

# Review of Treasury's Macroeconomic Forecasting Capabilities

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## Executive Summary

This review examines Treasury's macroeconomic forecasting capabilities. It takes as given the quantitative conclusions of the previous three reviews of Treasury's forecasting of the economy. It also does not examine issues related to forecasting of tax revenues, which were covered in detail in the 2005 and 2012 reviews. The main conclusions of this review are:

- Treasury's forecasting approach is likely to generate reliable forecasts at times when economic conditions are normal but will be challenged at other times. This is true of most forecasters. By construction, Treasury's forecasts are weighted towards achieving trend-like, consensus outcomes. There is a high probability that structural changes or persistent shocks will not be adequately incorporated into the forecasts, either analytically or quantitatively. This increases the risk of persistent errors being made in Treasury's forecasts.
- Treasury's approach is narrower than most public sector forecasters. It relies on a small number of single-sector models. Though rigorous, they are by definition a narrow description of the economy.
- These models are applied by sector analysts with short tenure in an environment of high turnover. This limits the staff's ability to develop true sector experience or technical expertise. In this environment it is important that senior staff provide technical guidance to the less experienced staff and, from a forecasting perspective, provide guidance on the major macroeconomic themes over the forecast period. At present, senior staff take a more informal and iterative role in the production of the forecasts compared with other institutions.
- Judgment is a crucial aspect of the forecasting process. This is especially the case when forecasts are generated in an iterative way by inexperienced staff, using single-sector models. The models should be a complement to well-informed judgement, not a substitute for it, as now often seems to be the case. The models cannot of themselves incorporate economy-wide themes in a consistent way. In Treasury's forecasting process judgment seems to have a presentational focus rather than an analytical one. There seemed to be little emphasis on bringing to bear deep sectoral expertise or a deep analysis of major macroeconomic themes. The latter requires input from senior members of the Division.
- Treasury's problems in forecasting nominal GDP growth, identified in each of the past three reviews, persist. As previously, these arise from errors in forecasting the GDP deflator but real GDP growth has also been over-predicted in the past few years. This is true of other forecasters. There is no easy solution to improving the GDP deflator forecasts. Commodity prices and the terms of trade are hard to forecast. Treasury has developed a rigorous framework for analysing commodity prices over the long term. However, over the two-year forecast horizon, Treasury now assumes that prices will be unchanged. This is common and reasonable but leaves its forecasts vulnerable to large changes in commodity prices. On balance, there has been no improvement in Treasury's capacity to forecast the GDP deflator over a two-year horizon since the 2012 review.
- To strengthen Treasury's short-term forecasting framework and reduce the institutional risk it faces, it is necessary to expand the range of inputs and views, including from senior staff, into its forecast process. It is also important to strengthen the culture, to develop economy-wide forecasting skills and to encourage analysis beyond the scope of the underlying models.

- Previous reviews have highlighted the need for detailed scenario analysis to explore the risks around the forecasts. This is sensible and some scenarios have been published in the Budget papers. This review observes that MECD’s capacity to conduct rigorous scenario analysis is limited by its narrow analytical framework, iterative forecast process and systems involved.

## Issues

### a. Staff

During the course of discussions for this review a consistent theme emerged. That related to the technical capabilities of staff across all levels of seniority. Concerns were expressed about whether the sector analysts had the econometric and economic training to identify problems with the models currently in use and to further develop the modeling framework. Concerns were also expressed about the capacity of more senior staff to provide technical assistance to the sector analysts in this area given their other responsibilities. These issues were seen as a constraint on the ongoing development of the quantitative aspects of the forecasting process.

This review concludes that the skill level in the Division is sufficient to generate a credible set of forecasts using existing quantitative tools. However, there are two areas in which the Division will be challenged. The first is on the future development of quantitative tools and the introduction of an economy-wide model into the forecasting process. The second is adequately accounting for economy-wide shocks and events outside the scope of the single-sector models in the forecasts.

### b. Models

The econometric models that underpin the sector forecasts are rigorous, theoretically sound and fit history reasonably well. They have been developed in Treasury over a number of years. When combined with the staff issues noted above, Treasury has an unusual reliance on one vehicle – the models -- to deliver its forecasts. This is an institutional risk if the models are not regularly audited and redeveloped. As a result, it is crucial that the models are audited on a regular basis and are improved or rebuilt if they are found to provide unreliable forecasts.

### c. Judgement and culture

In applying judgment in Treasury much attention is focussed on producing a set of forecasts that is both internally consistent and consistent with how events had evolved since the last published Treasury forecasts. There seemed to be less emphasis on bringing to bear deep sectoral expertise or an assessment of major macroeconomic themes. This should be a role for more senior members of MECD.

### d. Systems

Treasury’s forecasting framework is built around spreadsheets maintained by the sector analysts and consolidated in larger and more elaborate spreadsheets (the NAFF spreadsheets) maintained by the National Accounts team. It is worth noting that several people highlighted strains in the NAFF spreadsheets. They entail significant linkage risks and seem to have regular errors. Their breakdown would considerably impede Treasury’s forecasting capacity.

## Recommendations

### a. Broaden analytical inputs and contribution from senior staff

Treasury should broaden the analytical inputs into its forecasting process in a number of ways:

- The 2012 review recommended embedding an economy-wide model into the process. This should be done. It would provide a broader focus of discussion and improve the Division's ability to incorporate economy-wide shocks appropriately in the forecasts. It would also enhance the productivity of MECD. It should not generate Treasury's forecasts but should be a means of identifying what are some of the key issues each forecast round;
- Other analytical forecasting techniques should also be developed. These include examining more closely the leading indicator properties of the partial data and developing a small VAR of the Australian economy;
- Develop nowcasts of the economy to reduce the uncertainty around the starting point of Treasury's forecasts;
- Broaden the role of international developments in the forecasts by embedding IOU more effectively into the forecast round;
- A feature of Treasury's forecasts is the limited role for financial variables to drive the cycle. Introducing an economy-wide model or some of the time series models mentioned above would go some way to resolving this issue. Financial variables are more rigorously embedded in them. That said most models fail to capture the full complexity of the role of finance in the economy. Further analytical work on the issue should be conducted.

The forecasting process could also be enhanced by greater scrutiny by a wider range of senior staff across the Group. At this stage forecasts are prepared by MECD and then presented to the Executive. It would be worthwhile drawing on the experience and expertise of senior members of MMPD or other Divisions in the preliminary discussions of the major macroeconomic themes that are likely to be relevant over the forecast horizon. This would sharpen the contribution of judgment in the forecasting process and greatly assist the less-experienced staff.

#### **b. Improving judgment and analysing atypical events**

Judgment needs to be applied in a more rigorous way, focusing on issues that may have a substantive impact on the forecasts rather than being weighted toward technical or presentational issues. This can be achieved in a number of ways: more vigorous discussion of the risks around the exogenous assumptions underpinning the forecasts needs to be held at the start of the forecast round; more focus should also be given to issues that may be atypical or beyond the scope of the single-sector models to capture; questions about whether the economy will converge on the long-run projections over the two-year forecast period should be debated vigorously to prevent the short-term forecasts from being anchored by the long-run projections; and Treasury should commit more time to monitoring financial risks around the outlook by examining a range of high-frequency market data that typically signal some stresses in financial markets as well as monitoring low-frequency financial developments such as the evolution and quality of private sector balance sheets and financial decisions.

#### **c. Staff**

The number of staff in the Division is adequate to fulfil its forecasting and other tasks. However, if it is decided to embed an economy-wide model more fully in the forecast process and to develop time series or leading indicator models to broaden the range of inputs in the process it will be necessary to draw on staff members with strong econometric and macro skills or add an additional staff member with those skills

Ideally a small team would be set up in MECD to manage the quantitative aspects of the forecasts. It would consist of a senior person with strong econometric and macro skills, working with a technically strong sector analyst and perhaps a graduate.

This team would be responsible for generating the forecasts using the model and also leading any scenario analysis conducted by the Division. It would also develop a broader suite of time series and leading indicator models, work with the sector analysts on their single-sector models and, on a regular basis, audit the forecasting performance of those models.

If an objective of staff development in the Division is to produce people with sound long-term macro judgment then management of the staff of MECD should be more structured. Ideally, The Division should be structured to ensure that there are a number of analysts who have worked on a range of Australian sectors before analysing and forecasting the whole economy. Staff with strong technical skills should be given the opportunity to work in the quantitative unit recommended above.

#### **c. Systems**

As the NAFF spreadsheets are crucial to the process Treasury should investigate whether in fact they have become too large, complex and possibly unstable. Treasury should also explore whether the National Accounts team's suggestion of migrating the NAFF spreadsheets to EViews is feasible.

#### **d. Presentational material**

If the recommendations about models, staff and systems are followed then MECD's capacity to run a range of economic scenarios would be significantly enhanced.

The Budget papers could also be enhanced by extending the discussion of the risks around the outlook. An addition that could be made would be to examine how the Budget outcomes would vary if Consensus rather than Treasury forecasts were achieved. An advantage of doing this would be to illustrate how the Budget might look if the views of external parties were applied rather than Treasury's.

Alternatively, forecasts based on the range of Consensus commodity price forecasts could also be presented.

# Review of Treasury's Macroeconomic Forecasting Capabilities

## Introduction

Treasury has undertaken three reviews of its forecasting performance since 2002<sup>1</sup>. Each review measured the performance of Treasury forecasts relative to outcomes and other forecasters. The conclusions of each review were consistent. Treasury's forecasts of macroeconomic variables were: unbiased over the full sample from the early 1990s; mostly as good as other forecasters or naïve trend-following models over that period; and were superior for real over nominal variables. Nonetheless, it is evident that over this period the forecasts were punctuated by persistent and sometimes large errors over horizons relevant to policy-makers and advisers. This was true of other forecasters. These errors occurred when there were persistent shocks to the economy – the upswing in commodity prices and their subsequent fall – and at turning points in the economy. Treasury's difficulty in forecasting nominal variables, as a result of errors in forecasting the GDP deflator, has been a persistent problem. It continues today.

This review does not intend to revisit Treasury's forecasting track record so soon after the 2012 review nor consider aspects of the forecasting of tax revenues. However, for completeness an update of some of the more important charts from the 2012 review appears in Appendix 1. They support the conclusions of other reviews. Treasury forecasts do not do well when there are persistent shocks to the economy. Real GDP growth has been overestimated in each of the past five years. Nor do they forecast the GDP deflator well. Budget forecasts over-predicted the deflator in four of the past five years. On balance, this has meant a persistent overestimate of nominal GDP growth over that period.

This review will focus on measures that may enhance the performance of Treasury's macroeconomic forecasts and improve the efficiency of the process. It is based on discussions with colleagues in MECD, MMPD and TAD, observations made during one forecasting round and a review of internal and published Treasury documents<sup>2</sup>. Other material published by central bank and finance ministries was also reviewed.

Each previous review provided recommendations to improve Treasury's macroeconomic and tax revenue forecasting and to increase the discussion of forecast uncertainties and errors in the Budget papers. These recommendations have tightened the relationship between forecasters of the macroeconomy and forecasters of tax revenue within Treasury. They have also increased the focus on forecasting the income-side of the economy. The recommendations have also led to an expanded discussion of forecast errors and alternative scenarios in the Budget papers.

During this exercise it became apparent that the capacity of MECD to produce reliable forecasts, be nimble in response to changes in the economic outlook and meet other objectives was closely intertwined. Thus, while the recommendations of the review focus on improving the forecasting capacity of the Division they do so in a way that should enhance its flexibility and efficiency.

**Treasury's approach is likely to generate reliable forecasts at times when economic conditions are normal but will be challenged at other times. By construction Treasury's forecasts are weighted towards achieving trend-like, consensus outcomes. This increases the risk of persistent errors being made in Treasury's forecasts. Errors at turning points are almost inevitable.**

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<sup>1</sup> Reviews were conducted in 2002, 2005 and 2012.

<sup>2</sup> I am grateful to colleagues for their time and candour. Angelia Grant and Brenton Goldsworthy were particularly helpful in organising the process as well as providing useful insights into Treasury forecasting.

Treasury's approach is narrower than most public sector forecasters. It has become reliant on a small number of single-sector models. This reliance is not a problem in itself. The models provide a sound base for forecasting. They are rigorous and fit history well. But they are applied by less experienced staff in an environment of high staff turnover and short tenure. This is an institutional risk. The models should be a complement to well-informed judgement, not a substitute for it, as now often seems to be the case.

To strengthen Treasury's short-term forecasting framework and reduce the institutional risk it faces, it is therefore necessary to expand the range of inputs and views, including from senior staff, into its forecast process. It is also important to strengthen the culture, to develop economy-wide forecasting skills and to encourage analysis beyond the scope of the underlying models.

## 1. Forecasting in the Treasury

Forecasts by public sector organisations perform a number of roles. For Treasury they frame Government Budget and other policy discussions, identify emerging themes or risks in the economy and inform the public and media about the likely path of the economy. Practitioners are very forgiving of forecast errors as they understand the difficulty of predicting the future. However, public sector forecasters are held to a higher standard by the public, media and other users of forecasts. For that reason accuracy is important. Large or persistent errors can undermine the credibility of a forecaster and its policy advice. It is probably no coincidence that many public sector organisations have commissioned reviews of their forecasting in recent years following the forecast errors around the 2008 financial crisis and its aftermath<sup>3</sup>.

A review of the forecasting approaches of other public sector organisations shows that their forecasts are dependent on some combination of economy-wide models, time-series techniques, single-sector models, input from sector analysts and judgment applied during the early stages of the forecasting process and sometimes afterwards by senior policy makers<sup>4</sup>. The weight given to each of these inputs varies across institutions and often over time within the same institution.

To the extent that a consensus exists about best forecasting practice it is that an economy-wide model should form the core of the process and that a variety of other inputs should complement it. This is because a system-wide model more effectively captures the inter-linkages in the economy. It is also acknowledged that most approaches, including models, produce inaccurate forecasts so drawing on a range of inputs may help triangulate a better outcome<sup>5</sup>. In practice, the economy-wide model provides the first pass through of the exogenous influences over the forecast period<sup>6</sup>. This is then augmented by the expertise of sector analysts, other short-term models and judgement of senior policy makers to generate the final forecasts. Utilising a model also brings efficiency gains to an organisation by making it easier to run a range of analytically rigorous scenarios. This is relevant to the day-to-day work of MECD.

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<sup>3</sup> The Bank of England has reviewed its forecasting process, see Stockton (2012) and Burgess et.al. (2013). The Reserve Bank of Australia conducted a similar review in 2014 and the NZ Treasury conducted a review in 2007 (Schoefisch (2007)) and is again looking at its forecasting process. The Bank of Canada extended its model suite to enhance its process, Gervais and Gosselin (2014).

<sup>4</sup> See Appendix 2.

<sup>5</sup> The Bank of England is perhaps most explicit in its strong desire to have a range of models and inputs into its forecasting process, Burgess et.al. (2013). See also Pagan and Roberston (2004). Similarly the Bank of Canada highlights the need for multiple approaches as "no one model can answer all questions. Using multiple models is one of the Bank's strategies to deal with economic uncertainty", Gervais and Gosselin (2014) pg 1.

<sup>6</sup> Burgess et.al. (2103), Pagan and Robertson (2004).

**Treasury's forecasting framework is more one dimensional than this. When combined with staffing and resourcing constraints discussed below this creates an institutional risk for Treasury should economic circumstances change or shocks occur beyond its relatively narrow forecasting approach.** The RBA's sectoral approach is similar to Treasury's but it can draw on models developed in its Economic Group to enrich the forecasting process.

Treasury's approach to its short-term (the next two years) forecasting is based around single-sector models of various aspects of the economy augmented by input from sector analysts. This input may include information provided by partial or leading indicators, business surveys and liaison. Most of the expenditure components of GDP are modelled explicitly as are some income components. Forecasts for some bulk commodity exports are built from liaison with BREE and bottom-up analysis from large resource companies. Forecasts for most components of business investment are derived from the ABS Capital Expenditure (Capex) survey or reports on large-scale mining investment projects. The sector forecasts are combined by the National Accounts team in the NAFF spread sheet. The National Accounts team is also responsible for constructing the income-side forecasts from the inputs of sector analysts and their own construction of various measures of profits. Judgment is applied at each stage of the process: by the sector analysts after the models have been run; by senior members of the Division; and by the NAFF team when all the forecasts are combined to produce an economy-wide outcome.

The forecasting round begins with the release of the quarterly national accounts. Key commodity price, exchange rate and interest rate assumptions are set and forecasts for Australia's major trading partners are provided by the International Outlook Unit. Sector analysts then run their models. In applying judgment to the models attention is paid to the recent performance of the models and also their forecasts relative to previous forecasting rounds. These initial forecasts are subject to internal peer review at sector meetings and externally at various Joint Economic Forecasting Group (JEFG) sub-committee meetings. This produces an iterative process as initial forecasts are adjusted in response to these discussions and consistency checks by the NAFF team and Division management. A final set of forecasts is constructed for review at the full JEFG meeting before they are presented to the Executive.

The econometric models that underpin the sector forecasts are rigorous, theoretically sound and mostly fit history reasonably well. Most are error correction models (ECMs). As such they incorporate desirable long-run theoretical properties while also including short-run dynamics that are relevant for the forecast horizon. They have been developed in Treasury over a number of years.

Treasury has also introduced a set of medium-term forecasts that assume that the economy will adjust to close any output gap in the five years following the end of the two-year short-term forecast horizon. These are based on internal estimates of the output gap and potential GDP growth. When first published they implied real GDP growth of 3-1/2 % over the medium-term horizon. This approach is similar to that of the Office for Budget Responsibility (OBR) in the UK<sup>7</sup>. The OBR starts with an estimate of the output gap and then assumes that the economy and monetary policy will adjust to close the output gap over the medium term. The OBR's assessment of the path of adjustment appears to be less mechanical than Treasury's current approach. It includes an assessment of the current factors driving the economy and "current influences that might suggest a path *[to potential]* different to historical experience"<sup>8</sup>.

One aspect of Treasury's forecasting methodology should be highlighted. **By construction, Treasury's forecasts are biased toward achieving trend-like, consensus outcomes.** Forecasts will be

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<sup>7</sup> OBR (2011).

<sup>8</sup> OBR (2011) pg. 22. Italics added.

above or below trend depending on starting conditions and the degree of judgment applied. This follows from a number of practices.

For a small, open economy like Australia persistent and short-term deviations from trend are likely to be driven by global economic shocks, large changes in commodity prices or from the financial sector. Other factors could also be important but these three factors encompass much of Australia's experience with shocks. Treasury's Australian forecasts are underpinned by global growth forecasts that are close to international agencies and consensus. From time to time different forecasts are assumed, such as the recent below-consensus view on China. But typically, these differences are not large enough to alter the shape of the domestic forecasts. Moreover, the channels of influence from the global economy into Australian forecasts are limited to enter via major trading partner growth. Commodity prices are now also assumed to be unchanged over the two-year forecast horizon. Financial factors also play a limited role in the forecasting process, both within the empirical models and in the application of judgment.

With these assumptions in place it is difficult to produce a forecast that is significantly different from trend in the absence of a large change in the consensus on global growth, commodity prices and financial parameters between each forecast round. Moreover, given their nature, the error-correction models used by the sector analysts have a pull to trend that will complement the above practices.

## **2. Issues**

The quality of Treasury's forecasts rests heavily on the interaction of sector analysts, their models and the application of judgment applied during the forecasting process. Given the relatively narrow base of Treasury's forecasting process it is important that this interaction works effectively as possible.

### **a. Staff and Governance**

During the course of discussions for this review a consistent theme emerged. That related to the technical capabilities of staff across all levels of seniority. Concerns were expressed about whether the sector analysts had the econometric and economic training to identify problems with the models currently in use and to further develop the modeling framework. Concerns were also expressed about the capacity of more senior staff to provide technical assistance to the sector analysts in this area given their other responsibilities. These issues were seen as a constraint on the ongoing development of the quantitative aspects of the forecasting process. It was observed that the limited use of AUS-M by the Division may reflect skills gaps in the Division.

The review observes that there is a wide range of technical skills in the Division across all levels of seniority. In response MECD has implemented an impressive training program for new entrants into the Division to provide them with the skills required to make them proficient in their roles. This helps bring staff up to a skill level needed to perform the day-to-day aspects of their roles and to generate forecasts with the existing set of quantitative tools. However, it may not be sufficient to allow them to expand on that set of tools or to apply well-rounded macro views to their forecasts.

Skill levels in other areas such as the analysis, interpretation and reporting of economic developments are very high and appropriate for the forecasting capacity.

Ongoing development of technical skills would be desirable. The Division's commitment of resources to an internal training program is an example of this as it its willingness to encourage further study. On that score one member of staff has just returned from PhD studies while another is about to do a PhD.



**This review concludes that the skill level in the Division is sufficient to generate a credible set of forecasts using existing quantitative tools. However, there are two areas in which the Division will be challenged. The first is on the future development of quantitative tools and the introduction of an economy-wide model into the forecasting process. The second is adequately accounting for economy-wide shocks and events outside the scope of the single-sector models into the forecasts. These issues will be considered later in the sections on models and judgment.**

In addition to these concerns about the level of quantitative skills, the high turnover and short tenure of less experienced staff is an issue. This places an added responsibility on senior staff to ensure that broader macro issues are being accounted for appropriately in the forecasts. The review notes that senior staff seem to have a more informal and iterative role in the forecasting process than at other institutions. It should be noted that this conclusion was derived from interviews and observations during one forecasting round that was not particularly contentious. Therefore, it should be acknowledged that it may not extend more generally. Treasury's approach is designed to give sector analysts responsibility for their forecasts while ensuring that more senior staff can shape the outcome. It is important that when balancing these objectives, Treasury ensures that the macroeconomic expertise and judgment of senior staff remains a critical element of the process.

A key feature of Treasury's forecasting process is the heavy reliance on less experienced staff to generate the forecasts. The sector forecasts are generated by sector analysts, running a variety of single-sector models. A feature of MECD staff at this level is their short tenure and high turnover. The sector analysts are engaged and keen to produce good analysis and forecasts. However, with some exceptions, few are experts on their sectors and, under current staffing arrangements, are unlikely to develop deep expertise. One outcome of this is a heavy reliance on the estimated models in the generation of forecasts. Deep sector expertise is not widely applied to assess whether the forecast outcomes of the models are providing a reliable guide to the future. To the extent that judgment is applied it is either for presentational reasons – to keep forecasts consistent with previous forecasting rounds or to smooth the profile – or technical to smooth out the impact of recent "misses" by the model. That said, the forecast documentation and sector meetings reveal a high degree of transparency about how judgment is applied. This is desirable.

Also, again with exceptions, the sector analysts are not as technically proficient as the developer of the underlying models. When combined with the often limited sector experience this means that it is very difficult for them to assess whether it is appropriate to rely on the models' forecasts or adjust them for factors that are specific to their sector. It also means that it is difficult to come to strong conclusions about the causes of any forecast errors in the models and whether the models need to be reworked or changed. Ongoing model development and improvements are therefore limited, again with some exceptions.

Under these circumstances it is important for senior staff in the Division to provide strong support to the sector analysts in a number of ways. The first is assisting them in the development of their technical and skills and the development of their models. The second is to provide clear guidance on what are likely to be some of the major economic themes over the forecast horizon (see discussion of judgment below).

**Under current arrangements it is difficult for all analysts to gain sufficient experience to develop the ability to produce well-rounded, macro views on the outlook or to challenge the results of the empirical models. To the extent that judgment is a key input to good forecasting practice then this is a limitation. This is not necessarily a question of skills or ability; rather it is about staff turnover and their development.**

## b. Models

As a result of the above, the various models have become the key driving influence of Treasury's forecasts. As noted, they are rigorous, fit history well and have many desirable theoretical and empirical characteristics.

But models have their limitations, especially when conditions or economic behaviour change. **When combined with the staff issues noted above, Treasury has an unusual reliance on one vehicle – the models -- to deliver its forecasts. As a result, it is crucial that the models are audited on a regular basis and are improved or rebuilt if they are found to provide unreliable forecasts.** To some extent this is happening. As noted, the forecast documents clearly differentiate between the models' forecasts and judgments applied. This is necessary to establish the track record of the models. However, it is not clear how rigorously and frequently this analysis is done. It is also not clear how model redevelopment is organised. Some new work has been done on producing disaggregated inflation forecasts. However, other model improvements seem to be much more limited. This was attributed to both time constraints and skill gaps in the Division.

This review cannot judge the forecast accuracy of the models. It would note, however, that many of the models require technical adjustments to improve their historical fit. Some of these adjustments were the logical use of dummy variables to account for unusual events but some models also need (sometimes multiple) time trends to fit history. This need not impede or improve their forecasting ability. The sector analysts did not seem to have a strong view on this. However, the need to apply these adjustments does highlight that the reliability of models does change over time. It emphasises the need for closer scrutiny of them by suitably skilled staff.

While not wishing to get into the details of underlying models in this document it is worth giving a number of examples. One is the model for household consumption. To fit history it is necessary to include a "time-varying constant". This was introduced to account for the significant over-prediction of consumption from the mid-2000s onwards. It is posited that it may capture demographic influences. It improves the historical fit but it occupies considerable time in the discussion of the outlook as it is not clear to users what behaviour it is capturing. Also, in some wage models the constant term provides most of the information about the forecast profile of wage growth. This may reflect the historical stability of the series that is forecasted, the wage price index. While not wrong, these points highlight some of the tensions of almost solely relying on models as the driver of forecasts.

Another feature of the models is the small and narrow role that financial variables play in driving them. This is common to many single-equation models. They often fail to have a meaningful role for financial variables or fail to capture the complexity of the interaction between finance and the economy. In the current suite of models financial variables enter via the exchange rate in trade and price equations, interest rates in dwelling investment and wealth in private consumption. However, the role of interest rates in dwelling investment is small. And, from a forecasting perspective, the role of wealth in private consumption is tangential as it is just assumed to grow at trend. In effect, the sector specialist is simply adding another trend to the model over the forecast horizon.

## c. Judgment and culture

Judgment is a crucial aspect of the forecasting process. This is especially the case when forecasts are generated by single-sector models. By their nature they cannot of themselves incorporate economy-wide themes in a consistent way. It is also true at times when behaviour is changing or when the economy is being driven by events outside either the historical period over which models were estimated or beyond their limited scope. These are the times when Treasury's forecasts have erred in the past.

As noted, the forecasting process in Treasury is very diligent in identifying one level of judgment, that applied by the sector analysts to their model forecasts. It was striking as well that everyone involved in the forecasting process was conscious of maintaining the integrity and credibility of Treasury forecasts. Much attention was focussed on producing a set of forecasts that was both internally consistent and consistent with how events had evolved since the last published Treasury forecasts.

But this appeared to be the main way that judgment was applied to the forecasts. Most emphasis was placed on technical issues, such as adjusting the model outcomes to offset past misses or presentational ones. With the presentational focus being the delivery of an internally consistent set of forecasts, a sensible profile or a logical evolution from the last set of published forecasts. There seemed to be less emphasis on bringing to bear deep sectoral expertise or a deep analysis of major macroeconomic themes that may be out of the ordinary. Senior members of MECD should drive these discussions.

Treasury does try to bring in external expertise to shape its judgment by discussing the outlook with private sector economists and liaison contacts. However, the former occurs late in the forecast round while the liaison function is still developing.

Reflecting their limited role in the modelling process very little focus seems to be devoted to assessing how financial factors could shape the outlook.

It is likely that a number of factors combine to limit the extent of sectoral and macro judgment. These would include the staff issues noted above and perhaps an institutionally cautious approach to developing and publishing non-consensus views. Senior members within MECD felt that sector analysts should have more ownership of their forecasts.

Treasury's forecasts also have to span the short-term – the next two years – and the medium to long term beyond that. The medium to long-term projections correctly assume a reversion to more normal economic conditions, including growth converging to potential and commodity prices reverting towards their underlying cost curves. These long-term assumptions are founded on rigorous internal analysis.

In spanning these time frames there is a risk that the short-term forecasts become “anchored” by the long-run assumptions and build in an inherent bias toward returning to normal conditions over the two-year forecast period. As an example, the 2005 review of forecasting concluded that it was appropriate to assume that growth in nominal GDP would return to a more normal 5-5-1/2% range over the coming forecast period. With the benefit of hindsight this was the wrong time to provide such forecasting guidance as the subsequent commodity price shock dominated actual outcomes. It is not clear whether such a rule of thumb anchored Treasury's nominal GDP forecasts over that period, resulting in large forecast errors. However, it highlights the need to strongly debate whether the factors that will drive a convergence to long-run assumptions will occur over the short-term forecast horizon. The review has no view on whether this occurs currently but it should be embedded in the forecast culture.

#### **d. Systems**

Treasury's forecasting framework is built around spreadsheets and EViews programs maintained by the sector analysts and consolidated in larger and more elaborate spreadsheets (the NAFF spreadsheets) maintained by the National Accounts team. It is worth noting that several people highlighted strains in the NAFF spreadsheets. They entail significant linkage risks and seem to have regular errors. When these occur it is necessary for the sector analysts to recheck their numbers. This is problematic in the limited time available during the forecast round. It was noted that

Treasury's IT department has said that these spreadsheets are the largest and most complex in the Department. The National Accounts team noted that moving their framework from spreadsheets onto EViews may be more stable and more efficient.

#### e. Unfinished business

The 2012 review made 11 recommendations to improve Treasury's macro and revenue forecasting and enhance the quality and transparency of Treasury's public communication. Most have been implemented but some are still a work in progress.

Each of the past three reviews highlighted Treasury's relative weakness in forecasting the GDP deflator. This was initially due to missing the decline in inflation during the early 1990's recession and more recently by the volatility in commodity prices. Both the 2005 and 2012 review concluded that more resources should be devoted to forecasting the GDP deflator and commodity prices. This has been reflected in the development of a rigorous empirical model for analysing long-run trends in Australia's terms of trade. Technical work has also been done on some domestic production deflators and a disaggregated approach to forecasting prices has been developed.

However, over the two-year forecast horizon commodity prices are assumed to remain unchanged. This reflects the considerable difficulty of accurately predicting them. Treasury's forecasts therefore remain vulnerable to large changes in commodity prices. This has been reflected in considerable overestimates of nominal GDP growth in recent years as commodity prices have fallen sharply. Overestimates of real GDP growth also contributed to forecast errors over this period. As commodities make up a much larger share of Australia's exports, this means that Treasury's GDP deflator and nominal GDP forecasts are more vulnerable to error than previously.

There is no easy solution to this issue. The current approach of assuming unchanged prices is reasonable and common practice. But it runs the risk of embedding large or persistent errors in Treasury's forecasts if commodity prices change much over time. The alternative of forecasting prices is very difficult and carries with it its own risks. An alternative would be to further expand the discussion of risks around the forecasts in the Budget papers by incorporating the views of private-sector commodity analysts into alternative Budget scenarios (see below). **On balance, there has been no improvement in Treasury's capacity to forecast the GDP deflator since the 2012 review.**

The review also recommended more use of scenario analysis around Treasury's central forecasts. Scenario analysis has been performed more regularly by Macroeconomic Group over recent years to frame internal discussion of economic issues. The Budget papers have also included a limited discussion of the impact of alternative scenarios on the Budget outcome. Within MECD's forecasting function, there has been little use of scenario analysis during forecast rounds. **This review observes that MECD's capacity to conduct rigorous scenario analysis is limited by its narrow analytical framework, iterative forecast process and systems involved.**

The 2012 review also recommended that it was important to embed a macroeconomic model (at the time the TRYM model) into the economic forecasting process as a complement to the existing forecasting framework and to facilitate the analysis of shocks to the economy. Treasury now subscribes to the AUS-M model. At the time of writing it does not form a meaningful part of the forecast round or of the Division's analysis of shocks. Some sector analysts compared their forecasts with AUS-M but these were exceptions. It was suggested that analysts have been unwilling to use of AUS-M because they do not have the required skill base. As existing staff have not used AUS-M for forecasting or scenario analysis there is no basis for judging its reliability as a forecast tool.

The report also recommended increasing Treasury's liaison function. This is happening. However, Treasury's liaison program is smaller and less intensive than the RBA's.

### 3. Possible consequences

In sum, the key features of Treasury's approach to forecasting include:

- The use of a small number of single-sector models. Though rigorous, they are by definition a narrow description of the economy;
- These are used by staff with short tenure in an environment of high turnover and, therefore, constrained transfer of institutional knowledge;
- Judgment is applied consistently but narrowly, with a focus on presentational and technical issues, rather than on thematic factors that may be driving the economy;
- By default Treasury has become unusually reliant on these single-sector models for forecasting purposes;
- Senior members of the Division have an informal and iterative role in the forecasts.

Consequences include:

- An institutional risk should the forecasting performance of the models not be audited over time and should they not be redeveloped as required;
- A framework that will bias towards trend-like, consensus outcomes;
- A high probability that structural changes or persistent shocks will not be adequately incorporated into the forecasts, either analytically or quantitatively. It must be acknowledged that this is a difficult task, not just for Treasury. Turning points will always be difficult to predict;
- A culture that does not allow enough time for individuals to gain well-rounded, macroeconomic analysis and forecasting skills, with some exceptions.

### 4. Recommendations

Past reviews have shown that Treasury produces reliable forecasts most of the time but when economic conditions are unusual the forecasts become less reliable. This is not unusual. Indeed, it should be expected. However, it is during these times that policy makers require a more accurate assessment of the path of the economy and the risks around that. It is very likely that this tendency will persist under Treasury's current forecasting regime. This is partly due to the structure of the forecasting framework and simply a reflection of the fact that it is more difficult to forecast in unusual times.

The recommendations of this review are an attempt to produce better outcomes during these periods. The recommendations focus on bringing to bear: more rigorous analysis; a greater range of inputs and views; and a strengthening of the culture of the Division to make its analysis more nimble during these times. In doing so, they will reduce the institutional risk run by Treasury as a result of its rather narrow forecasting process. They should also make MECD more efficient.

The review is conscious of the need to remain largely inside existing resource constraints.

#### **a. Broaden analytical inputs and contribution of senior staff**

Treasury should broaden the analytical inputs into its forecasting process in a number of ways.

The 2012 review recommended embedding an economy-wide model into the process. This should be done. It would provide a broader focus of discussion and improve the Division's ability to incorporate economy-wide shocks appropriately into the forecasts. A feature of Treasury's framework is that it is more limited than many other public sector forecasters. By construction it focusses on a narrow set of issues, the building blocks of the sector forecasts. This constrains the extent to which it can incorporate exogenous or atypical drivers of the economy in a coherent way. Introducing a model into the process would overcome some of these issues. It would also enhance the productivity of MECD by allowing more rigorous scenario analysis.

The model should not generate Treasury's final forecasts. It should be a means of identifying what are some of the key issues each forecast round. The Treasury subscribes to AUS-M, a TRYM-like model. Given its limited use to date it cannot be judged whether this model would be appropriate for forecasting purposes. Treasury should review its suitability for the task and also consider other alternatives.

Other analytical forecasting techniques should also be explored. These would complement the single-sector models used in the sector forecasts. These should include examining the forecasting properties of many of the partial indicators used by the sector analysts more rigorously. At present, the single-sector models drive the dynamics of the forecasts. When they miss (that is, when their residuals are large) some judgment is applied to smooth the forecasts.

A more rigorous use of potential leading indicators would tighten this judgment and also assist sector analysts in making judgments about the ongoing reliability of the current range of models. More ambitiously, a small-system VAR, similar to those used by the RBA could be developed. This could include a small number of variables to be forecast (say GDP, inflation, employment) and a small number of exogenous variables. This would provide another cross-check of the forecasts generated by the macro model and sector analysts.

In addition to these forward-looking quantitative techniques, Treasury should sharpen its analysis of current conditions in the economy. This is currently done by bringing together the analysis of the individual sector analysts. This analysis is rigorous. However, it could be formalised and quantified better through the application of nowcasting techniques. These are now commonly used by other public sector forecasters such as the Bank of England and also increasingly in the private sector. The main benefit of nowcasting is to reduce the uncertainty around the starting point of the forecasts.

As noted earlier, international developments enter Treasury's forecasts in a very narrow way, mainly via major trading partner growth. The linkages between Australia and the rest of the world are obviously more complex than this. Also the Australian economy frequently experiences themes that are consistent globally. Current examples include the weakness in corporate investment and sluggish growth in wages and prices. While it is difficult to formally quantify these common themes, they are important to understand and to incorporate into the discussion and judgment around the forecasts. To do this effectively IOU will need to be better integrated into the forecasting process and work closely with the rest of MECD in identifying global themes that may also shape Australia's outlook.

A feature of Treasury's forecasts is the limited role for financial variables to drive the cycle. This is appropriate for the projections and medium-term forecasts. But it is a constraint over the 2-year forecast horizon. Introducing an economy-wide model or some of the time series models mentioned above would go some way to resolve this issue. Financial variables are more rigorously embedded in them. That said most models fail to capture the full complexity of the role of finance in the economy. Qualitative judgment is also important. (See below).

The forecasting process could also be enhanced by greater scrutiny by a wider range of senior staff across the Group. At this stage forecasts are prepared by MECD and then presented to the Executive. It would be worthwhile drawing on the experience and expertise of senior members of MMPD or other Divisions in the preliminary discussions of the major macroeconomic themes that are likely to be relevant over the forecast horizon. This would sharpen the contribution of judgment in the forecasting process and greatly assist the less experienced staff.

## **b. Judgment, biases and culture**

Judgment needs to be applied in a more rigorous way, focusing on issues that may have a substantive impact on the forecasts rather than being weighted toward technical or presentational issues. This can be achieved in a number of ways.

More vigorous discussion of the risks around the exogenous assumptions underpinning the forecasts needs to be held at the start of the forecasting round. There is no one method for treating the exogenous variables in forecasting. Treasury's approach is common and reasonable. Forecasts by international agencies and consensus guide Treasury's forecasts of global growth, with Treasury tilting its numbers depending on its assessment of risks. Commodity prices and the exchange rate are held constant and short-term interest rates evolve with market pricing. This leaves Treasury's forecasts vulnerable to any changes in these common sources of shocks to the Australian economy.

While such a discussion would not change the central path of the forecasts it would allow a better calibration of the risks and their presentation, (see below).

One way to do this would be to more actively engage with those who had well-formed but non-consensus views. This is especially the case for commodity prices given the heightened vulnerability of Treasury's forecasts to changes in them. Typically, such views reside in the private sector not the public sector. Greater liaison between Treasury and private sector commodity price analysts would be beneficial. More generally the structure of meetings and engagement with external parties should be reorganised. External parties should be met early in the forecast round rather than toward the end of the process.

More focus should also be given to issues that may be beyond the scope of the single-sector models to capture or are atypical. In addition, questions about whether the economy will converge on the long-run projections over the two-year forecast period should be debated vigorously to prevent the short-term forecasts from becoming anchored by the projections.

Like most forecasting processes, Treasury's has a limited role for financial factors to drive the cycle. Introducing an economy-wide economic model would go some way to resolve this limitation. But, even here, the role of finance is limited. Treasury's ability to incorporate financial influences on the economic outlook would be enhanced by greater monitoring of the area. This should include examining a range of high-frequency market data that typically signal some stresses in financial markets as well as monitoring low-frequency financial developments such as the evolution and quality of private sector balance sheets and financial decisions. This type of work is already done in international agencies such as the BIS and IMF and central banks in their Financial Stability Reviews. As a starting point Treasury could simply leverage off this work and augment it with closer liaison with domestic and international financial intermediaries.

## **c. Staff**

The number of staff in the Division is adequate to fulfil its forecasting and other tasks. However, if it is decided to embed an economy-wide model more fully in the forecast process and to develop time series or leading indicator models to broaden the range of inputs in the process it will be necessary

to draw on staff members with strong econometric and macro skills or add an additional staff member with those skills.

Ideally a small team would be set up in MECD to manage the quantitative aspects of the forecasts. It would consist of a senior person with strong econometric and macro skills, working with a technically strong member of the sector analysts and perhaps a graduate.

This team would be responsible for generating the forecasts using AUS-M and also leading any scenario analysis conducted by the Division. It would also develop a broader suite of time series and leading indicator models, work with the sector analysts on their single-sector models and, on a regular basis, audit the forecasting performance of those models.

If an objective of staff development in the Division is to produce people with sound long-term macro judgment then management of the staff of MECD should be more structured. Ideally, the Division should be structured to ensure that there are a number of analysts who have worked on a range of Australian sectors before analysing and forecasting the whole economy. Staff with strong technical skills should be given the opportunity to work in the quantitative unit recommended above.

A number of people suggested that the sector analysts should take more ownership of their forecasts. One suggestion was to have each sector analyst present on their sector, including a discussion of model failures and enhancements, once a year. This would make model review and development more transparent.

#### **d. Systems**

As the NAFF spreadsheets are crucial to the process Treasury should investigate whether in fact they have become too large, complex and possibly unstable. Treasury should also explore whether the National Accounts team's suggestion of migrating the NAFF spreadsheets to EViews is feasible.

#### **e. Presentational material**

If the recommendations about models, staff and systems are followed then MECD's capacity to run a range of economic scenarios would be significantly enhanced.

The Budget papers could also be enhanced by extending the discussion of the risks around the outlook. Budget Statement 7 currently provides some sensitivity analysis of Budget outcomes to a range of economic parameters. This is useful. An addition that could be made would be to examine how the Budget outcomes would vary if Consensus forecasts were achieved rather than Treasury's. An advantage of doing this would be to illustrate how the Budget might look if the views of external parties were applied rather than Treasury's. In conducting this analysis, exploring how the Budget would look if the extremes of the Consensus range were achieved would also be useful. For example, how would the Budget look if either the high or low Consensus estimate of nominal GDP growth were met?

Alternatively, forecasts based on the range of Consensus commodity price forecasts could also be presented.

## **5. Conclusion**

If the recommendations of this review are followed a Treasury forecasting round would proceed as follows:



- Liaison with businesses, financial institutions, other forecasters, including commodity price forecasters would be held at the start of the forecast round;
- A detailed qualitative discussion of some of the major medium-term themes working through the domestic and global economies would be held. A conclusion about how these may lead to persistent or atypical trends in the economy would be drawn as would an assessment of whether Treasury's quantitative tools could capture them. This should be led by senior members of MECD with contributions from other relevant Divisions;
- The assumed path of the exogenous variables would be set. A detailed discussion of the risks around those variables would be held at this stage, forming the basis for possible scenario analysis;
- Forecasts would be generated by an economy-wide model using the assumed path of the exogenous variables, including the rest of the world, commodity prices and the exchange rate. Note that an alternative path, endogenising the exchange rate and interest rates via a policy reaction function could also be run at this stage. This would show how the outlook would look as it might in a real-world scenario;
- Sector analysts would then present their forecasts, including those generated by their single-sector models, leading indicator models and sector expertise. These would be reviewed against the results of the full model. Discussion should focus on whether the model or the sector-specific work is capturing the main themes;
- Based on the qualitative review of: major themes; the model-based forecasts; and the sector forecasts a transparent assessment of whether and how judgment should be applied to the forecasts should be held. This should be led by senior members of MECD. Key considerations would be whether the models or sector work were broad enough to capture other background influences at work in the economy. If they are not, then a discussion of how they may be adjusted would be necessary;
- A set of forecasts that incorporated the full model, sector inputs, qualitative and quantitative judgment would be produced;
- Presentation of forecasts at JIEFG.

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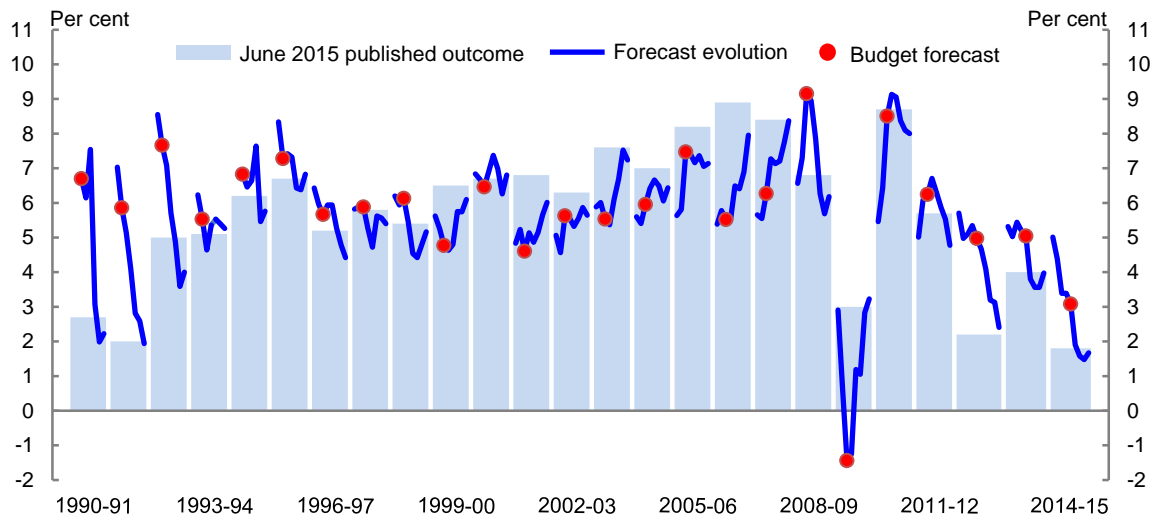
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## Appendix 1 – Aspects of forecast performance

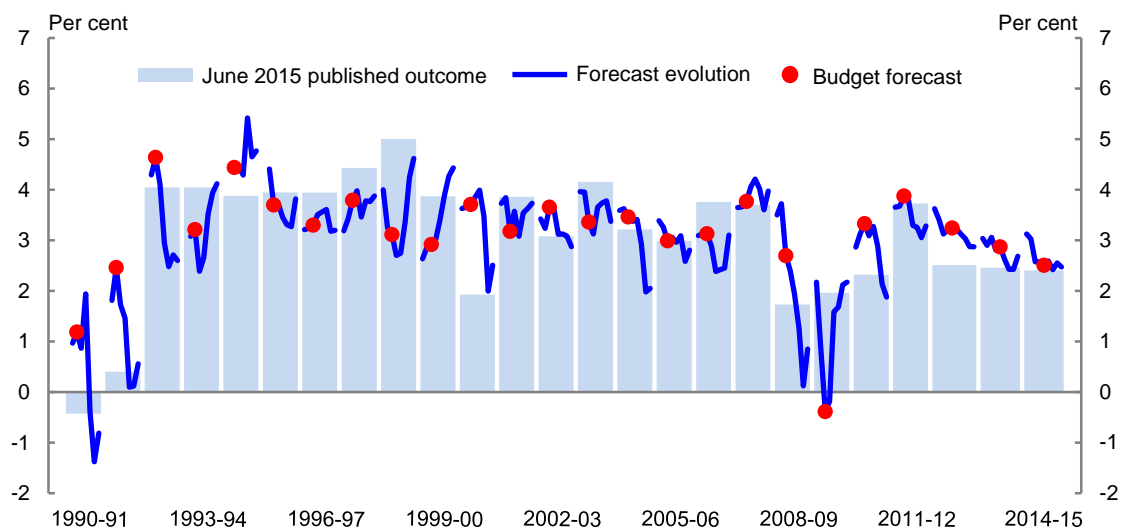
Figure 1: Evolution of Nominal GDP Forecasts



Note: Budget forecast is for the budget year (for example, the 2014-15 Budget forecast is for 2014-15).

Budget forecasts have over-predicted nominal GDP growth in four of the past five years. This was due to both misses on real GDP growth and the GDP deflator.

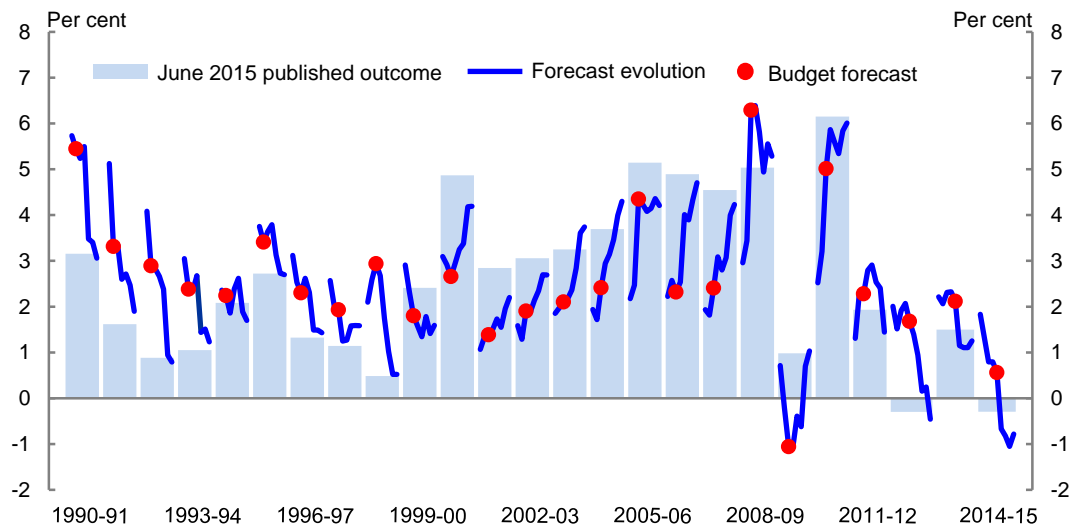
Figure 2: Evolution of Real GDP Forecasts



Note: Budget forecast is for the budget year (for example, the 2014-15 Budget forecast is for 2014-15).

There has been a tendency for the Budget to over-predict real GDP growth in the past few years, with Budget forecasts for growth in real GDP exceeding the actual outcome in each of the past five years. The mean error was 0.5 per cent in that time

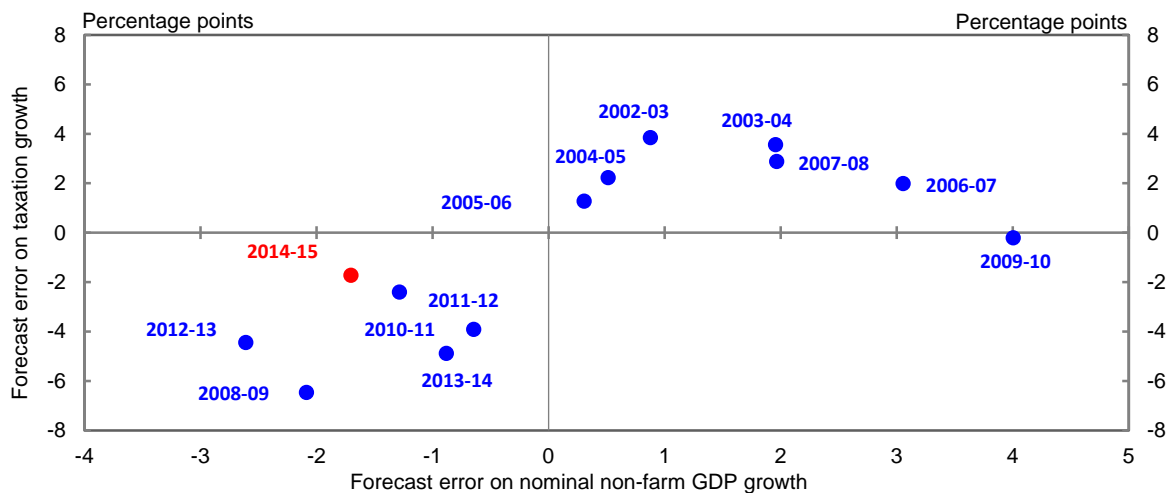
Figure 3: Evolution of GDP Deflator



Note: Budget forecast is for the budget year (for example, the 2014-15 Budget forecast is for 2014-15).

The GDP deflator has grown more slowly than predicted in four of the past five years. The mean error in that time was 0.6 per cent, slightly higher than that of real GDP growth.

Figure 4: Budget forecast error for nominal GDP growth and tax revenues



Note: Chart is as at the 2015-16 Budget. This chart plots the Budget forecast errors on nominal non-farm GDP growth and on tax receipts growth (excluding capital gains tax) from 2002-03 to 2014-15. Forecast error for 2014-15 is an estimate.

The under-prediction of tax revenues has been broadly consistent with the over-prediction of nominal GDP growth over this period.

## Appendix 2 – Public Sector Forecasting processes<sup>9</sup>

### CANADA

#### Bank of Canada

- The main model for macroeconomic projections is ToTEM (Terms-of-Trade Economic Model). This is a large-scale multi-sector DSGE model that reflects the consensus view of key Canadian macroeconomic linkages.
- ToTEM is complemented by LENS (Large Empirical and Semi-structural model), which is a large-scale macroeconomic general equilibrium model. It is based on a system of estimated reduced-form equations that describe the interactions among key macroeconomic variables.
- Regional offices regularly visit firms, associations, and provincial governments to assess economic developments.

#### Finance Canada

- The Canadian Department of Finance tracks, evaluates and forecasts Canada's economic performance. It regularly surveys private sector economists on their views on the economic outlook. The average of private sector economic forecasts has been used as the basis for fiscal planning since 1994.

### EUROPEAN MONETARY UNION

#### European Central Bank

- The economic forecasts are a combination of national and euro-wide perspectives. The forecasts for each economy are aggregated and consistency at the euro area level is then assessed.
- The ECB does not provide details on how the forecasts for each economy are constructed, except to say that each country is different.
- The ECB has developed a euro area DSGE model called the New Area-Wide Model. Its design has been guided by two main considerations: to provide a comprehensive set of core projection variables; and to allow conditioning on monetary, fiscal and external developments which are an important element of the projections.

### INTERNATIONAL INSTITUTIONS

#### Organisation for Economic Cooperation and Development

- Most countries in the OECD are modelled separately. Near-term forecasts are based on a suite of statistical models using high frequency indicators. The rest of the world is modelled through regional blocks.
- The core of each of these country models consists of a production function determining output in the long term; a wage-price block; a description of the government sector;

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<sup>9</sup> The material in this appendix was prepared by Angelia Grant.

consumption, personal income and wealth; international trade; and financial markets. An error-correction structure is used in the estimated equations.

- The OECD also uses the NiGEM model of the British National Institute of Economic and Social Research, which is structured around national accounting identities. Linkages in NiGEM take place through trade and competitiveness, interacting with financial markets and international stocks of assets.

### **International Monetary Fund**

- The IMF's World Economic Outlook presents an analysis of global economic developments in the near and medium term, with projections for up to four years into the future. These forecasts are compiled using a 'bottoms-up' approach. That is, country teams generate projections for individual countries. These are then aggregated, and a series of iterations are undertaken where the aggregates feed back into individual country forecasts. Because forecasts are made by the individual country teams, the methodology can vary from country to country and series to series depending on many factors.
- The IMF also publishes the Fiscal Monitor, which analyses the latest public finance developments and provides medium-term fiscal projections. These fiscal projections for individual countries are prepared by IMF desk economists, and assume that announced policies will be implemented.

## **NEW ZEALAND**

### **New Zealand Treasury**

- NZTM (New Zealand Treasury Model) is an integral part of the forecasting process. This model is a macroeconomic general equilibrium model, initially based on the Murphy Model of Australia, but adjusted to allow for differences in data and institutional structures.
- A number of indicator models, which are typically single-equation models, are used for short-term forecasts. These models are designed to use available data as well as sector analysts' judgement to formulate short-term forecasts. These forecasts are then put into NZTM as if they are historical data. Judgement is used to smooth the adjustment between short-run forecasts and the model's forecast of the dynamic path.
- There is an internal panel of senior Treasury staff that review the forecasts and a panel of external experts which include academic scholars and ex-public and private sector forecasters. There is also a business liaison program. The Treasury has commissioned external reviews of its forecasting performance and carries out regular monitoring of its forecasting performance.

### **Reserve Bank of New Zealand**

- NZSIM is the central structural forecasting model used by the RBNZ. It is a DSGE model based on optimising economic agents who are subject to constraints and market frictions.
- Statistical models are used as a cross-check for the central forecasts and provide a basis for incorporating judgement into the final published forecasts. The suite of statistical models contains a broad range of models. For example, the smallest models in the suite use a single indicator to forecast the variable of interest, while the largest model contains around 400 series. They include factor models, bivariate indicator models, VARs and BVARs.
- Economists at the Reserve Bank also regularly visit businesses.

## UNITED KINGDOM

### Bank of England

- The central organising model is COMPASS. This replaced the previous central organising model, BEQM, which had been in use since 2003. An enhanced and updated suite of models was introduced in 2011 alongside COMPASS.
- COMPASS (Central Organising Model for Projection Analysis & Scenario Simulation) is an open economy New Keynesian DSGE model. The purpose of the central model is to provide an organising framework to help frame the discussions of the key forces shaping the current state of the economy and how they might affect the forecast. The surrounding suite of models and tools provide ways to cross-check, interrogate and adjust the forecast.
- The suite of models used alongside COMPASS include: (1) various extensions of COMPASS to incorporate economic shocks and channels missing from the baseline model (e.g. energy and financial sector); (2) models which expand the scope of the forecast (e.g. the post transformation model and the balance sheet model); and (3) models which generate alternative forecasts.
- In the third category, there are around 15 models in this statistical suite; they are normally used to produce judgement-free forecasts which act as a cross-check on the forecasts. The majority use simple econometric relationships, such as error correction models.

### Office for Budget Responsibility

- The Office for Budget Responsibility was created in 2010 to provide independent and authoritative analysis of the UK's public finances. It produces five-year forecasts for the economy and public finances twice a year. It also assesses the long-term sustainability of public finances.
- The main tool for producing the economic forecasts is a large-scale macroeconomic model, but it also uses various auxiliary analytical tools, examines recent data and assesses alternative economic forecasts.
- The large-scale macroeconomic model was originally designed and developed by the Treasury, but is now jointly maintained and developed by the Treasury and the OBR. The model is principally a model of the economic activity described and recorded in the national accounts.
- There is wide consultation undertaken on the forecasts. This includes consultation with representatives from the Bank of England, the National Institute of Economic and Social Research (NIESR), the European Commission (EC), the OECD and the IMF as well as government economists and other analysts. The OBR has an advisory panel of economic and fiscal experts to advise on their work program and analytical methods.

### UK Treasury

- Since 2010, the responsibility for producing all official economic and fiscal projections has been transferred from the UK Treasury to the independent Office for Budget Responsibility.
- The UK Treasury publishes monthly reports on private sector forecasts.

## UNITED STATES

### Administration (Council of Economic Advisers, Department of Treasury, Office of Management and Budget)

- The Administration's forecasts are prepared using a macroeconomic model developed by the private sector, calibrated by the Council of Economic Advisers and reviewed by Treasury and the Office of Management and Budget. They are published semi-annually in the President's Budget and in the Mid-Session Review.

### Board of Governors of the Federal Reserve System

- The Federal Reserve Board produces projections of various economic indicators for the economy of the US before each meeting of the Federal Open Market Committee. These projections are often called Greenbook forecasts.
- The FRB uses two distinct structural models to produce forecasts. The first is the FRB/US model, which is a large-scale estimated general equilibrium model of the US economy. FRB/US contains all major components of the product and income sides of the US national accounts.
- The second is a DSGE model called Estimated Dynamic Optimization-based (EDO) Model, which is a medium-scale New Keynesian DSGE model of the US economy that has been used at the FRB since 2006. Compared with other DSGE models, EDO includes greater disaggregation of domestic spending, notably housing and consumer durables. Another distinctive feature is the introduction of two production sectors, for fast- and slower-growing industries.

### Congressional Budget Office

- The CBO produces independent analysis of budgetary and economic issues to support the Congressional budget process. It provides budget analysis and cost estimates for proposed legislation.
- The CBO publishes projections of budgetary and economic outcomes that are based on the assumption that current laws regarding federal spending and revenues will generally remain in place. Those projections, which are known as baseline projections, cover the 10-year period used in the Congressional budget process.
- It also provides budget projections beyond the standard 10-year budget window. Those projections, which focus primarily on the coming 25 years, show the effects of demographic trends, economic developments, and rising health care costs on federal spending, revenues, and deficits.
- The CBO draws information for its economic forecasts from ongoing analysis of daily economic events and data, the major commercial forecasting services, consultation with economists both within and outside the federal government, and the advice of the experts on its Panel of Economic Advisers.