Christopher Kent: Economic forecasting at the Reserve Bank of Australia

Address by Mr Christopher Kent, Assistant Governor (Economic) of the Reserve Bank of Australia, to the Economic Society of Australia (Hobart), University of Tasmania, Hobart, 6 April 2016.

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Accompanying charts can be found at the end of the speech

I thank Daniel Rees, who provided invaluable assistance in preparing these remarks, and is the Head of the Bank's new Macroeconomic Modelling Section (see below).

Introduction

Let me start by thanking the University of Tasmania and the Tasmanian branch of the Economic Society of Australia for hosting this event.

Today I am going to talk about economic forecasting, which plays an important role in policy deliberations at the Reserve Bank of Australia (RBA). It assists in interpreting economic developments and, because monetary policy typically affects economic activity and inflation with a lag, it is a necessary part of determining and communicating the appropriate stance of policy.

I'm also going to discuss the results of an external review of our forecasting methods and processes, which we have just published, and our responses to the recommendations therein.

Our current approach to forecasting has been in place for some years. While it has served us well, we thought it was time to consider whether our methods and processes would continue to be appropriate and how we might improve upon them. To do this, we commissioned two eminent economists to conduct a review, Professor Adrian Pagan of the University of Sydney and Dr David Wilcox of the Federal Reserve Board of Governors.[1]

The existing approach to forecasting at the RBA

The process of economic forecasting actually involves a wide range of activities. The most familiar relates to the construction of forecasts that reflect our best estimates of future economic outcomes.[2] Each quarter in the *Statement on Monetary Policy*, we publish forecasts for Australia's major trading partners' GDP growth, as well as Australia's terms of trade, GDP growth, unemployment rate and inflation over the next two-and-a-half years. However, these numbers are just a summary of an extensive process in which our analysts incorporate incoming data, assess the relevance of new events, construct forecasts for a large number of economic variables, analyse various scenarios and consider a range of key risks to the outlook. All of this provides a useful framework to guide policy deliberations and then communicate those decisions.

This process may lead us to revise the economic outlook – either in response to unexpected developments or shocks, or to news that changes our views on how the economy is evolving. If a change in the outlook is judged to be significant, it may warrant a change in the stance of monetary policy. However, that link between the forecasts and policy is by no means a

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[1] Professor Pagan is one of Australia's foremost academic economists and served on the Board of the Reserve Bank from 1995 to 2000. Dr Wilcox is Director of the Division of Research and Statistics at the Federal Reserve Board of Governors in the United States.

[2] I use the term "forecast" somewhat loosely, since these are conditioned on a range of assumptions, such as a fixed nominal exchange rate and a particular path for the cash rate, and hence could better be described as "projections".

mechanical one. In part, that is because any policy response will depend on the nature of the change to the outlook, including whether it has been driven primarily by supply or demand shocks, and how persistent those shocks are likely to be. Also, any policy response will depend on an assessment of the extent to which the economy will adjust of its own accord. It is important to recognise that sufficiently flexible economies can do much to right themselves, with households and businesses responding to the signals provided by changes in prices, wages and the exchange rate. Such changes have played a major role in the adjustment of the Australian economy to the decline in commodity prices and mining investment over recent years.[3] Another important consideration is the sizeable degree of uncertainty about the outlook. While a revision to the central outlook might appear to be of substance, it may still be relatively small compared with the considerable degree of forecast uncertainty. And finally, other considerations, beyond the near-term outlook of the macroeconomy, may be relevant, including the prospects for financial stability.

The role of models

Modelling can play a useful role in the forecasting process, including by helping to identify the nature of the shocks affecting the economy. Models can also provide a sense of how the economy might respond to alternative policy paths or different assumptions about key variables, such as commodity prices or the exchange rate to name just two. In addition, models allow us to check whether our forecasts are consistent. For example, does the path for output and employment imply a plausible path for productivity? And do they imply patterns of economic behaviour that are broadly in line with historical experience? A recent instance is the decline in wage growth over recent years, which has been larger than implied by the historical relationship with the unemployment rate. Of course, we may be justified from time to time to think that history is likely to be a poor guide, but it's worth being explicit about any such deviations. Finally, while models play an important role in the forecasting process, the value of models should not be overstated, particularly because no one model that we have captures all of the relevant features of an economy or consistently "beats" other forecasts.[4]

Central forecasts

Central forecasts attract a great deal of attention and commentary from financial market participants, the press and the general public. The extent of that attention is often unwarranted. As several of my colleagues have noted over the years, point forecasts should be treated with a healthy degree of scepticism.[5] It is unlikely that GDP growth or inflation will exactly match point forecasts, or even narrow ranges around those points. Instead, central forecasts are best thought of as our view of the most likely of a wide range of possible outcomes, with small changes in the forecasts unlikely to reflect anything more than a modest shift in the balance of risks.

To avoid fallacies that can accompany false precision, we recently altered what we refer to as "Table 6.1" of the forecasts in the *Statement* by presenting ranges for GDP and inflation in ½ percentage point increments, rather than ¼ percentage point increments (shown below). No

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[3] For a discussion of these issues, see Lowe P (2016), "Resilience and Ongoing Challenges", Keynote Address to the UDIA National Congress 2016, Adelaide, 8 March.

[4] Models usually involve some reasonable simplifications of reality so as to make them tractable and possible to estimate. Such models will be unable to capture all relevant considerations all of the time.

[5] For example, see Stevens G (2011), "On the Use of Forecasts", Address to the Australian Business Economists Annual Dinner, Sydney, 24 November; Lowe P (2010), "Forecasting in an Uncertain World", Address to the Australian Business Economists Annual Forecasting Conference Dinner, Sydney, 8 December; Stevens G (2004), "Better Than A Coin Toss? The Thankless Task of Economic Forecasting", Address to the Economic Society of Victoria and the Australian Industry Group, Melbourne, 17 August; and Stevens G (1999), "Economic Forecasting and Its Role in Making Monetary Policy", Address to the Economic Society of Australia Forecasting Conference, Melbourne, 19 August.

doubt that will not discourage some readers from using their rulers to measure the graphs and focus on revisions down to the nearest 0.1 percentage point! Also, some commentators will be tempted to draw attention to what they might describe as "large ½ percentage point changes" when the forecasts are revised, even though any such revisions may reflect much smaller adjustments if it is the case that the forecasts have merely crossed rounding barriers.[6] The key point I'd like to make here is that if we judge any forecast revision to be of substance worth noting, we'll note it!

To emphasise this point further, it is worth remembering that the available data are subject to a degree of measurement error. In the case of real GDP, for example, quarterly growth rates can easily be revised up or down by ½ percentage point or more in the first four years after the initial estimate (Graph 1).[7] The recent revision to GDP growth – of 0.2 percentage points in the September quarter of 2015 – was relatively minor, though the data now suggest that GDP growth picked up in the second half of 2015 to be more in line with the strength that was apparent in a range of indicators of the labour market and business conditions at that time.

Starting points

A critical element of forecasting is to have a sense of where the economy is now and in which direction it's currently heading. This comes from carefully dissecting the incoming economic data in an attempt to disentangle signals from noise and determine the extent to which shocks will be long-lived or transitory.[8] In addition to publicly available data, we make use of information obtained from our business liaison program. We also use information gleaned from econometric models, which include both single-equation models of individual variables as well as larger models that attempt to capture the behaviour of multiple variables simultaneously.

The various information sources that we use don't always provide a clear message about where we are and where we are heading. Indeed, it is naïve to think that the truth can reside in a single source of data or a particular model. To an extent, this reflects the usual noise in the various types of information, as well as uncertainty about the strength of different economic relationships. Combining information from a variety of sources, and models, typically results in more robust conclusions than relying exclusively on a single source.

The behaviour of inflation provides a timely example. A wide range of information suggests that inflation is low and likely to remain so over the next couple of years. This includes both structural (DSGE) and statistical (VAR) models of inflation. These attribute the outcomes over the past year or more, in part, to the influence of foreign "factors" – as captured by low inflation and low interest rates in the advanced economies. These can have a direct effect on inflation in Australia via the prices of imports. There are indirect effects as well, whereby spare capacity in product and labour markets globally may have contributed to relatively low inflation and wage outcomes in Australia. The models suggest that these influences on Australian inflation are typically quite persistent, which reinforces the message from other sources that inflation is likely to remain low for some time.

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[6] To be clear, if an initial forecast of a particular number had been close but less than say 2¼ per cent, for example, it would have been rounded down to 2 per cent, but a minor upward revision of less than ½ percentage point could mean it subsequently rounds up to 2½ per cent.

[7] J Bishop, T Gill and D Lancaster (2013), "GDP Revisions: Measurement and Implications", *RBA Bulletin* (March), pp. 11–22, discuss the pattern and size of revisions to real GDP over recent years.

[8] Lowe P (2010), "Forecasting in an Uncertain World", Address to the Australian Business Economists Annual Forecasting Conference, Sydney, 8 December, describes the inputs into the forecast process in greater detail.

Uncertainties

For several years we have presented confidence intervals for GDP growth and inflation forecasts in the *Statement* (Graph 2).[9] These summarise the extent of uncertainty based on previous forecast errors. Since February of last year, we have also published an unemployment rate forecast and confidence intervals around that.

In addition to confidence intervals, the forecasting process leads us to think about the risks associated with specific economic developments and to quantify those where possible. Each quarter, we discuss a range of scenarios that explore how the economy might respond under conditions that vary from the central case. For example, what if commodity prices, the exchange rate or overseas economic conditions evolve differently to the paths embedded in our central forecasts? These exercises help us to identify events that could have a meaningful effect on the economy and to which policymakers may need to respond.

Background to the Pagan-Wilcox review

We commissioned Adrian Pagan and David Wilcox to conduct a review of forecasting in Economic Group in late 2014. We asked for their views on whether there were areas we could improve upon, whether the tools of forecasting were the right ones and whether we were using the forecasts appropriately. We did not commission the Review as a result of any concerns about our recent forecasting experience or because we felt that our existing procedures were fundamentally flawed. But it was time for a careful health check of our approach.

Professor Pagan and Dr Wilcox visited the Bank for two weeks during one of our regular forecasting rounds. They spent time with individual sections in Economic Group, examining our models and forecasting approaches in detail. They also met with senior management and attended our internal forecast discussions.

Their review represents a thorough analysis of our forecasting procedures. We have made it publicly available today. I will attempt to summarise its key conclusions and describe how we have responded to the recommendations.

The review's conclusions and recommendations

The Review concluded that our forecasting practices were fundamentally sound and produced information conducive to good policymaking. The reviewers praised the knowledge, motivation and technical proficiency of our analysts. They also commended the use of models and the spirit of open debate in our internal forecasting discussions.

But there is always room to improve. The Review made a number of recommendations, which can be summarised in three categories: the development of new models; changes to forecast procedures; and organisational changes.

Development of new models

There were two recommendations regarding the modelling tools we used.

- First, the Review recommended that we put additional resources into developing and analysing "full-system" or "general equilibrium" models of the economy – that is, models which account for the simultaneous responses of a large number of key variables to unexpected developments (or shocks).

[9] For information on the construction of these confidence intervals, see Tulip P and S Wallace (2012), "Estimates of Uncertainty around the RBA's Forecasts", RBA Research Discussion Paper No 2012–07.

The Review recommended supplementing our existing models with one that incorporates our separate single equation estimates for a range of key variables into a system of equations.[10]

- Second, the Review noted the enormous changes to the structure of the Australian economy over the past decade or more, particularly, but not exclusively, related to the mining boom. These developments caused shifts in the composition of economic activity, such as the large pick-up in mining investment that peaked in 2012. Hence, the relationships between economic variables may be different from the past. The Review recommended placing more emphasis on investigating the robustness of existing economic models to structural change and provided a number of suggestions on how to do this.[11]

Changes to existing forecast procedures

The Review also recommended some modifications to some of our forecast procedures.

Forecast horizon

It suggested we consider extending the forecasting horizon beyond two-and-a-half years. It was acknowledged that doing so would be more straightforward when using model-based forecasts. Moreover, the current approach has a number of advantages. A two-to-three year horizon is a period over which monetary policy, and what could broadly be termed "demand-side" factors, tend to influence economic activity. Over longer horizons, "supply-side" influences, like changes in the trend rate of productivity growth or the non-accelerating inflation rate of unemployment (NAIRU), are likely to be more important. These factors are more difficult to forecast than short-run, demand-side influences, and are not affected by monetary policy decisions.

However, following large and persistent disturbances, such as a once-in-a-century boom in commodity prices, the economy may not return to its steady state within the existing forecasting horizon. This could complicate the assessment of whether current policy settings are appropriate, hence the recommendation to extend the horizon.

Cash rate paths

Another recommendation was related to a "technical assumption" about the cash rate that underpins our forecasts. At the time of the Review, we typically assumed that the cash rate

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[10] I should note that full-system models of one sort or another have a long history at the Bank and already play a role in the forecasting process. The earliest examples of such models date back as far as the 1970s and include the RBA1 model (Henderson J and P Norman (1975), "The Equations of the RBA1/74 Model of the Australian Economy", RBA Research Discussion Paper No 7504) and the RBA76 model (Jonson P, E Moses and C Wymer (1976), "A Minimal Model of the Australian Economy", RBA Research Discussion Paper No 7601). In the late 1990s, Economic Research Department staff constructed a small empirical model of the Australian economy. This model was documented in Beechey M, N Bharucha, A Cagliarini, D Gruen and C Thompson (2000), "A Small Model of the Australian Macroeconomy", RBA Research Discussion Paper No 2000-05 and Stone A, T Wheatley and L Wilkinson (2005), "A Small Model of the Australian Macroeconomy: An Update", RBA Research Discussion Paper No 2005-11. More recently, our staff have developed more complex dynamic stochastic general equilibrium (DSGE) models. These models were documented in Jääskela J and K Nimark (2011), "A Medium-scale New Keynesian Open Economy Model of Australia", *Economic Record* (87), pp. 11–36 and Rees D, P Smith and J Hall (2015), "A Multi-sector Model of the Australian Economy", RBA Research Discussion Paper No 2015-07. These sorts of models feature in our internal forecast meetings. However, I think it is fair to say that full-system models have not been fully integrated into our forecasting procedures and the nature of those models has been somewhat distinct from the single-equation models that most of our analysts work with day-to-day.

[11] For example, by estimating models incorporating time-varying coefficients or using techniques such as exponential smoothing that reduce the weight given to certain observations when estimating the parameters of a model.

would remain constant across the forecast horizon.[12] This has the advantage of simplicity. Also, over short horizons it often provides a reasonable approximation to what econometric models and financial market participants would expect. However, over longer horizons a constant cash rate assumption may be less plausible, particularly when interest rates are far from average levels. The Review recommended considering alternatives to a constant cash rate assumption. A number of alternatives exist, including: the path implied by financial market prices; a path consistent with the past behaviour of the Bank as summarised by an estimated "monetary policy rule"; or an *ad hoc* path postulated by staff members. There is no consensus about which of these alternatives is optimal.[13]

Broaden discussion of the forecasts

The Review also made suggestions relating to the presentation of our forecasts in the *Statement*. In particular, the authors recommended that we publish a forecast for the unemployment rate. They noted that to assess the state of the real economy it is not sufficient to know the pace of GDP growth; one also needs to know how this rate of growth relates to potential growth and hence the extent to which spare productive capacity is rising or falling. While we have always focused on these concepts in our internal analysis, publishing unemployment rate forecasts provides useful information in this regard.

Discussion of the risks

An additional suggestion was to alter our discussion of risks to the forecasts in the *Statement.* The Review argued that there was scope to provide more guidance on the plausibility and implications of alternative scenarios, rather than merely providing a list of events that could affect the outlook.

It is possible to come up with any number of scenarios that may cause economic outcomes to differ from a given set of forecasts. It is worth noting, however, that many plausible scenarios may have fairly benign implications. To give one example, we typically condition our forecasts on a constant exchange rate, even though it would be unusual for the exchange rate to remain steady for any length of time. However, the effect of an exchange rate movement will depend in large part on whether it has occurred in response to other developments, such as a change in commodity prices. The consequences of such exchange rate movements are predictable to some degree and, in many instances, have tended to help insulate the economy from adverse developments offshore or even domestically. In other circumstances, a large exchange rate movement (or even a lack of movement in the face of other developments) may represent an important shock to the economy.

One can also imagine scenarios that are unlikely to occur but may have far more substantial implications for the economic outlook if realised. These scenarios can be difficult to quantify but may be worth discussing nonetheless. An example that we discussed in our most recent *Statement* was the potential for financial instability in China to lead to a sharp slowdown in economic activity there and in the Asian region more broadly.

Organisational suggestions

Finally, the Review made some recommendations regarding the organisation of Economic Group.

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[12] However, we have used different conditioning assumptions at various times. For example, during the global financial crisis we conditioned our forecasts on financial market interest rate expectations.

[13] Some central banks, including the Bank of England and the European Central Bank, condition their forecasts on paths implied by financial market prices; others, including the Sveriges Riksbank and the Norges Bank, condition their forecasts on staff expectations of the future policy interest rate.

The first was to establish a section dedicated to the development and use of full-system macroeconomic models. It would build upon the work of the existing modelling team and develop a new model. The establishment of such a section would facilitate the greater use of models within the Bank, increase cooperation between different sections generating the forecasts and help to enhance the familiarity of our staff with these types of models.

The Review also encouraged the Bank to consider whether existing hiring and staffing policies encouraged the right mix of generalists and technical specialists. In particular, it highlighted macroeconomic modelling as an area requiring technical expertise. In addition, the Review questioned whether personnel across Economic Group were distributed optimally, with the suggestion that more staff could be dedicated to modelling if there were fewer staff monitoring overseas economies and/or participating in the Bank's Regional and Industry Analysis section, which conducts liaison across the country.

Responses to the review

My colleagues and I have spent time discussing the Review's conclusions, re-examining our existing procedures and developing appropriate responses.

We have already implemented some of the Review's recommendations:

- We have added a quantitative discussion of our unemployment rate forecasts to the *Statement*, with a graph of confidence intervals to illustrate the extent of uncertainty.
- The *Statement's* Outlook chapter now provides a more comprehensive explanation of the uncertainties around our forecasts, including more information about the channels through which risks could affect the economy.
- We have changed the nature of the cash rate assumption underpinning our forecasts. Since the start of 2015, we have conditioned our forecasts on the assumption that the cash rate moves broadly in line with the path implied by financial market pricing.
- To increase the Bank's capacity to use full-system models, we have established a new Macroeconomic Modelling section within the Economic Analysis Department. This has primary responsibility for generating model-based analysis to enhance the quality of our forecasting processes and policy advice. I should emphasise that this section will complement our existing forecasting processes, not replace them. As is the case at many other central banks, our forecasts will still be generated by a range of analysts and will feature a degree of judgement, rather than be mechanical, model-based forecasts. However, the forecasts will be usefully informed by the insights and analysis that full-system models can provide.

The Review recommended redirecting resources from monitoring overseas economies and conducting business liaison to other activities, particularly modelling. However, we have sourced staff for the new modelling section from across Economic Group more broadly and have no intention of reducing the extent of our liaison program. This reflected our assessment that the benefits of monitoring overseas economies and conducting domestic economic liaison go well beyond the direct contribution to our quarterly forecasting process.[14] In addition, the

[14] Liaison information helps fill information gaps to strengthen the Bank's capacity to assess structural trends in the Australian economy. Two recent examples of this include better understanding the responsiveness of the construction sector to changes in interest rates and whether this has changed over time, and understanding why non-mining business investment has not picked up as forecast. The State Offices also play a key role in enhancing the Bank's engagement with the public via presentations on economic developments to businesses and community organisations, teacher conferences, and university and school students across the country. For more information about the role of the RBA's Business Liaison program see RBA (2014), "The RBA's Business Liaison Program", *RBA Bulletin* (September), pp. 1–6 and Heath A (2015), "The Role of the RBA's Business Liaison Program", Address to the Urban Development Institute of Australia, Perth, 24 September.

liaison program provides valuable insights for forecasting. For example, during the mining investment boom, liaison provided timely and accurate information about construction projects that was not available elsewhere. Combining our liaison on each project has provided a reasonably accurate picture of what has transpired. Moreover, because a commodity price boom of this magnitude had not been experienced before, models estimated using historical data would have had difficulty anticipating the extent of the response of mining investment. Similarly, our analysts monitoring overseas economies help us to understand the economic and financial developments affecting our trading partners, particularly in the Asian region, in a way that would not be possible from using publicly available forecasts of a limited range of variables such as GDP and inflation from organisations like the International Monetary Fund or Consensus Economics.

Conclusion

The Pagan-Wilcox Review was a comprehensive health check of our forecasting approach. While the Review confirmed that our methods are fundamentally sound, it provided a number of valuable suggestions for how we could improve the way we forecast. We have already responded to many of the suggestions and are in the process of following up on others. While these changes are unlikely to see much of an improvement in forecast accuracy, they have the potential to enhance the role that forecasting plays in the policy process and facilitate the usefulness of the forecasts as an important tool of communication.

'Table 6.1': Output Growth and Inflation Forecasts[a]

Per cent

	Year-ended					
	Dec 2015	Jun 2016	Dec 2016	Jun 2017	Dec 2017	Jun 2018
GDP growth	2½	2–3	2½–3½	2½–3½	2½–3½	3–4
CPI inflation	1.7	1½	2–3	2–3	2–3	2–3
Underlying inflation	2	2	2–3	2–3	2–3	2–3
	Year-average					
	2015	2015/16	2016	2016/17	2017	2017/18
GDP growth	2½	2–3	2–3	2½–3½	2½–3½	2½–3½

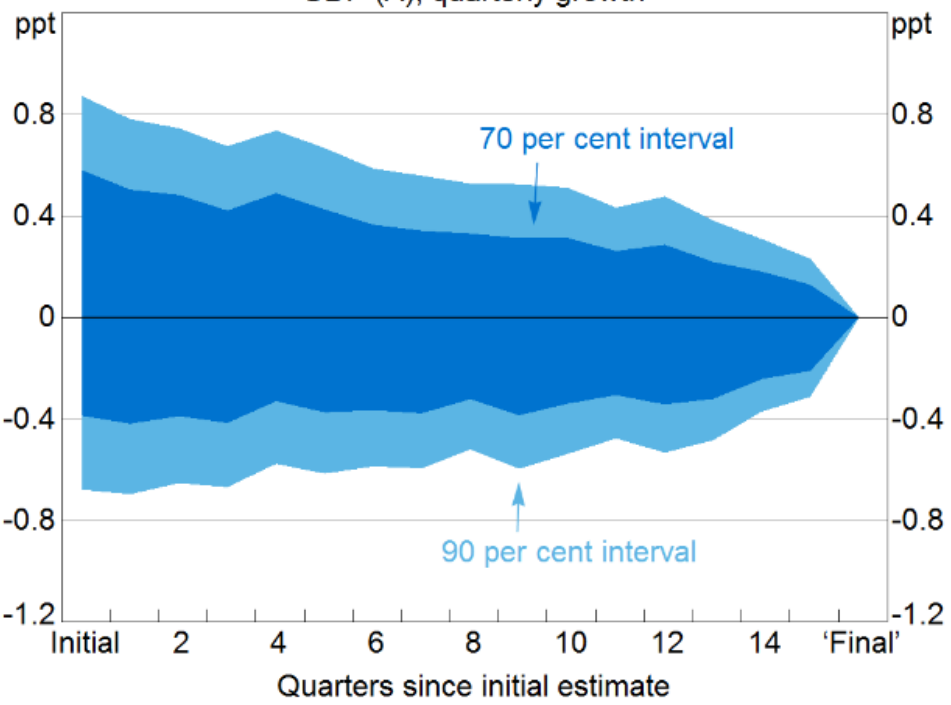
(a) Technical assumptions include A$ at US$0.72, TWI at 62 and Brent crude oil price at US$35 per barrel; shaded regions are historical data

Sources: ABS; RBA

Graph 1

Uncertainty around Estimates of GDP

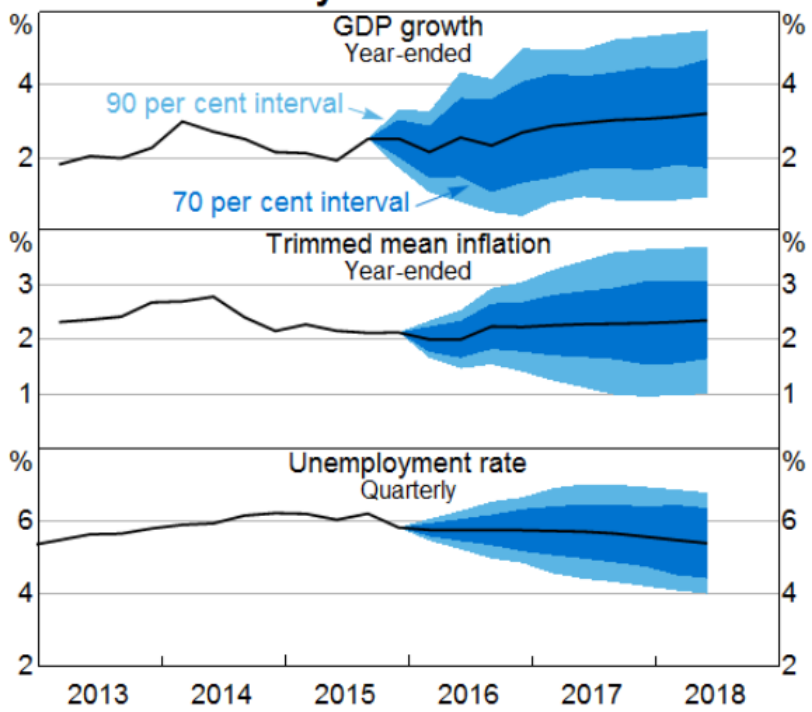
GDP (A), quarterly growth



Sources: ABS; Bishop, Gill and Lancaster (2013); RBA

Graph 2

Uncertainty Around Forecasts*



* Confidence intervals reflect RBA forecast errors since 1993

Sources: ABS; RBA