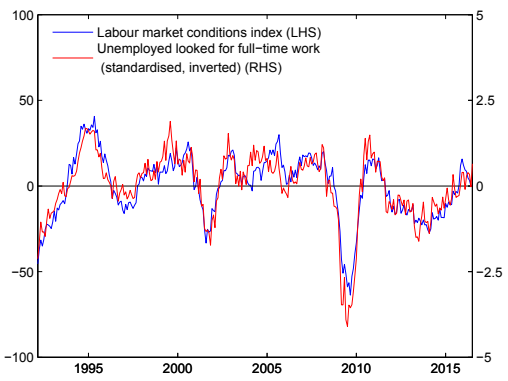
(b)



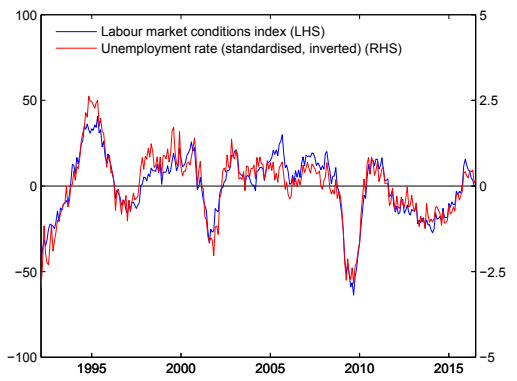
(c)



(d)

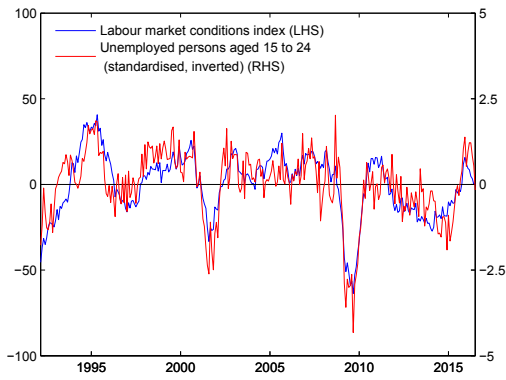


(e)

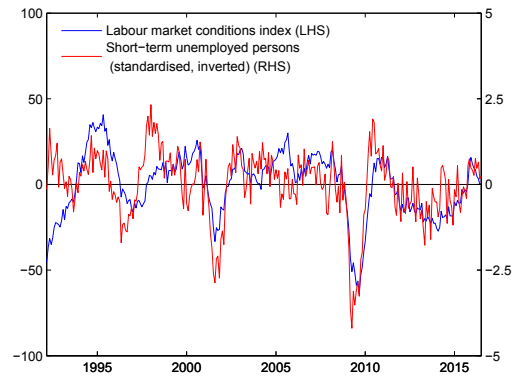


(f)

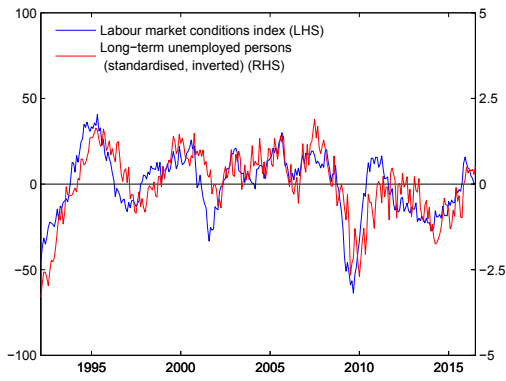
Figure 2: Labour market conditions index and variables used in the index.



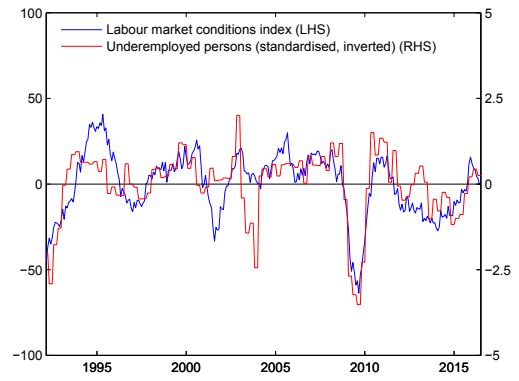
(a)



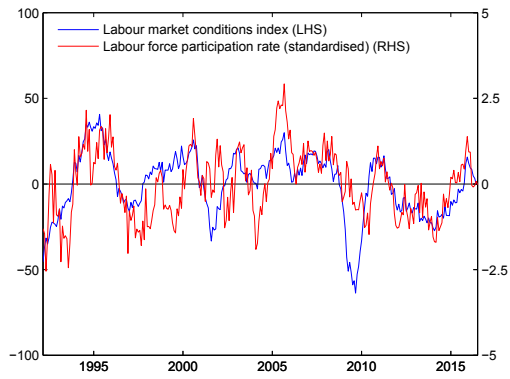
(b)



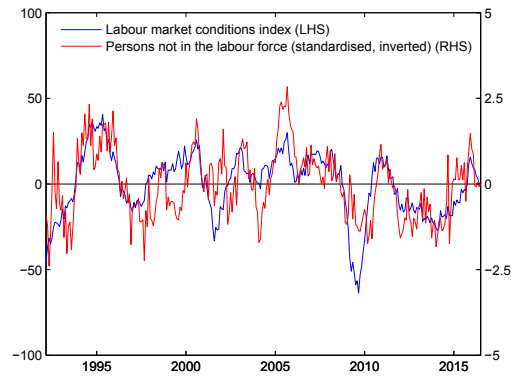
(c)



(d)



(e)



(f)

Figure 3: Labour market conditions index and variables used in the index.

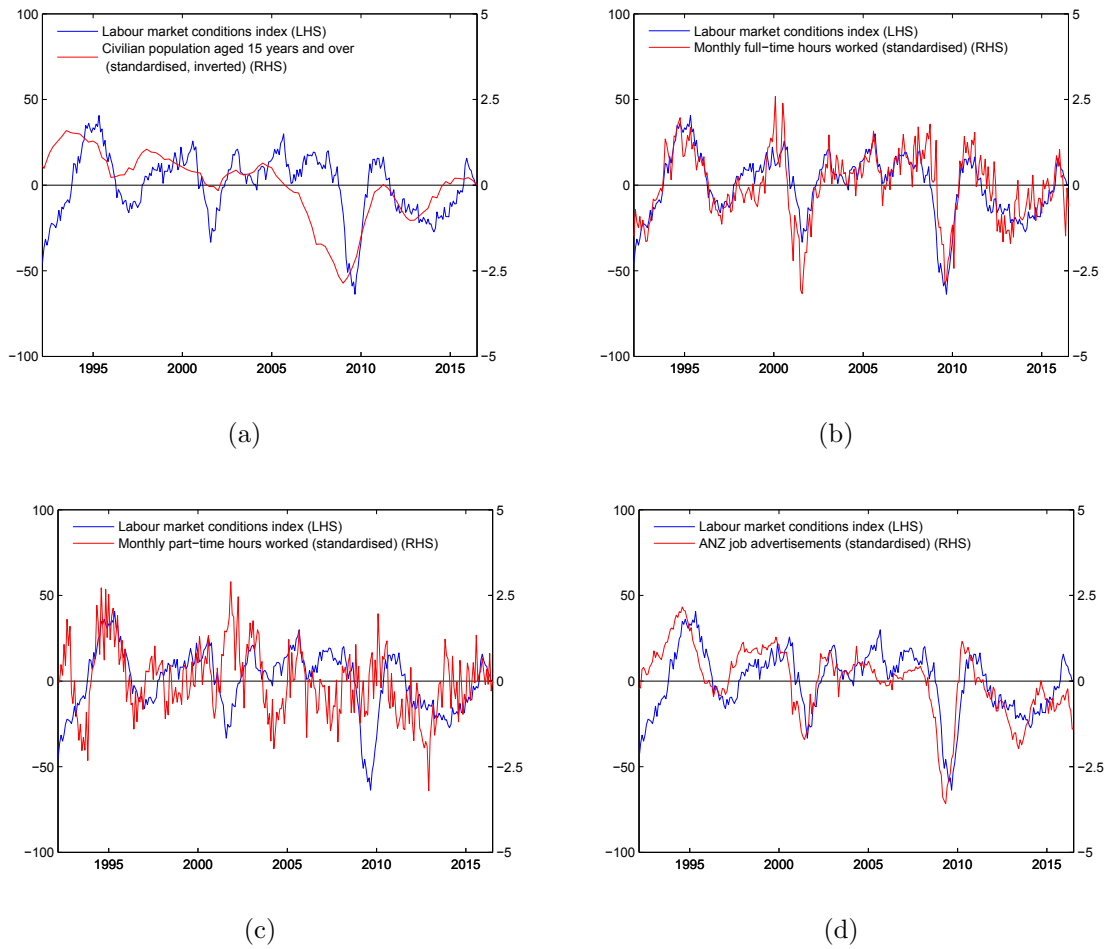


Figure 4: Labour market conditions index and variables used in the index.

4.2 Relationship with Wage Growth

This section examines whether the labour market conditions index may be more useful than the unemployment rate in explaining recent subdued wage growth. The measure for wage growth is the Australian Bureau of Statistics Wage Price Index for the private sector, all industries, including bonuses. As this data series is reported quarterly, it is transformed to monthly data by holding the series constant in each month of the quarter.

Table 4 reports the contemporaneous and leading correlations between the labour market conditions index and wage growth. It also reports the correlations with the unemployment rate to determine if the labour market conditions index provides a greater amount of predictive power. The correlation coefficients are calculated from 1998M9 to 2015M10 due

to wage data availability and to ensure that the correlation for each period is calculated based on the same number of data points.

Table 4: Correlations between labour market conditions index and wage growth.

	Annual wage growth					
	t	$t + 1$	$t + 2$	$t + 3$	$t + 4$	$t + 5$
Labour market conditions index	0.39	0.45	0.50	0.54	0.57	0.59
Annual change in unemployment rate (inverse)	0.23	0.28	0.34	0.38	0.43	0.46

There is a reasonably high correlation between wage growth and the labour market conditions index, but the magnitude of the correlation suggests that the labour market conditions index cannot fully explain recent subdued wage growth. Nevertheless, the correlation is around 25 per cent greater than the correlation with the unemployment rate alone. Further, the labour market conditions index leads wage growth, with a higher correlation between the index and wage growth in the next 3 to 5 months. This indicates that the index may be useful for forecasting wage growth.⁴

4.3 Variance Decomposition

This section examines the proportion of variability in each of the labour market variables that is explained by the labour market conditions index. More specifically, an R^2 measure is constructed to assess the power of the labour market conditions index in explaining the variation in each of the labour market variables.

The R^2 measure provides the proportion of variation explained by the first principal component. As shown in Table 5, the labour market conditions index explains a significant proportion of the variation in employed persons, full-time employed persons, the employment-to-population ratio, unemployed persons, unemployed persons who looked for full-time work, the unemployment rate, unemployed persons aged 15 to 24 and monthly full-time hours worked. For example, it explains 73 per cent of the variation in employed persons and 85 per cent of the variation in unemployed persons. The index explains a small proportion of the variation in the civilian population aged 15 years and over and the monthly hours worked in part-time jobs.

⁴ More generally, given the labour market conditions index is consistent with business cycle movements, it is likely to be useful for forecasting other macroeconomic variables. For example, the correlation coefficient between annual consumption growth and the labour market conditions index is 0.61.

Another way of viewing these results is that the data on employed persons, full-time employed persons, the employment-to-population ratio, unemployed persons, unemployed persons who looked for full-time work, the unemployment rate, unemployed persons aged 15 to 24 and monthly full-time hours worked are most correlated with the factor. That is, it is these variables that are given the most weight in constructing the labour market conditions index and, therefore, in estimating the amount of slack in the labour market.

Table 5: Variation explained by the common factor.

	Variable	R^2
(1)	Employed persons	0.73
(2)	Full-time employed persons	0.72
(3)	Employment to population ratio	0.87
(4)	Unemployed persons	0.85
(5)	Unemployed persons who looked for full-time work	0.84
(6)	Unemployment rate	0.87
(7)	Unemployed persons aged 15 to 24	0.65
(8)	Short-term unemployed persons (under 26 weeks)	0.38
(9)	Long-term unemployed persons (52 weeks and over)	0.55
(10)	Underemployed persons	0.48
(11)	Labour force participation rate	0.31
(12)	Persons not in the labour force	0.41
(13)	Civilian population aged 15 years and over	0.13
(14)	Monthly hours worked in full-time jobs	0.64
(15)	Monthly hours worked in part-time jobs	0.04
(16)	Newspaper job advertisements	0.44

4.4 Robustness

There are many variables that can be included in constructing a labour market conditions index. Ideally, a number of variables that are timely and that give a broad coverage of measures are included, but not so many variables that it is onerous to update the index. This section examines the robustness of the labour market conditions index to the inclusion of other labour market data.

Appendix A outlines a number of additional labour market variables. The addition of these variables to those already used in the estimation provide a dataset of 60 labour market variables.⁵ Figure 5(a) shows the two constructed indices. When the full set of

⁵ Many of these variables are related to each other via identities. As such, this robustness check also provides an indication of how identities affect the constructed index.

60 variables are used to construct the labour market conditions index, the level of the index shifts. In order to examine whether relative movements in the index remain the same, Figure 5(b) shows the two constructed indices when they are indexed to begin at the same point. The indexes constructed by the 60-variable and 16-variable data sets are almost identical in terms of relative movements.⁶

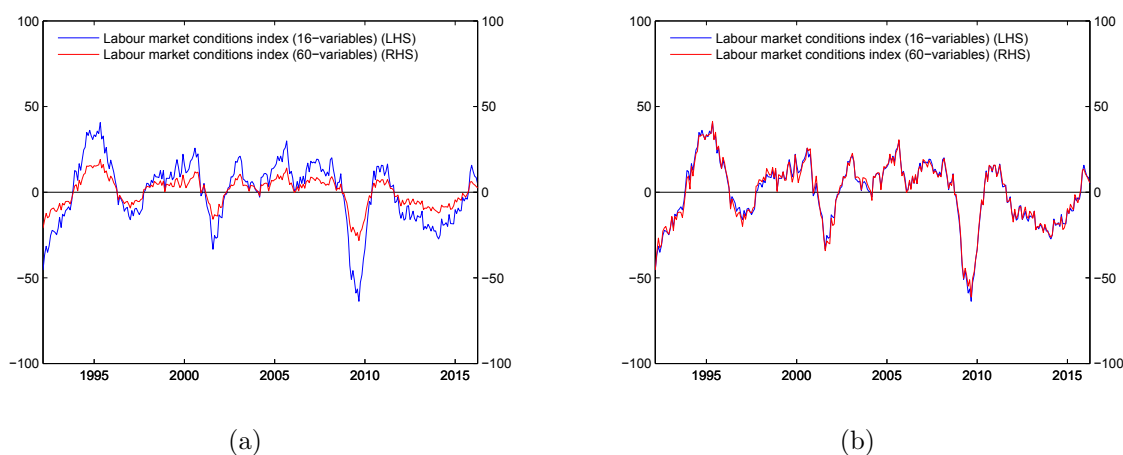


Figure 5: Labour market conditions index comparisons.

5 Concluding Remarks

This paper constructs a labour market conditions index for Australia. The index is constructed using principal components analysis with 16 labour market variables. The variables are chosen to provide a comprehensive coverage of the labour market.

Movements in the index are broadly consistent with the business cycle in Australia. The index shows that there was a large amount of slack in the Australian labour market during the global financial crisis. While conditions in the labour market tightened in the immediate aftermath of the crisis and the unemployment rate fell as the economy grew strongly, the unemployment rate then drifted up as the terms of trade fell and the mining investment boom began to unwind. The labour market conditions index has recently

⁶ In addition, one could include other survey measures in the construction of the index. However, this is unlikely to have a significant impact on the results given the expected high correlation with the index. For example, the correlation coefficient between the index and the index for the number of employees in the past 3 months from the National Australia Bank (NAB) Quarterly Business Survey is 0.7.

picked up to perform at around average conditions.

The correlation between wage growth and the labour market conditions index is stronger than the correlation with the unemployment rate alone. In addition, the labour market conditions index is a strong leading indicator of wage growth. The index is not sensitive to the addition of other variables.

Appendix A

Most data are sourced from the Australian Bureau of Statistics labour force survey. The exceptions are (51)—(54) and (59)—(60), which are constructed from the detailed labour force data, and (58), which is based on administrative data that are not publicly available.

Table 6: Variables used in testing robustness of labour market conditions index.

Variable	Transformation
(17) Male employed persons	$\Delta_{12}\ln$
(18) Female employed persons	$\Delta_{12}\ln$
(19) Male full-time employed persons	$\Delta_{12}\ln$
(20) Female full-time employed persons	$\Delta_{12}\ln$
(21) Part-time employed persons	$\Delta_{12}\ln$
(22) Male part-time employed persons	Δ_{12}
(23) Female part-time employed persons	Δ_{12}
(24) Male employment-to-population ratio	Δ_{12}
(25) Female employment-to-population ratio	Δ_{12}
(26) Male unemployed persons	$\Delta_{12}\ln$
(27) Female unemployed persons	$\Delta_{12}\ln$
(28) Male unemployed looking for full-time work	$\Delta_{12}\ln$
(29) Female unemployed looking for full-time work	$\Delta_{12}\ln$
(30) Unemployed looking for part-time work	Δ_{12}
(31) Male unemployed looking for part-time work	$\Delta_{12}\ln$
(32) Female unemployed looking for part-time work	$\Delta_{12}\ln$
(33) Male unemployment rate	Δ_{12}
(34) Female unemployment rate	Δ_{12}
(35) Unemployment rate for persons who looked for full-time work	Δ_{12}
(36) Male unemployment rate looked for full-time work	Δ_{12}
(37) Female unemployment rate looked for full-time work	Δ_{12}
(38) Unemployment rate looked for part-time work	Δ_{12}
(39) Male unemployment rate looked for part-time work	Δ_{12}
(40) Female unemployment rate looked for part-time work	Δ_{12}
(41) Persons in the labour force	$\Delta_{12}\ln$
(42) Labour force, males	$\Delta_{12}\ln$
(43) Labour force, females	$\Delta_{12}\ln$
(44) Participation rate, males	Δ_{12}
(45) Participation rate, females	Δ_{12}
(46) Not in the labour force, males	$\Delta_{12}\ln$
(47) Not in the labour force, females	$\Delta_{12}\ln$
(48) Civilian population aged 15 years and over, males	$\Delta_{12}\ln$
(49) Civilian population aged 15 years and over, females	$\Delta_{12}\ln$
(50) Monthly hours worked in all jobs	$\Delta_{12}\ln$
(51) Unemployed persons, under 4 weeks	$\Delta_{12}\ln$
(52) Unemployed persons, more than 4 weeks and under 13 weeks	$\Delta_{12}\ln$
(53) Unemployed persons, more than 13 weeks and under 26 weeks	$\Delta_{12}\ln$
(54) Unemployed persons, more than 26 weeks and under 52 weeks	$\Delta_{12}\ln$
(55) Probability of flow from unemployed to employed	$\Delta_{12}\ln$
(56) Probability of flow from not in the labour market to employed	$\Delta_{12}\ln$
(57) Probability of flow from employed to unemployed	$\Delta_{12}\ln$
(58) Unemployment benefit recipients	$\Delta_{12}\ln$
(59) Unemployed because lost last job	$\Delta_{12}\ln$
(60) Unemployed because left last job	$\Delta_{12}\ln$

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