

Results of the Review of the Leading Indicator of Employment

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Abstract:

The results of the final stage of the latest review of the Department of Employment's Leading Indicator of Employment (Indicator) are presented in this paper. This review was foreshadowed in Connolly and Lee (2008) and stated more specifically in Connolly, Lee and Stevens (2013). It has involved a broader consideration of alternative components, especially international series, than previous reviews. This broader consideration was needed in the light of the effects of the Global Recession and structural changes in the economy and the labour market (such as the shift from advertising jobs in newspapers to internet advertising).

This final stage draws on previous stages of the Review (summarised in Labour Economics Section 2014) where the current components and alternative series were considered individually, leading to a shortlist of potential components. In the final stage, we tested combinations of the shortlisted individual series against each other and chose the preferred new Indicator. A number of alternative methods, ranging from the simple (equal weightings on each component) to the very sophisticated (Kalman Filtering, with time-varying parameters estimated econometrically for each component) were used to establish the weights on each component. Somewhat surprisingly, the weights for the preferred new Indicator were determined by the simplest method; namely, equal weighting.

The preferred new Indicator is composed of five monthly series. The following two are components of the current Indicator: the Westpac-Melbourne Institute Leading Index of Economic Activity; and the Westpac-Melbourne Institute Consumer Sentiment Index. The following two international series were added: the US Yield Difference; and the official (NBSC) Purchasing Managers Index for the Output of Manufacturing in China. Another domestic series, the NAB Forward Orders Index, has been added, but two existing components, the ANZ Newspaper Job Advertisements series and the Employment Outlook Index from the Dun and Bradstreet National Business Expectations Survey, have been removed.

Note: This paper reflects the authors' views and does not necessarily represent those of Department of Employment or the Australian Government. Mr Ryland has retired since contributing to this paper. The authors would like to thank other members of the Labour Economics Section in the Department of Employment for their assistance with this review. They would also like to thank their discussant, Dr Tom Karmel, and other contributors to the discussion at the Australian Labour Market Research Workshop in Fremantle in November 2014 and other reviewers of earlier drafts of this paper.

Introduction

The latest Review of the Department of Employment's Leading Indicator of Employment (Indicator), which has been in operation since July 2007, was foreshadowed in Connolly and Lee (2008)¹. In that paper, they suggested that a review would be required as a result of the effects of the Global Recession on the economy and the labour market and the associated poor performance of the current Indicator around this time. Reflecting the effects of international influences in the Global Recession on the Australian labour market, they also stated that "consideration could be given to including offshore indicators in a future version of the Indicator" (the current Indicator consists entirely of Australian component series). We adopted this suggestion, with a wide range of overseas variables examined in the latest Review.

The Review was stated more specifically in Connolly, Lee and O'Gorman (2012) and Connolly, Lee and Stevens (2013).

Apart from the Global Recession, another reason why this Review is required is the effects of structural changes in the economy and the labour market; especially the shift from advertising jobs in newspapers to advertising over the internet. One of the components of the current indicator is the ANZ Newspaper Job Advertisements series, but as at April 2014, Newspaper Job Advertisements only represented 2.7 per cent of the total of ANZ Newspaper and Internet Job Advertisements, in seasonally adjusted terms.

As with the previous review of the Indicator, we decided to use only monthly series as components. This follows problems of lack of timeliness and large jumps in the Indicator when series were eventually released, which were experienced with some previous versions of the Indicator when quarterly series (such as real GDP and the ABS Job Vacancy series) were used. It is interesting to see that the Melbourne Institute has taken the same approach of removing quarterly series and only using monthly series in its formation of its new Leading Index of Economic Activity, which it publishes in conjunction with Westpac Bank.

The exclusion of quarterly series such as the two mentioned above also reduces the potential problems with the effects of data revisions and data gaps on the proposed leading indicator of employment. Real GDP is one of the most often revised statistics released by the ABS (partly because it has many components). There is a gap of five quarters in the ABS job vacancy series². While estimates have been made for this gap (such as Connolly and Tang 2011), exclusion of the ABS job vacancy series from the list of potential components eliminates this potential problem.

One particular problem is the end-point problem; namely, that the most recent values of the leading indicator and cyclical employment are revised whenever a new

¹ It was also stated more specifically in Connolly, Lee and Stevens (2013).

² From August 2008 through August 2009.

month of data is added to the series or recent data are revised. This is likely to have a very minor effect on the results of this analysis (because the end-point problem usually only affects the last seven or so monthly observations and there are 199 observations in the sample used for this analysis) and so has not been specifically addressed in this analysis. However, in the actual implementation of the new Indicator, consideration will be given to methods of reducing the end-point problem (such as smoothing around ARIMA forecasts of the components instead of using the final terms of the Henderson 13-term centred moving average to determine the last few month's values of the components).

The methods and aims used in deriving a new Indicator were the same as for the current Indicator; namely, to obtain a composite leading indicator of cyclical employment that has predictive power for peaks and troughs in cyclical employment with a lead time of more than six months (because the usual convention is that it takes at least six monthly moves in the same direction following a peak or trough, before a change in direction can be confirmed, and lags in data availability after the month to which it refers), and so if the lead time is six months or less, the Indicator will not give advance warning of turning points, and is not much use for policy or programme purposes. The cyclical components of employment, its explanatory variables and alternative leading indicators are determined in the same way as for the current Indicator; namely, by subtracting the one-year centred moving average (representing the short-term trend) from the six-year centred moving average (representing the long-term trend), then normalising and standardising the result. Further information on the methodology used for the current Indicator is available in Connolly and Stevens (2013).

The four current components (ANZ Newspaper Job Advertisements, the Dun & Bradstreet Employment Expectations Index, the Westpac-Melbourne Institute [new] Leading Index of Economic Activity and the Westpac-Melbourne Institute Consumer Sentiment Index) and a wide range of alternative series were considered as part of the current Review. The results of the examination of individual series are summarised in Labour Economics Section (2014). To illustrate the wide range of series considered and rejected, a list of the rejected series is provided in Appendix A. This led to a shortlist of potential components which is discussed in the next Section.

The final stage of the current Review, explained in the rest of this paper, consists of testing combinations of the shortlisted individual series against each other and choosing the preferred new Indicator. A number of alternative methods, ranging from the simple (equal weightings on each component) to the very sophisticated (Kalman Filtering, with time-varying parameters estimated econometrically for each component) were used to establish the weights on each component. These are explained in the rest of this paper, before the paper concludes with the choice of the preferred new Indicator.

Potential Component Series for the New Indicator

It would have been too time-consuming and inefficient to consider all combinations of each of the current and alternative series in the Review. Instead, most of the series were ruled out of contention after individually examining the performance of their cyclical components against cyclical employment.

The results of this examination of individual series against cyclical employment are summarised in Labour Economics Section (2014). This process led to a shortlist and a reserve list of series for further consideration.

The shortlist of series for further consideration included the following two international series:

- Electricity Production in China
- US Yield Difference (10-year bond yield – 90-day bank bill interest rate)

The short-list also included the following four domestic series:

- Dun & Bradstreet Employment Expectations Index³
- NAB Forward Orders Index
- Westpac-Melbourne Institute Leading Index of Economic Activity⁴
- Westpac-Melbourne Institute Consumer Sentiment Index⁵

As the ANZ Newspaper Job Advertisements series is a component of the current Indicator, it was also evaluated in this final stage of the Review.

The plan for the initial part of the final stage of the Review was to examine combinations of series on the shortlist shown above, and only to include series from the reserve list of series in this stage if the combination of variables on the shortlist doesn't result in a satisfactory new Indicator.

The reserve list also had two international series as follows:

- Building Permits in USA
- Official Purchasing Managers' Index of Manufacturing Output in China (National Bureau of Statistics of China)

³ This series is a component of the current Indicator.

⁴ The new series for the Westpac-Melbourne Institute Leading Index of Economic Activity has been a component of the current Indicator since the February 2014 release of the Indicator. The old series has not been available since the end of 2013.

⁵ This series is a component of the current Indicator. In an earlier part of the Review, each of the five component series of the Westpac-Melbourne Institute Consumer Sentiment Index were separately tested and eliminated from further consideration.

The reserve list also had four domestic series as follows:

- NAB Employment Expectations Index
- Westpac-Melbourne Institute Unemployment Expectations Index
- Hours Lost by Full-time Workers working Short Hours for Economic Reasons (ABS)
- Total Dwelling Approvals (ABS)

Methods and Initial Results

A number of alternative methods, ranging from the simple (equal weightings on each component) to the very sophisticated (Kalman Filtering, with time-varying parameters estimated econometrically for each component) were used to establish which series were chosen as components, which lags were used (if any) and the weights allocated to each component. These methods and the initial results from conducting them are discussed in this Section.

The key reason why we estimated time-varying parameters is that international series, from China and the USA, were included on the short and reserve lists of potential components for the first time. As China is growing in importance as a direct trading partner and the USA is shrinking in importance as a direct trading partner of Australia's, it was considered appropriate to use estimation techniques that would allow for a rising weight to be allocated to Chinese series and a declining weight to be allocated to US series. The use of such a technique, specifically Kalman filtering, was suggested by Connolly, Law and Li (2013) for Chinese electricity production, as they stated that the usefulness of Chinese electricity production as a leading indicator of Australian employment had grown over time in line with the importance of China as a trading partner with Australia.

Before these time-varying parameter estimates could be conducted efficiently, it was first necessary to specify lags on the explanatory variables (otherwise, if a large number of lags of the variables were included as separate explanatory variables, it would have been difficult to obtain reliable Kalman Filter results). To do this, simple regression analysis, using the Ordinary Least Squares technique, of individual series against cyclical employment was used to establish likely lag lengths. These were conducted with a minimum lag on each explanatory variable of nine months, with three month intervals between lag lengths (i.e., the lags were nine months, 12 months, 15 months, etc) and a sample period of July 1994 through January 2011. This starting point was used because the relationship between cyclical employment and its leading indicators seemed to change after the mid-1990s, with shorter lags after this point. In addition, some of the data series, such as Chinese electricity production, were not available before the early 1990s (plus, a three-year period is required after the starting point of the data to obtain a fully accurate estimate of the long-term trend, because this trend is a three-year centred moving average).

January 2011 is used as the end of the estimation period, as this represents the first peak in cyclical employment in the initial recovery from the Global Recession, with the period since then reserved for out-of-sample forecasting.

In addition to the variables on the short list and the ANZ Newspaper Job Advertisements series (which is a component of the current Leading Indicator), preferred lag lengths were also determined by this method for the international variables on the reserve list; because it was thought more likely that these would have to be substituted for variables on the shortlist than the domestic variables on the reserve list⁶.

When this was initially conducted, the coefficients for some of the shorter lag lengths for some of the explanatory variables, especially the US yield difference, were negative and statistically significantly different from zero. For these variables, the preferred lag length was at longer lag lengths with coefficients that were positive and statistically significant. The results of this simple regression analysis are shown in Table 1.

Table 1: Preferred Lag Lengths for Cyclical Components of Potential Leading Indicator Series from Bivariate Regression Analysis

Variable	Preferred Lag Length (months)	Coefficient Estimate	t-statistic on Coefficient Estimate	Adjusted R-squared
Chinese Electricity Production	9	0.326	8.53***	0.266
Official Purchasing Managers' Index of Manufacturing Output in China ^a	12	0.178	5.66***	0.330
ANZ Newspaper Job Advertisements	9	0.572	11.93***	0.416
US Yield Difference	39	0.287	6.91***	0.191
Building Permits in USA	27	0.456	7.87***	0.235
Dun & Bradstreet Employment Expectations Index	12	0.315	6.30***	0.163
NAB Forward Orders Index	15	0.324	9.60***	0.315
Westpac-Melbourne Institute Leading Index of Economic Activity	12	0.445	10.90***	0.373
Westpac-Melbourne Institute Consumer Sentiment Index	15	0.348	7.81***	0.233

Notes: The dependent variable for all these regressions was cyclical employment. The sample period for each equation was July 1994 through January 2011, except where otherwise noted. ^a The sample period was from October 2005 through January 2011. ***, ** and * denote statistically significant from zero at the one per cent level, five per cent level and 10 per cent level respectively.

The preferred lag lengths shown in Table 1 were used for the next part of the analysis in the final stage of the Review.

Two methods of estimating time-varying weights for the components were performed: Kalman Filtering and setting time-varying weights on the basis of

⁶ This is particularly so as there were only two international variables on the shortlist, whereas there were four domestic variables on the shortlist.

international trade and domestic shares of Gross Domestic Product (GDP). These methods and the results from using them are explained in turn.

Kalman Filtering

Hall and Cummins (2009, page 157) wrote that the Kalman Filter is an estimation method used to estimate “state-space” models. These models originated in the engineering literature in the early 1960s and were imported into economics in the late 1960s, with their importance in economics being partly due to their ability to model time-varying parameters in an intuitively appealing way. They stated:

In addition, the Kalman Filtering estimation method is an updating method that bases the regression estimates for each time period on last period’s estimates plus the data for the current time period; that is, it bases estimates only on data up to and including the current period. This makes it useful for investigating structural change in parameters or constructing forecasts based only on historical data.

The Kalman Filter technique from TSP International Version 5.1 (Hall and Cummins (2009) was used to estimate time-varying parameters for the cyclical components of the variables in the shortlist. The expectation from using this technique is that the coefficient on Chinese electricity production would be positive and rise smoothly over time, reflecting China’s growing importance as a trading partner with Australia, while the coefficient on the US Yield Difference would fall smoothly over time but remain positive, reflecting the diminishing importance of the USA as a direct trading partner with Australia.

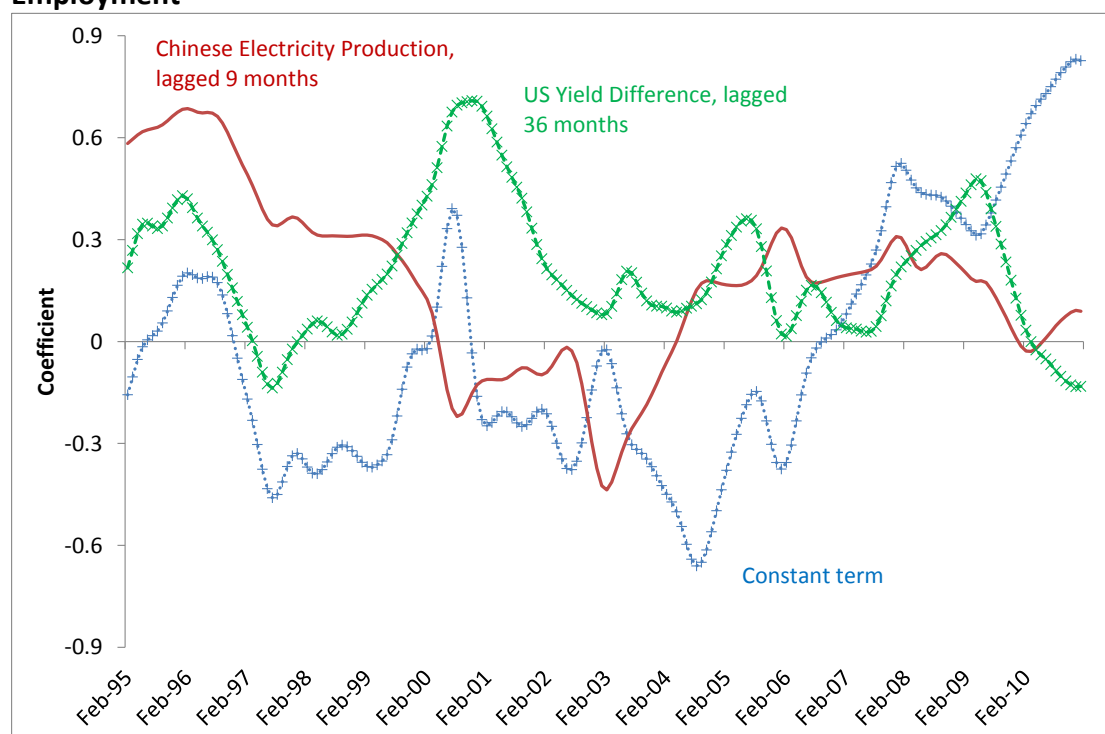
The base sample period used was the same as for the bivariate regression analysis; namely, July 1994 through January 2011, although the actual sample period is slightly shorter than this depending on the number of explanatory variables in the Kalman Filter model. We made several attempts to estimate a satisfactory Kalman Filter model, but none were successful. In general, we used the default settings in TSP International where the first few observations were used to provide the initial estimates of the coefficients. When all coefficients were allowed to vary through time, all of the smoothed coefficients were negative at one time or another during the estimation period, except for the coefficients for the Westpac-Melbourne Institute Leading Index of Economic Activity, lagged 12 months.

When the coefficients on the domestic explanatory variables were restricted to be constant through time, with only the constant term and the coefficients of the two international variables allowed to vary through time, the estimated smoothed coefficients are as shown in Figure 1 and the explanatory notes below Figure 1.

As shown in Figure 1, the restricted Kalman Filter estimates were also unsatisfactory. The estimated coefficients for Electricity Production in China were negative for a substantial portion of time, while the estimated coefficients for the the US Yield Difference were negative for some of the time, during the sample period. Even

though the coefficients were smoothed, they did not evolve smoothly through time in accordance with expectations. Also, the estimated coefficient for one of the domestic variables that was restricted to be constant through time; namely the Dun and Bradstreet Employment Expectations Index, is negative (although this coefficient is not statistically significantly different from zero), which is contrary to expectations.

Figure 1: **Estimated Smoothed Coefficients from Kalman Filter Estimation of Time-varying Parameters of International Components of Potential Leading Indicator of Employment**



Source: Kalman Filter estimates of coefficients in the smoothed state vectors of a potential Composite Leading Indicator of Employment. Apart from the variables shown in Figure 1, the other explanatory variables were restricted to have constant coefficients through time. These variables, with their estimated coefficients shown in brackets after the variables are: the Westpac-Melbourne Institute Leading Index of Economic Activity, lagged 12 months {0.321}; the Dun and Bradstreet Employment Expectations Index, lagged 12 months {-0.0111}; Westpac-Melbourne Institute Consumer Sentiment Index, lagged 15 months {0.0674}; and the NAB Forward Orders Index, lagged 15 months {0.0295}. Version 5.1 of the TSP International computer package was used for the analysis. The sample period actually used for the estimation of smoothed state vectors was February 1995 through January 2011, with the period from July 1994 through January 1995 used to estimate prior weights.

Domestic and International Shares of GDP

In the absence of satisfactory results from Kalman Filtering, we attempted a simpler method of obtaining coefficient estimates that varied appropriately through time. We allocated relative weights to the domestic and international variables according to their shares of Australian GDP. In doing so, we assumed that the allocation that was relevant to the variable for Chinese electricity production was not only Australia's exports to China as a share of Australian GDP, but also the export shares of other Dynamic Asian Economies or DAEs (Hong Kong, India, Indonesia, Malaysia, Singapore, South Korea, Thailand and Taiwan), given the close trade linkages among

these countries. Similarly, we also assumed that the allocation that was relevant to the variable for the US yield difference was not only USA's exports as a share of Australian GDP, but also the export shares of other Developed Countries or DCs that are Major Trading Partners of Australia (i.e., Canada, France, Germany, Italy, Japan, New Zealand and the UK), given the linkages (not only through trade but through other channels such as investment and business confidence) between the USA and other developed countries. The domestic and international shares or weights were allocated according to the following three equations:

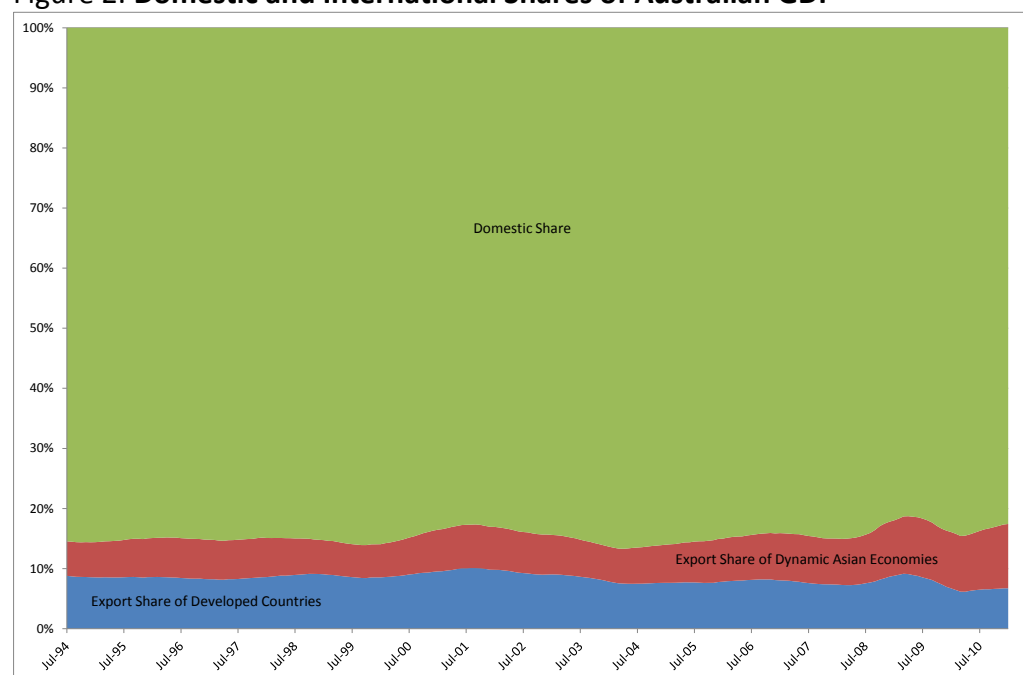
$$\text{Share (DAEs)} = \frac{\text{Value of Exports of Goods and Services from Australia to DAEs}}{\text{nominal Australian GDP}} \quad (1)$$

$$\text{Share (DCs)} = \frac{\text{Value of Exports of Goods and Services from Australia to DCs}}{\text{nominal Australian GDP}} \quad (2)$$

$$\text{Domestic Share} = 1 - \text{Share(DAEs)} - \text{Share(DCs)} \quad (3)$$

The domestic share was applied equally to the four domestic series (Dun & Bradstreet Employment Expectations Index, NAB Forward Orders Index, Westpac-Melbourne Institute Leading Index of Economic Activity; and Westpac-Melbourne Institute Consumer Sentiment Index). The evolution of these three shares through time is shown in Figure 2, for the sample period used in the econometric estimation.

Figure 2: Domestic and International Shares of Australian GDP



Sources: The values of Australian exports of goods and services to Developed and Dynamic Asian economies were obtained from ABS international trade data. Data on exports of goods (merchandise) were obtained from Spreadsheet 14a from ABS (2014), *International Trade in Goods & Services, March 2014*, ABS Cat No. 5368.0 and converted to a moving annual sum to reduce irregularities in the data, while data on the value of exports of services by destination were obtained from Spreadsheet 5 from *International Trade in Services by Country, by State and Detailed Services Category, Financial Year 2012-13*, ABS Cat No. 5368.0.55.003. These were divided by Australian nominal GDP, which was obtained from ABS (2014), *Australian National Accounts: National Income, Expenditure and Product, December quarter 2013* (Cat. No. 5206.0).

The share of DAEs has risen at the expense of the share of DCs, while the domestic share has fallen slightly (by about two percentage points).

The resulting equation was estimated using the Non-linear Least Squares technique in the TSP International Version 5.1 computer package⁷, using the same sample period as for the Kalman Filtering of July 1994 through January 2011. The results are as shown in equation (4):

$$\begin{aligned}
 \text{Employment}_t = & 0.0493 + 1.774 * \text{Share (DAEs)}_{t-9} * \text{Chinese Electricity Production}_{t-9} \\
 & (1.55) \quad (4.02)^{***} \\
 & + 1.334 * \text{Share (DCs)}_{t-9} * \text{US Yield Difference}_{t-39} \\
 & (2.89)^{***} \\
 & + \text{Share (Domestic)}_{t-9} * \\
 & \{0.0256 * \text{Consumer Sentiment}_{t-15} + 0.332 * \text{Economic Activity}_{t-12} \\
 & (0.35) \quad (6.09)^{***} \\
 & - 0.270 * \text{Employment Expectations}_{t-12} + 0.267 * \text{Forward Orders}_{t-15}\} \quad (4) \\
 & (-3.51)^{**} \quad (4.24)^{***}
 \end{aligned}$$

Adjusted R-squared statistic = 0.537; Durbin-Watson statistic = 0.06 [0.000, 0.000]
Lagrange Multiplier Heteroscedasticity statistic = 58.5 [0.000]

Where:

Employment_t is the cyclical component of total employment.

Share (DAEs)_{t-9} is the share of Australian Exports of Goods and Services to Dynamic Asian Economies in Australian nominal GDP, lagged 9 months.

Chinese Electricity Production_{t-9} is the cyclical component of Chinese Electricity Production, lagged 9 months.

Share (DCs)_{t-9} is the share of Australian Exports of Goods and Services to Developed Main Trading Partner Countries in Australian nominal GDP, lagged 9 months.

US Yield Difference_{t-39} is the cyclical component of the US Yield Difference, lagged 39 months.

Share (Domestic)_{t-9} is a proxy for the share of domestic production in Australian nominal GDP, lagged 9 months.

Consumer Sentiment_{t-15} is the cyclical component of the Westpac-Melbourne Institute Consumer Sentiment Index, lagged 15 months.

Economic Activity_{t-12} is the cyclical component of the Westpac-Melbourne Institute Leading Index of Economic Activity, lagged 12 months.

Employment Expectations_{t-12} is the cyclical component of the Dun & Bradstreet Employment Outlook Index, lagged 12 months.

⁷ This equation could have been estimated using Ordinary Least Squares regression, but it would have needed a respecification of the variables to do so and the estimated coefficients might have been harder to interpret.

*Forward Orders*_{*t-15*} is the cyclical component of the NAB Forward Orders Index, lagged 15 months.

The numbers in round brackets below the coefficient estimates are their t-statistics; the numbers in square brackets after the diagnostic statistics below the equation are the probabilities that the null hypothesis that the coefficient is zero would not be rejected; *** denotes statistically significant from zero at the one per cent level; ** denotes statistically significant from zero at the five per cent level; and * denotes statistically significant from zero at the 10 per cent level.

The results of this equation are only moderately satisfactory. The main drawbacks are that the coefficient for the Employment Expectations Index is negative (and statistically significant) and the coefficient for the Consumer Sentiment Index is very low and not statistically significant.

Other Quantitative Analytical Techniques Considered

An external reviewer of an earlier version of this paper suggested that we could consider logit or probit techniques, presumably with the peaks and/or the troughs allocated a value of one and all other observations to be allocated a value of zero, as this would enable more weighting to be allocated to whether the alternative indicators predicted peaks or troughs.

However, these approaches would most probably be unworkable. Limited-dependent-variable econometric methods such as logit or probit approaches were designed for, and are generally used with, unit record data where there are at least hundreds if not thousands of observations. They are highly unlikely to work successfully in deriving the weights for a new monthly leading indicator of employment, because in the sample period used (July 1994 through January 2011) there have only been six strongly confirmed peaks⁸ and five strongly confirmed troughs in cyclical employment. It would not be sensible to increase the number of non-zero observations by pooling these peaks and troughs and allocating both of them a value of one (with a value of zero assigned to an observation on cyclical employment not being a peak or trough), because this could lead to perverse results (for example, an explanatory variable that should have peaks that precede peaks in cyclical employment but has troughs at those times instead would wrongly appear to be a successful predictor of this type of dependent variable).

Another complication with the proposed alternative limited-dependent variable approach is that it could be difficult to determine the appropriate lag lengths for

⁸ *Strongly confirmed turning points* (peaks or troughs) are said to have at least six consecutive moves in the same direction before the turning point (but they don't have to be immediately before), followed by at least six consecutive moves in the opposite direction immediately after the turning point. *Weakly confirmed turning points* are turning points that are not strongly confirmed, but have at least six consecutive moves in the same direction immediately before the turning point, followed by at least three consecutive moves in the opposite direction immediately after the turning point, or at least three consecutive moves in the same direction immediately before the turning point, followed by at least six consecutive moves in the opposite direction immediately after the turning point.

explanatory variables. In the current approach, the initial lag lengths on the explanatory variables are determined by regression analysis using continuous variables, which is the same method used to estimate the weights for these explanatory variables. With a limited dependent variable, however, there would not be the same consistency between the method used initially to determine the lags on the variables and the method used to determine the weights for the variables.

Another external reviewer suggested that we could take the lead of Lim and Nguyen (2013) and consider inverse-variability weightings, principal components, and dynamic factor allocation approaches.

The traditional inverse-variability approach, where the weight allocated to each component is the inverse of each component's variability, is not relevant in this particular analysis because all of the components have been standardised (by dividing by the standard deviations of the difference between the one-year and six-year trends of the variables), so that they already have similar variability. In any case, Lim and Nguyen (2013) don't recommend this approach themselves, stating that "The main disadvantage is that the weights of the components are computed independently of each other and without reference to the significance of the components to a reference cycle".

Principal components analysis was considered and ruled out. This technique can be useful if there are many highly collinear explanatory variables and one doesn't need to retrieve the weightings of the individual components, which can be difficult if more than one principal component is chosen. In the current analysis, there were only several explanatory variables and they were not highly collinear. The Condition(X) number for the set of six explanatory variables in equation (4) above, unweighted for trade shares, was only four, indicating very low collinearity. Also, it was considered to be very important to be able to allocate weights to the individual components and this can be complicated with principal components analysis.

Dynamic factor allocation was also considered and ruled out. The theoretical framework for this approach is based on an assumption that there is a single unobserved latent variable which drives the common variation in the observed variables. This assumption seems quite inappropriate to the current analysis where there is considerable evidence that since the Global Recession, there have been new and different sources of variation, particularly from developments in Australia's main trading partners such as China and the USA. In any case, the technique that Lim and Nguyen (2013) use in their dynamic factor allocation estimation is Kalman filtering, which as shown above has already been applied in this analysis.

Further Regression Analysis

Following the unsatisfactory results from the two separate attempts to estimate time-varying parameters, a different approach was taken in the next stage of regression analysis. A key part of this approach was to replace the variable for Chinese electricity production with another Chinese variable; namely, the Official

Purchasing Managers' Index of Manufacturing Output in China. Since this variable is only available in recent years when China has been a major trading partner of Australia, this effectively imposes a time-varying parameter on the estimate (i.e., the parameter is zero before the variable is available) for the period when China was a less important destination for Australia's exports.

As mentioned in Connolly, Law and Li (2013), both Chinese electricity production and the Official Purchasing Managers' Index of Manufacturing Output in China are worthy of further investigation as leading indicators of Australian employment. One of the key reasons for putting Chinese electricity production on the shortlist is that it is available for a longer time than the Official Purchasing Managers' Index of Manufacturing Output in China. However, the latter variable has a better performance over the last five years than the former variable as a leading indicator of Australian employment.

The latter variable is only available electronically from January 2005, and in terms of a centred six-year trend, is only fully accurate from January 2008. The specification of the cyclical component of this variable was improved, using the methods explained in Appendix B, to make the variable more accurate up to January 2008.

Apart from the Purchasing Managers' Index of Manufacturing Output in China, the other explanatory variables used for the regression analysis were similar to the previous econometric analyses. One difference is that the ANZ Newspaper Job Advertisements series, which is a component of the current Indicator, was used as an explanatory variable in a few of the alternative regressions. It was estimated to have a positive coefficient of 0.0286, which was statistically insignificant⁹ when the sample from July 1994 through January 2011 was used. However, in a separate regression analysis it was estimated to have a counterintuitive negative and statistically significant coefficient of -0.874 for the period since the start of 2008 to January 2011, probably reflecting both the Global Recession and the continuing shift of job advertising from newspapers to the internet. Details of these regression analyses are available from the senior author¹⁰. Other differences were that in some of the estimated equations, the variable for the Leading Index of Economic Activity was lagged by another year (i.e., by 24 months in addition to being lagged by 12 months) and some slightly different lags were tested for some of the other explanatory variables.

A key innovation that was made for the regression analysis conducted for the current Review, which was not done in the regression analysis to establish the weights in the current Indicator, is an examination to see whether lagged dependent variables (i.e., past cyclical employment) and/or lagged residuals add anything significant to the explanatory power of a potential new Indicator. In testing these lagged dependent variables or lagged residual terms, we decided that there would have to be a lag of at least nine months before they could be added as an

⁹ That is, not statistically significantly different from zero. The t-statistic on this coefficient was 0.44 with an associated probability of 66 per cent, relating to the hypothesis that the coefficient is zero.

¹⁰ The senior author can be contacted via email at greg.connolly@employment.gov.au.

explanatory variable. This is because a move in the Indicator of at least six consecutive months in the opposite direction to the current direction is needed before a turning point can be confirmed, and we decided that there would need to be another three months beyond this to allow for reaction times (in policies and/or programme responses) to the turning point, to be useful.

One potential problem with adding lagged dependent variables (and possibly also lagged residuals or error terms, since these variables are functions of lagged dependent variables) to an econometrically estimated equation is that it can bias the estimates of the coefficients of the remaining explanatory variables in the equation.

Achen (2001) showed that this bias can be so severe that coefficients can change sign or at least appear to be statistically insignificant and biased towards zero when they are actually significant. He also showed that this bias is likely to be most severe when there is positive autocorrelation in the residuals of the equation with the lagged dependent variable omitted and trending in the other explanatory variables. Both of these circumstances apply to cyclical employment and its explanatory variables. He then warned against using lagged dependent variables in equations under these conditions.

Wilkins (2013) showed that under fairly general assumptions, these potential biases can be reduced by adding additional lags of the dependent variable and explanatory variables in the estimated equation. The Wilkins (2013) approach was used and an initial equation was estimated, using the Nonlinear Least Squares regression method, with a constant term and the explanatory variables described above. The initial estimate using this approach is explained in detail in Appendix C. In this equation, the coefficients of the lagged dependent variable and the lagged residual (both lagged nine months) were estimated to be statistically significant and of the opposite signs. This lag (i.e., nine months) and longer lags were tested in forming the preferred equation. When forming the new econometrically estimated leading indicator, the intention was to move the estimated variables forward nine months. However, this meant that when lags of nine months were used for the lagged dependent variable or the lagged residual, the concurrent values of cyclical employment became a component of this version of the leading indicator. In turn, this biased this version towards being a concurrent indicator rather than a leading indicator. To overcome this problem, longer lags of the dependent variable and residual were used for the preferred equation. The estimates of the preferred equation are shown in Table 2.

Table 2: Results of Preferred Estimate of Potential Leading Indicator Equation with Lagged Dependent Variables and Residual Terms Tested

Variable	Lag Length (months)	Coefficient	Coefficient Estimate	t-statistic on Coefficient Estimate
Constant term	Not applicable	β_0	-0.0262	-1.04
Lagged Error Term	18	ϕ_{18}	-0.154	-2.63***
Lagged Error Term	27	ϕ_{27}	0.252	4.37***
Official Purchasing Managers' Index of Manufacturing Output in China	9	β_1	0.188	7.68***
US Yield Difference	39	β_2	0.152	4.64***
Westpac-Melbourne Institute Consumer Sentiment Index	12	β_3	0.255	7.08***
Westpac-Melbourne Institute Leading Index of Economic Activity	12	β_4	0.185	5.00***
Westpac-Melbourne Institute Leading Index of Economic Activity	24	β_5	0.526	8.69***
NAB Forward Orders Index	18	β_6	0.231	6.06***

Notes: The dependent variable was cyclical employment. The sample period was July 1994 through January 2011. ***, ** and * denote statistically significant from zero at the one per cent level, five per cent level and 10 per cent level respectively. The diagnostic statistics were as follows: Adjusted R-squared statistic = 0.728; Durbin-Watson statistic = 0.10 [0.000, 0.000]; Lagrange Multiplier Heteroscedasticity statistic = 0.21 [0.650].

These results are satisfactory. The coefficients of all of the explanatory variables are statistically significant with the expected positive sign (with the exception of the constant term, for which the sign and statistical significance are unimportant, and the lagged dependent variable, for which there were no strong expectations about the sign and for which a negative sign had been estimated at a lag of nine months, as shown in Appendix C).

The Adjusted R-squared statistic indicates that almost three quarters of the variation in cyclical employment is explained by the explanatory variables (including the lagged dependent variables). While this may seem low for a time series regression, it should be borne in mind that monthly data are used, all of the explanatory variables are lagged by at least nine months, the sample period includes the Global Recession and the dependent variable is a difference between a one-year and a six-year trend. All of these factors make it harder to achieve high levels of explanatory power.

The Durbin-Watson statistic is very low, which most probably indicates that there is a substantial amount of positive autocorrelation remaining, despite including dependent variables with long lags as explanatory variables. Once again, this is partly a consequence of the highly transformed nature of the dependent variable as a difference between a one-year and a six-year trend.

A potential new Indicator, called NLIOE, was formed from the equation described in Table 2 by shifting forward each of the variables nine months in time (except of course the constant term). In this way, this potential Indicator is based on optimising the power to explain the level of cyclical employment nine months into the future. The full specification of the resulting Indicator is as follows:

$$\begin{aligned}
 \text{NLIOE}_t = & -0.0262 + 0.188 * \text{Chinese PMI for Manufacturing Output}_t \\
 & + 0.152 * \text{US Yield Difference}_{t-30} + 0.255 * \text{Consumer Sentiment}_{t-3} \\
 & + 0.185 * \text{Economic Activity}_{t-3} + 0.526 * \text{Economic Activity}_{t-15} \\
 & + 0.231 * \text{Forward Orders}_{t-9} \\
 & - 0.154 * \text{Employment}_{t-9} + 0.252 * \text{Employment}_{t-18} \qquad (5)
 \end{aligned}$$

Where:

NLIOE_t is the new, econometrically estimated, Leading Indicator of Employment in time period t, and

All the other variables are as previously explained.

Equally Weighted Variables

Given the differences in estimates of some of the coefficients between different specifications and even more importantly, the variations in the estimate of the same coefficient through time in the Kalman Filtering, a much simpler approach of specifying equally weighted variables was also adopted to derive alternative Indicators for the final stage of testing.

Despite its simplicity, this approach has precedent, since the Indicator before the current one had each of its six components equally weighted (Connolly and Lee 2005). This indicator was used between 1997 and 2007.

Two separate equally weighted indicators were formed. The six-variable indicator had a weight of one-sixth on each of the current values of the cyclical components of the following variables:

1. the official (NBSC) Purchasing Managers' Index for Manufacturing Output in China
2. the US Yield Difference
3. the Westpac-Melbourne Institute Consumer Sentiment Index
4. the Westpac-Melbourne Institute Leading Index of Economic Activity
5. the Dun & Bradstreet Employment Expectations Index
6. the NAB Forward Orders Index.

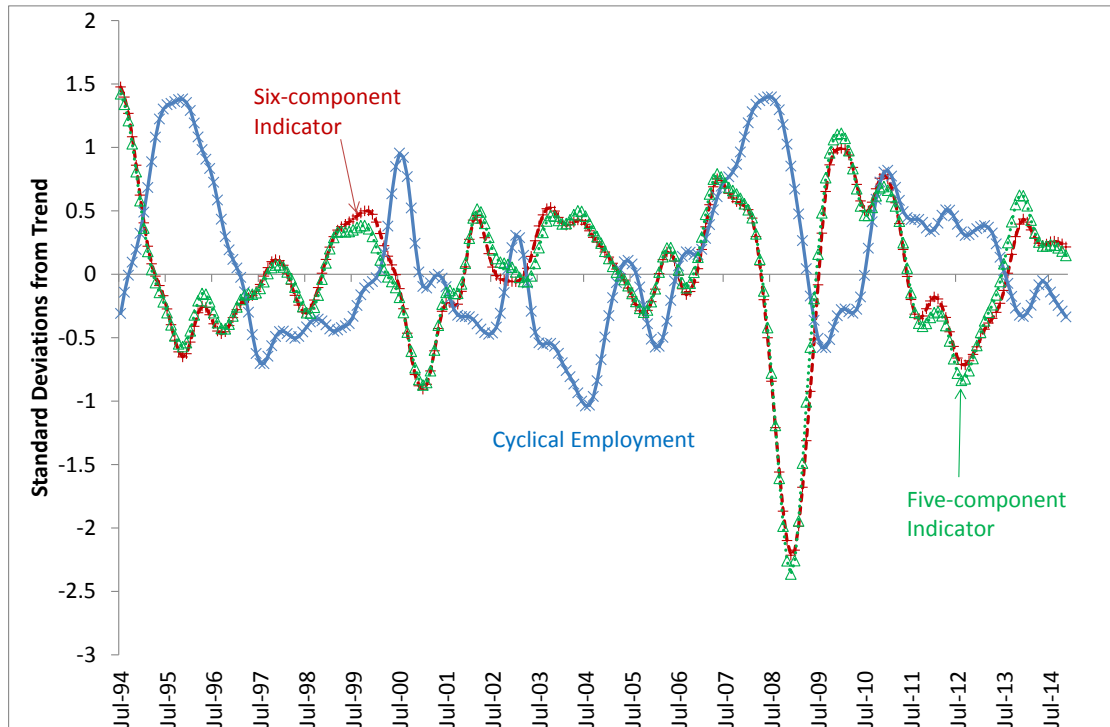
For the five-variable indicator, the Dun and Bradstreet Employment Expectations Index was deleted from the set of variables shown above. While the excluded variable is a component of the current Indicator, it performed the worst of the six variables shown above in the econometric testing. Its estimated coefficient was negative in both the Kalman Filter results shown in and under Figure 1 and in the trade-shares regression results shown in equation (4). Understandably, the five-variable indicator had a weight of one-fifth or 0.2 on each of the current values of the cyclical components of the five remaining variables.

Initial visual examination of both of these Indicators and how they performed in predicting peaks and troughs was done using a version of Figure 3. As shown in this Figure, the two Indicators were very similar (and so the five-variable Indicator would be favoured on the principle of Occam's Razor¹¹), but the six-variable Indicator performed slightly worse around some crucial turning points. For instance, in the downturn immediately after the start of the Global Recession, the five-variable Indicator had a clear trough in December 2008, but the six-variable Indicator had similar values in both December 2008 and January 2009. Another instance is the peak in late 1999, which occurred one month earlier (October) for the five-variable Indicator than for the six-variable Indicator (November).

For these reasons, we dropped the six-variable Indicator from consideration in the final round of testing to select a new Indicator.

¹¹ As stated in Wikipedia (http://en.wikipedia.org/wiki/Occam%27s_razor), Occam's Razor is "a principle of parsimony, economy, or [succinctness](#) used in problem-solving devised by [William of Ockham](#) (c. 1287 – 1347). It states that among competing hypotheses, the one with the fewest assumptions should be selected."

Figure 3: **Cyclical Employment and Five- and Six-Variable Equally Weighted Leading Indicators of Employment**



Source: constructed by the authors using the methods explained in this paper from various data sources. For brevity, both the sample period for econometric estimation (July 1994 through January 2011) and the out-of-sample forecasting period (February 2011 through November 2014) are shown in this chart.

Final Selection Tests for the New Indicator

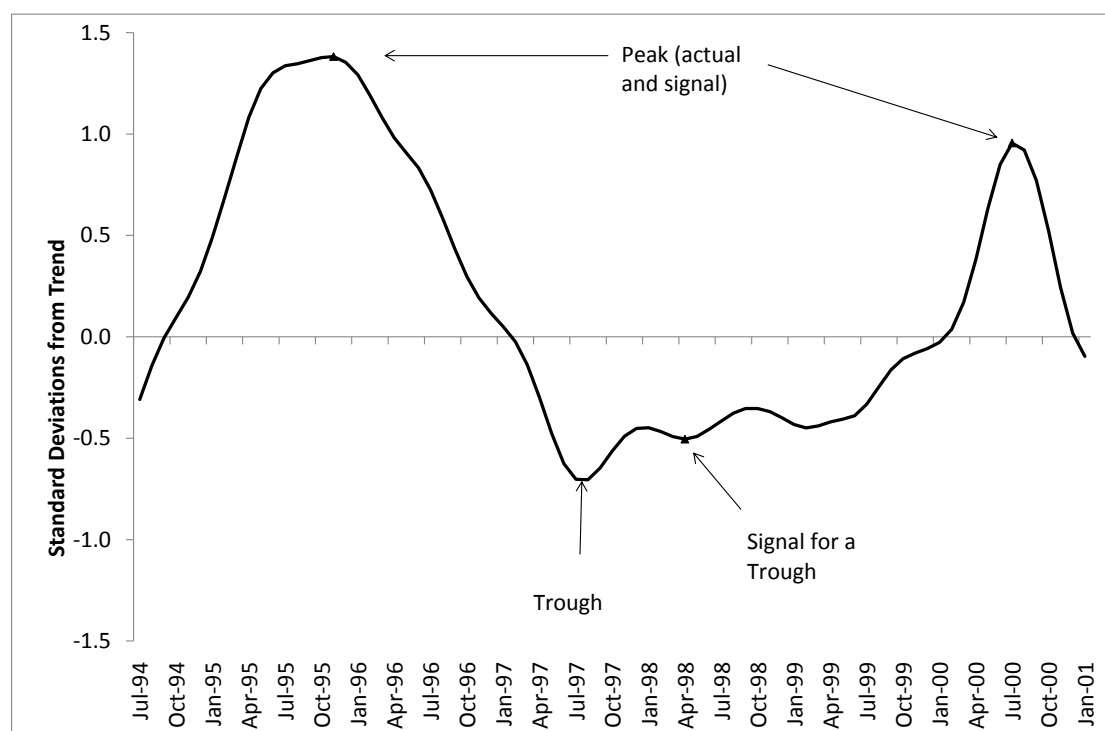
From the round of examination explained in the previous Section of this paper, there are two alternative Indicators to be tested in this final round of testing:

1. the New (econometrically estimated) Leading Indicator of Employment (NLIOE) and
2. the Equally Weighted Five Variable Indicator (EW5VI).

These were tested against cyclical employment in the final round of examination for the Review. For the sake of comparison, the current Indicator (LIOE) was included. In doing this examination, the reference months were used for each series instead of the reporting months, so that the alternative series would be compared accurately. With the current Indicator methods, the reference month for employment is moved forward two months to match the month of release of the Indicator. The analysis was conducted over the sample period for econometric estimation (July 1994 through January 2011), with a separate analysis of out-of-sample forecasting performance for the period from February 2011 through November 2014.

In contrast to the previous round of testing where selection of one of the alternative new Indicators was based on explanatory power in multiple regression equations, the assessment in this final round of selection is based on how well the alternative indicators predict the turning points (peaks and troughs) in cyclical employment. In conducting the formal analysis of performance, the quantitative assessment is based on performance in predicting signals of strongly confirmed turning points.¹² Weakly confirmed turning points were not used in the quantitative assessment because they are, as is indicated in their name, weaker as a signal of a peak or a trough, to the extent that sometimes it can be hard to distinguish a weakly confirmed turning point from an inflexion point. The quantitative assessment is based on the signal of when a turning point has occurred in cyclical employment and the alternative Indicators, rather than the actual peaks or troughs, because the former can readily be quantitatively determined at the time that a strong confirmation of a turning point is made, but the latter requires further analysis and observations to determine the actual peak or trough. An illustration of the distinction between the signals for, and actual peaks and troughs is given in Figure 4, which portrays the time series for cyclical employment between July 1994 and January 2001.

Figure 4: **Signals for, and Actual, Peaks and Troughs in Cyclical Employment**



Source: Calculated by the authors using standard Leading Indicator methodology from ABS Labour Force Survey (Cat. No. 6202.0) data for seasonally adjusted total employment.

In Figure 4, the signals for a peak, and the actual peaks in cyclical employment, coincide in November 1995 and July 2000. However, the only actual strongly

¹² The definitions of strongly and weakly confirmed turning points have already been provided in footnote 8.

confirmed trough in cyclical employment during the time period shown in Figure 4 occurs in August 1997, but the signal for this trough does not occur until April 1998.

The quantitative assessment was based on the average lead times, variability of lead times, and false signals (missed or extra turning points) between the alternative Indicators and cyclical employment, from July 1994 through January 2011. The results are shown in Table 3.

Table 3: Results of Analysis of Turning Point Signals between Potential Leading Indicators and Cyclical Employment during the Estimation Period

Time Period	Turning Point Signal in Cyclical Employment	Lead Time (months) for Five-Variable Equally Weighted Indicator	Lead Time (months) for Econometrically Estimated Indicator	Lead Time (months) for Current Indicator
November 1995	Peak	18	4	14
December 1997		extra peak		
April 1998	Trough	18	5	11
August 1998		extra trough		
July 2000	Peak	9	-5	2
June 2002	Trough	17	missed	9
January 2003	Peak	10	missed	missed
July 2004	Trough	15	16	missed
June 2005	Peak	13	4	12
January 2006	Trough	3	0	-6
July 2008	Peak	14	5	15
August 2009	Trough	8	1	4
January 2011	Peak	12	12	-9
Summary Statistics				
Maximum		18	16	15
Minimum		3	-5	-9
Average		12.5	4.7	5.8
Standard Deviation		4.5	5.9	8.2

Notes: The sample period for this analysis was July 1994 through January 2011 and the derivation and calculation of the Indicators are explained elsewhere in this paper.

An analysis of out-of-sample forecasting performance, using the period from February 2011 through November 2014, was also conducted, with results shown in Table 4. During this period, there were no strongly confirmed peaks or troughs in cyclical employment, so this analysis was based on how well the alternative indicators provided leading signals for the three weakly confirmed turning points in cyclical employment.

Table 4: Results of Analysis of Turning Point Signals between Potential Leading Indicators and Cyclical Employment during the Out-of-sample Forecasting Period

Time Period	Turning Point Signal in Cyclical Employment	Lead Time (months) for Five-Variable Equally Weighted Indicator	Lead Time (months) for Econometrically Estimated Indicator	Lead Time (months) for Current Indicator
July 2010			Extra strong trough	
January 2011			Extra weak peak	
October 2011		Extra weak trough	Extra weak trough	
May 2012				Extra strong trough
February 2013	Weak peak	12	10	3
December 2013	Weak trough	16	10	missed
May 2014	Weak peak	6	missed	9
Summary Statistics				
Maximum		16	10	9
Minimum		6	10	3
Average		11.3	10.0	6.0
Standard Deviation		4.1	0.0	3.0

Notes: The sample period for this analysis was February 2011 through November 2014 and the derivation and calculation of the Indicators are explained elsewhere in this paper.

The outcome of this quantitative assessment is clear, but slightly surprising. Despite its simplicity, the Five-Variable Equally Weighted Indicator outperforms both the current Indicator and the more sophisticated econometrically estimated Indicator. In terms of the key criterion of average lead times, the Five-Variable Equally Weighted Indicator performs very well, with an average lead time of over a year in the estimation period and almost a year in the out-of-sample forecasting period, but both the current Indicator and the econometrically estimated Indicator are barely suitable to be used (or retained) as an Indicator, because the average lead times are generally around or under six months¹³, but six consecutive monthly moves in a different direction are needed before a turning point signal can be confirmed.

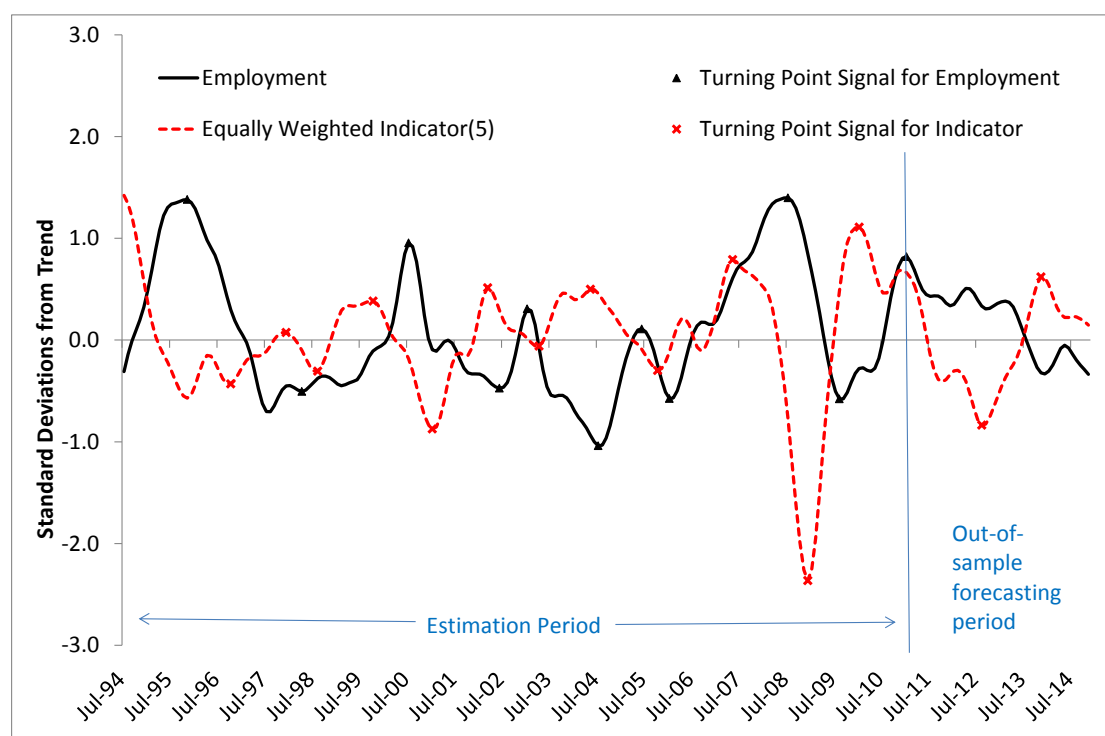
The average lead times of both the current Indicator and the econometrically estimated Indicator were reduced when they were lagging Indicators (twice for the current Indicator and once for the econometrically estimated indicator during the estimation period), not leading Indicators. During the estimation period, these two alternative indicators also missed detecting two turning point signals each for cyclical employment, whereas the Five-Variable Equally Weighted Indicator missed none of

¹³ The estimated strong performance of the econometrically estimated leading indicator in the out-of-sample forecasting period, where it was recorded as having an average lead of 10 months with no deviation from this average, is misleading, because the missed turning point is not taken into account in these calculations.

the turning point signals for cyclical employment, and was only less than six months lead time (3 months) for the January 2006 trough.

The Five-Variable Equally Weighted Indicator did have an extra peak (in December 1997) and an extra trough (in August 1998) that weren't present in cyclical employment. However, both this peak and trough were followed by weakly confirmed peaks and troughs in cyclical employment, 10 and 6 months later respectively. Visual evidence for this can be seen in Figure 5. What is also evident from Figure 5 is that neither the extra peak nor the extra trough, nor the corresponding movements in cyclical employment around three quarters of a year later, had much amplitude (i.e., all were in the range of + or – one standard deviation from trend). In other words, the extra turning points were not signalling major peaks or troughs in employment which did not subsequently occur.

Figure 5: Cyclical Employment and the Five-Variable Equally Weighted Indicator



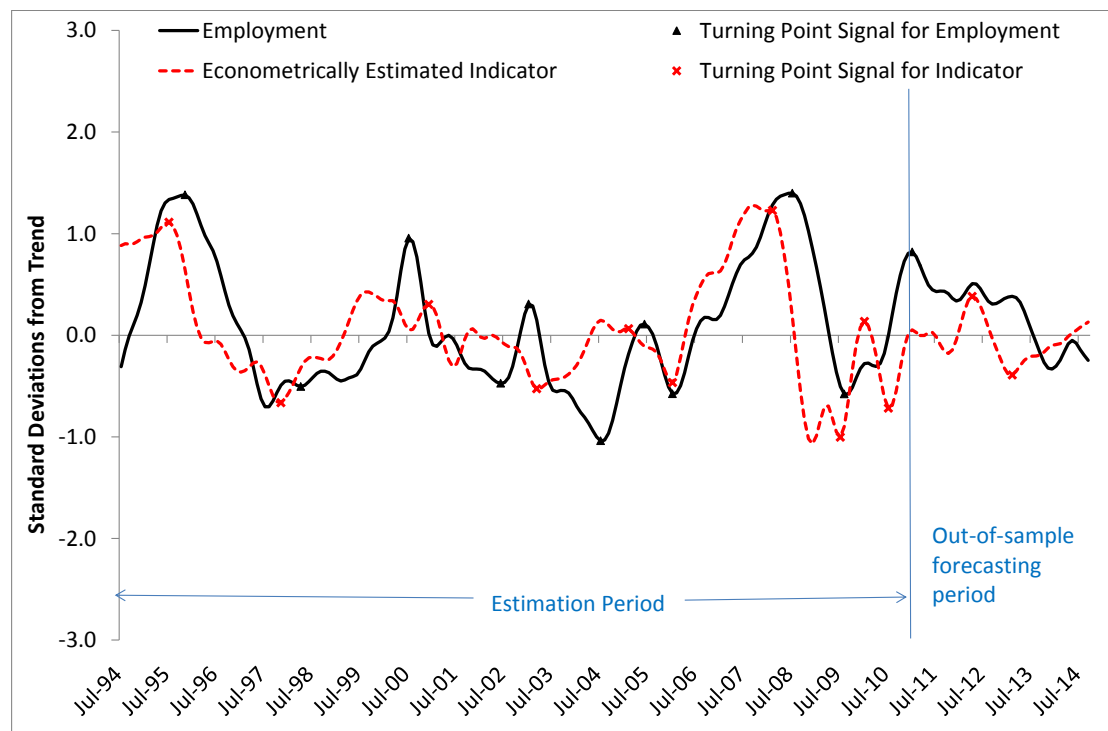
Source: constructed by the authors using the methods explained in this paper from various data sources.

Figure 5 also shows that there is reasonably good conformance between the shape of the two series. While the amplitude of the trough in this Indicator immediately after the Global Recession was substantially larger than the subsequent trough in cyclical employment, this is not necessarily a bad occurrence as it gives a strong signal of the potential effects that the Global Recession could have had on Australian employment. A probable explanation for the lower-amplitude trough in cyclical employment is that the Australian labour market was well placed to withstand the effects of the Global Recession (both directly through the flexibility of our labour market and indirectly through other protective mechanisms such as strong trade links with China and India and good prudential regulation of the Australian financial

system) and that substantial and effective action (fiscal and monetary stimulus, banks deposit guarantees, etc) was taken to reduce the effects of the Global Recession on the Australian labour market.

In addition to the econometrically estimated Indicator not performing as well in the quantitative assessment as the Five-Variable Equally Weighted Indicator, it doesn't look as suitable on visual inspection as this alternative Indicator, as can be seen in Figure 6.

Figure 6: **Cyclical Employment and the Econometrically Estimated Indicator**

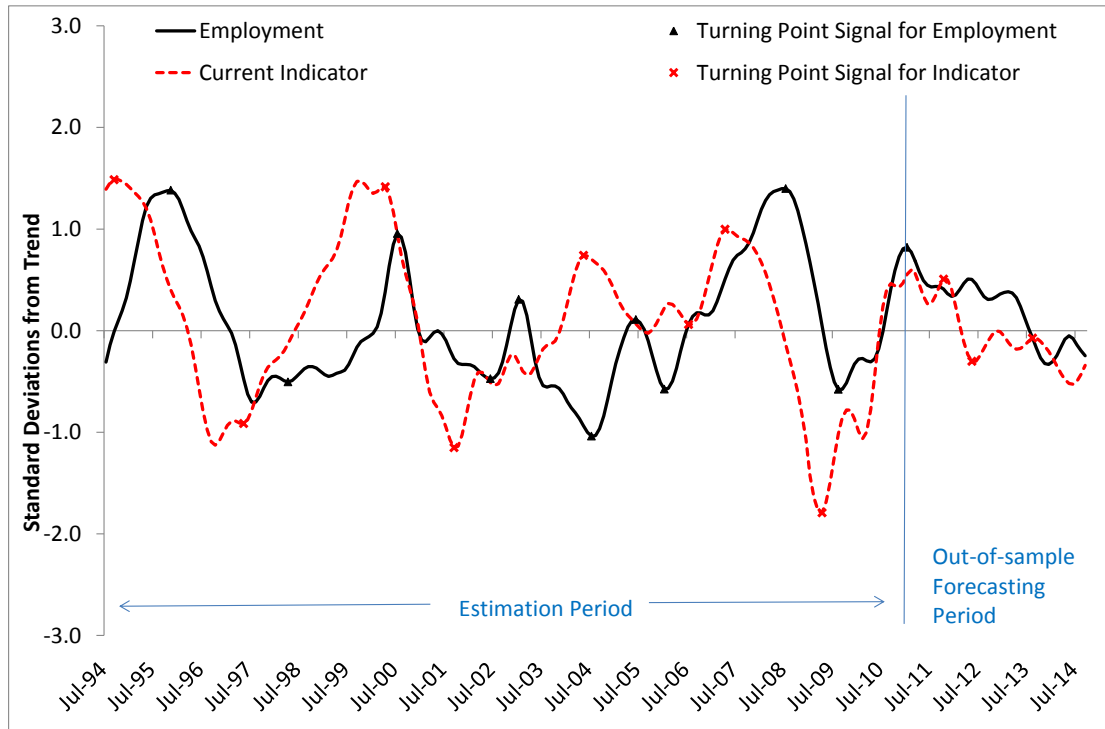


Source: constructed by the authors using the methods explained in this paper from various data sources.

While the econometrically estimated Indicator performed well in predicting the peak just before, and the trough immediately after, the Global Recession, it performed relatively poorly at many other times during the sample period.

As shown in Figure 7, the current Leading Indicator did not perform particularly well in the out-of sample forecasting period on visual inspection. Since it was a lagging indicator of the initial peak in cyclical employment after the Global Recession and since this period was used as the boundary between the estimation and out-of-sample forecast periods, this made it somewhat hard to assess its performance quantitatively in the analysis shown in Table 4.

Figure 7: Cyclical Employment and the Current Leading Indicator



Source: constructed by the authors using the methods explained in this paper from various data sources.

Conclusion

The results of the final stage of the Review are clear-cut: the current Indicator should be replaced with the Equally Weighted Five Variable Indicator, consisting of equal weights (i.e., 20 per cent each) of the following components:

1. the official (NBSC) Purchasing Managers' Index for Manufacturing Output in China
2. the US Yield Difference
3. the Westpac-Melbourne Institute Consumer Sentiment Index
4. the Westpac-Melbourne Institute Leading Index of Economic Activity
5. the NAB Forward Orders Index.

This should enable a major improvement of the predictive performance of the Leading Indicator. The average lead time of the current Indicator has fallen to around six months¹⁴ which is barely adequate, given that six consecutive monthly moves in a different direction are needed before a turning point signal can be confirmed. In other words, with an average lead time of six months, one has just finished

¹⁴ Note that this is not taking into account the fact that in the current Indicator, the Dun and Bradstreet Employment Expectations Index is lagged by 12 months. When account is taken of this fact, the average lead time of the current Indicator would be longer than six months.

confirming a turning point signal when there is likely to be a change of direction, which doesn't allow any time for policy and programme responses to be put in place and have sufficient time to act.

In contrast, the average lead time for the proposed replacement Indicator is over a year, which would allow time for the change in direction to be confirmed and for responses to be put in place and have time to act.

The proposed new Indicator has a reasonable degree of continuity with the current Indicator, since two of the four components of the current Indicator are also included in the proposed new Indicator. While the component (ANZ Newspaper Job Advertisements) that currently has the largest weight in the current Indicator is not included in the proposed new Indicator, the performance of this component has been falling since the Global Recession and its reliability is likely to continue to fall with the continuing shift of job advertising from newspaper to the internet.

The other component of the current Indicator that is not included in the proposed new Indicator is the Dun and Bradstreet Employment Expectations Index. While this still performs well as an individual leading indicator of employment, as shown in Table 1, it is dominated by other components when it is combined with them to form a composite leading indicator.

The proposed new Indicator includes two international variables: one relating to Australia's largest export destination, China, and the other relating to the world's largest economy, the USA, and that country's effect on other countries. The inclusion of these two variables supports the expectations of Connolly and Lee (2008) that a likely effect of the Global Recession is that international series would become more important as leading indicators of Australian employment.

It was initially somewhat surprising that the indicator that performed the best and became the proposed new Indicator was one of the simplest of the alternatives considered, especially when quite sophisticated methods such as estimating time-varying parameters using a Kalman Filter were employed. On reflection, however, it is not that surprising. The latter is optimised for "explaining" the level of cyclical employment nine months into the future, but this does not necessarily mean that it is the optimal Indicator for predicting turning points in cyclical employment. In another way, it is encouraging that such a simple Indicator made it through to be the proposed new Indicator.

There is a potential advantage in having five components in the proposed new Indicator, compared with the four components in the current Indicator. That is, if the performance of one of the components deteriorates, such as has happened in recent years with the ANZ Newspaper Job Advertisements series, there is an additional component to balance out this effect and help to maintain the overall performance of the proposed new Indicator.

Series eliminated after individual assessment in the current Review of the LloE

The following series were not considered for the testing of combinations of series, because they were eliminated after individual assessment in the current Review of the LloE. See Labour Economics Section (2014) if you require more information on the reasons for their elimination.

International Series

- Housing Starts in USA
- Industrial Production in USA
- Industrial Production in China
- Exports from China (in both nominal and real terms)
- Imports to China (in both nominal and real terms)
- Official Purchasing Managers' Index of Forward Orders for Manufacturing in China (National Bureau of Statistics of China)
- HSBC Purchasing Managers' Index of Manufacturing Output in China
- Exports from 3 Dynamic Asian Economies (Singapore, Taiwan and Hong Kong, in both nominal and real terms)

Domestic Series

Employment-related series

- The gross flow to employment (ABS)
- The gross flow from employment (ABS)
- The net flow to employment; i.e., the gross flow to employment minus the gross flow from employment (ABS)
- The proportion of people remaining in employment from month to month (from ABS LFS gross flows data)
- Number of Full-time Workers Working Short Hours for Economic Reasons (ABS)
- Aggregate Hours Worked (ABS)
- Aggregate Hours Worked per Employed Person (ABS)
- Lodgements of Applications for subclass 457 Business Temporary Entry Visas (from offshore, from onshore, and total) (DIBP)
- Short-term Arrivals from Overseas - total for employment purposes (ABS)
- ANZ Newspaper Job Advertisements Series¹⁵
- ANZ Internet Job Advertisements Series
- SEEK [internet] New Job Advertisements Series
- SEEK [internet] Employment Index (New Job Advertisements per Applicant)

¹⁵ Since this series is a component of the current Indicator, it was included in some alternative regression analyses for the sake of completeness in the testing routine.

Financial Series

- ASX200 Australian Share Price Index
- Price/Earnings Ratio for the ASX200 component of the Australian Share Market
- RBA Commodity Price Index (in both real and nominal terms)
- Australian Yield Curve (10-year bond yield – 90-day bank bill interest rate)
- ABS Retail Sales (in both real and nominal terms)
- Business Credit (RBA)
- Number of Insolvencies (ASIC)
- Number of New Company Registrations (ASIC), monthly

Other Series

- New Motor Vehicle Sales (ABS)
- Private House Approvals (ABS)
- Pre-mix Concrete Production (ABS)
- Short-term Visitor Arrivals from Overseas (ABS)
- Short-term Resident Departures to Overseas (ABS)
- Short-term Net Visitor Arrivals from Overseas (Visitor Arrivals - Resident Departures, ABS)
- NAB Business Confidence Index

Series eliminated after individual assessment in previous round of testing and not retested

International Series

- Baltic Dry Index (of shipping freight rates, Thomson Reuters)
- US Share Price Indices (Dow-Jones Industrial Average and Standard & Poors 500)
- US Sales of Existing One-family Homes
- Chicago Board Options Exchange Market Volatility Index (VIX) of US Share Prices (Standard & Poors 500)

Domestic Series

- Trade-weighted Exchange-rate Index of \$A (RBA)
- Money Supply (M3 measure, in both real and nominal terms, RBA/ABS/Westpac-TD Securities/Thomson Reuters)

Improving the Specification of the Cyclical Component of the Official Purchasing Managers' Index of Manufacturing Output in China

The Official¹⁶ Purchasing Managers' Index of Manufacturing Output in China is only available electronically from January 2005, and in terms of a centred six-year trend, is only fully accurate from January 2008. This creates problems in attempting to use the series in a longer time series analysis such as sample period used for this stage of the Review, which starts in July 1994.

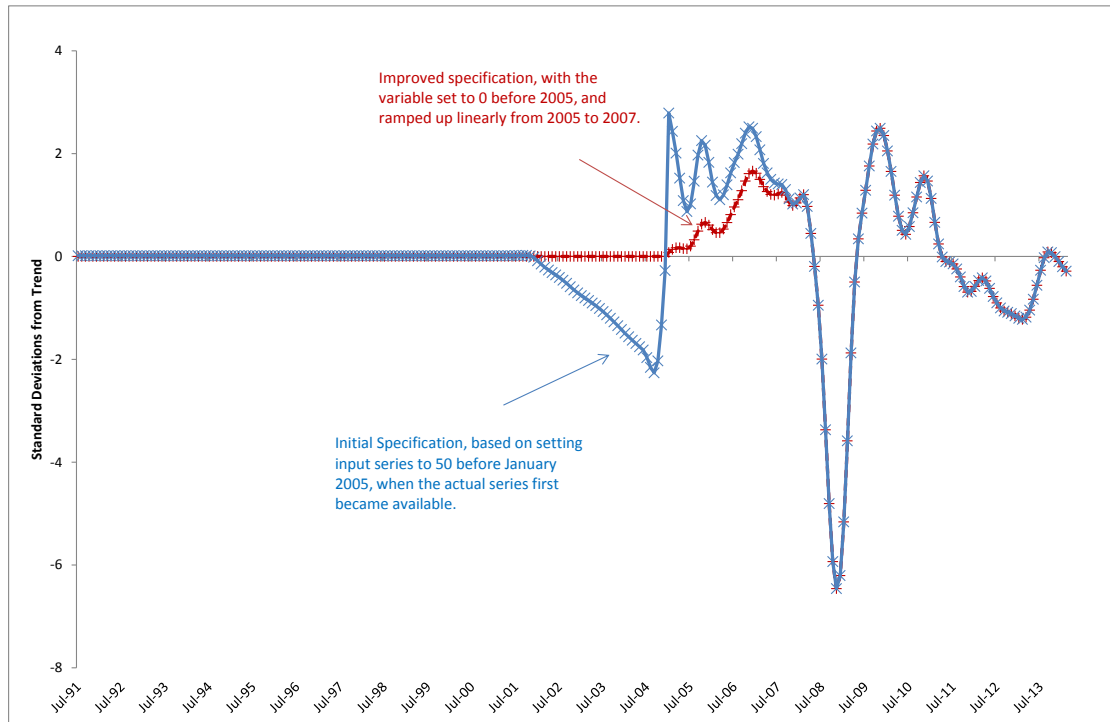
An initial attempt to extend the series back in time was made by setting the values of the raw variable to their baseline or neutral value of 50 percentage points (implying 50 per cent of the respondents to the survey expect an improvement in manufacturing output, while the other half expect a deterioration in manufacturing output). However, when the cyclical component of this extended series was calculated, it had the artefact of generating inaccurate negative values for the three years before the actual series began to be available (i.e., from the start of 2002 to the end of 2004), as shown in Figure 3. Also, the calculated cyclical component was also inaccurate for the first three years of actual data (i.e., from January 2005 to the end of 2007). To overcome these problems, an improved specification was constructed using the following three steps:

1. Setting the values of the cyclical component to zero before January 2005.
2. Progressively ramping up the values from zero to their calculated values over the next three years (i.e., by $1/36^{\text{th}}$ per month), in line with the increase in the accuracy of the constructed series. The cyclical component is calculated by taking the difference between the one-year trend and the six-year trend, then standardising and normalising it. In turn, the six-year trend is constructed as a centred moving average (i.e., two years and 11 months before the month in question, the month in question, then three years after). Therefore for January 2005, in calculating the six year trend, for the period up to and including January 2005, only one out of the 36 months is based on actual data, with the other 35 based on a preset value of 50. For February 2005, two out of the 36 months would be based on actual data, etc.
3. Using the constructed values of the series from December 2007 onwards.

The cyclical components of the initial and improved specifications are shown in Figure B1.

¹⁶ In this context, the term "Official" refers to the Purchasing Managers Index from the National Bureau of Statistics of China. This series is published in seasonally adjusted terms.

Figure B1: Cyclical Component of PMI of Manufacturing in China (original terms)



Source: Calculated in the Department of Employment, using the methods explained in this paper, from data from the National Bureau of Statistics of China.

As can be seen from Figure B1, use of the improved specification avoids the artificial negative values before January 2005 and the sudden artificial rise in values between late 2004 and early 2005.

Initial Estimate of Leading Indicator Equation with Lagged Dependent Variables and Residuals

An approach based on Wilkins (2013) was used to estimate an initial equation for a potential new Indicator. This approach allows for a lagged dependent variable and an autocorrelated error term to be included in the estimated equation, while reducing the bias in the estimates of the other explanatory variables. This approach involves including an extra lag on the lagged dependent variable and the explanatory variables. As previously mentioned, lags of nine months were used in the equation. This involved a modification of the approach in Wilkins (2013) in which lags of one time period were used. The general form of the equation estimated was:

$$\text{Employment}_t = \beta_0 + (\alpha + \varphi) * \text{Employment}_{t-9} + (-\alpha * \varphi) * \text{Employment}_{t-18}$$

$$+ \sum_{i=1}^6 \beta_i * X_{i,t-l(i)}$$

$$+ (-\beta\varphi) * \sum_{i=1}^6 \beta_i * X_{i,t-l(i)-9}$$

$$+ e_t \tag{C1}$$

Where:

Employment_t is the cyclical component of employment;

β₀ is the constant term;

α is the coefficient for the direct effect of the lagged dependent variable (lagged nine months) on the dependent variable;

φ is the coefficient for the direct effect of the lagged residual or error term (lagged nine months) on the dependent variable;

β_i are the coefficients of the six explanatory variables (shown below);

l(i) are the lags on the explanatory variables (shown in Table 1 and repeated below);

X_i are the six explanatory variables (shown below); and

e_t is the remaining error term.

As can be seen in equation C1, the coefficients are non-linear and so the equation was estimated using the Nonlinear Least Squares regression method in TSP International Version 5.1 (Hall and Cummins 2009). The results are as shown in Table C1.

Table C1: Results of Initial Estimate of Potential Leading Indicator Equation with Lagged Dependent Variable and Error Term

Variable	Lag Length (months)	Coefficient	Coefficient Estimate	t-statistic on Coefficient Estimate
Constant term	Not applicable	β_0	0.0363	1.39
Lagged Dependent Variable	9	α	-0.171	-2.36**
Lagged Error Term	9	φ	0.536	6.33***
Official Purchasing Managers' Index of Manufacturing Output in China	9	β_1	0.160	8.15***
US Yield Difference	39	β_2	0.167	4.54***
Westpac-Melbourne Institute Consumer Sentiment Index	12	β_3	0.222	7.08***
Westpac-Melbourne Institute Leading Index of Economic Activity	12	β_4	0.216	4.58***
Westpac-Melbourne Institute Leading Index of Economic Activity	24	β_5	0.321	5.76***
NAB Forward Orders Index	18	β_6	0.200	6.00***

Notes: The dependent variable was cyclical employment. The sample period was July 1994 through January 2011. ***, ** and * denote statistically significant from zero at the one per cent level, five per cent level and 10 per cent level respectively. The diagnostic statistics are as follows: Adjusted R-squared statistic = 0.734; Durbin-Watson statistic = 0.08 [0.000, 0.000]; Lagrange Multiplier Heteroscedasticity statistic = 2.64 [0.104].

Both the dependent variable and the error term or residual, lagged nine months, were statistically significantly different from zero, but each of these variables had opposite signs. Longer lags of both of these variables were tested in forming the preferred equation.

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