SECTION 2: APPROPRIATENESS OF FORECASTING METHODOLOGY

2.1: International Forecasting Practices

Summary

A survey of comparable macroeconomic and revenue forecasting agencies reveals:

- there is no commonly-accepted standard practice in the production of macroeconomic and revenue forecasts;
- most agencies draw upon a combination of modelling techniques, consumer and business surveys, business liaison, expert opinion, and judgement to produce macroeconomic and revenue forecasts; and
- the differences across agencies lie in the modelling techniques, particularly, the type and role of the models employed in the forecasting process, and the weight given to each of these inputs.

Macroeconomic Forecasting Practices

A high-level survey of macroeconomic forecasting practices indicates that most official agencies draw upon a combination of modelling techniques, and a range of other information, including judgement, to produce macroeconomic forecasts. The benefits of this multi-dimensional approach to macroeconomic forecasting have recently been documented by the Office for Budget Responsibility (OBR) (2011)[1] and the Reserve Bank of Australia (RBA) (2010).[2]

It is common for forecasting agencies to maintain two forecasting systems (Pagan and Robertson, 2002).[3]

- The first focuses on the short-term forecasting horizon (up to, perhaps, six months) and uses indicator or spread sheet models and relies heavily upon judgement supplied by in-depth analysis of major sectors of the economy undertaken by sector specialists.
- The second focuses upon longer time horizons (greater than six months) and modelling the economy as a 'system' with the core forecasting technology typically either:
  - a relatively small economy-wide structural macro-econometric model; or
  - single structural econometric equations, with national account identities preserved within a spread sheet system, and consistency between the elements of the forecasts achieved by iteration between sector specialists.

The choice of core forecasting technology depends on the extent to which the forecasting agency has the need to undertake policy evaluation. In setting monetary policy, central banks will necessarily consider the impact of different policy stances against the central case forecasts. In contrast, fiscal policy is concerned with improving resource allocation, typically within a medium-term fiscal framework. In ordinary economic circumstances, discretionary fiscal policy is not concerned with stabilising the economic cycle. This distinction may account for the greater tendency for central banks to invest the significant resources necessary to develop and maintain state-of-the-art modelling

[1] OBR, 2011, 'Forecasting the Economy', *Briefing Paper No. 3*.
[2] Lowe, P. 2010, 'Forecasting in an Uncertain World', *Address to Australian Business Economists Annual Forecasting Conference Dinner*, Sydney, 8 December.
[3] Pagan, A. and Robertson, J. 2002, 'Forecasting for Policy', *A Companion to Economic Forecasting* edited by Michael P Clements and David F. Hendry.

capability that focuses on cyclical, rather than medium to longer term, economic fluctuations, that is, in comparison with Treasury and Finance Departments.

Modelling techniques

One distinction between models is the trade-off between their conceptual coherence with economic theory and their empirical coherence with economic data.[4] Economy-wide structural macro-econometric models draw heavily on economic theory to determine their specification, which facilitates their use for policy evaluation. Fukac and Pagan (2009)[5] distinguish between four generations of structural macro-econometric models, with dynamic stochastic general equilibrium models at the cutting edge of modelling practice and the greatest coherence with economic theory. In contrast, vector autoregression (VAR) models are economy-wide systems of equations that model the interrelationships between economic variables while imposing minimal assumptions about the underlying structure of the economy. They aim to provide good statistical representations of the interactions between variables over the available sample period. They are more widely used in near-term forecasting.

Located between these ends of the spectrum are structural macro-econometric models that use economic theory to tie down the long run (or steady state) path of the modelled economy, but allow the data to dictate the short-run dynamic adjustment path of the economy to the long run steady state. These models are the second and third generation of models according to the Fukac and Pagan taxonomy and can be used as the core forecasting technology, as well as to evaluate the impact of macroeconomic policy

Economy-wide structural macro-econometric models that play a central role in macroeconomic forecasting include the Bank of England Quarterly Model, the HM Treasury and UK Office of Budget Responsibility Macroeconomic model, the US Federal Reserve FRB/US model, and the New Zealand Treasury Model. These models require considerable resources in development and maintenance.

In addition to the core forecasting technology, forecasting agencies may also maintain auxiliary models, as inputs into the forecasting and policy advising process. These models may draw upon information sources that have been excluded from the core forecasting model. They can also be used to analyse issues that would be difficult to undertake within the core forecasting technology, for example, the economic impact of one-off events, such as weather-related phenomena.

Additional inputs into the forecasting process

While useful, pure forecasts generated by econometric models are generally supplemented by in depth analysis of major sectors of the economy, drawing upon a range of other information, to produce a final macroeconomic forecast. The reasons for this have been well-articulated by the OBR (2011),[6] who note that:

> ‘Producing forecasts has never been solely a matter of cranking the handle of an econometric model. Models are an imperfect representation of the world. They are necessary simplifications of reality. Forecasters are typically confronted with at least some key behavioural equations that do not explain the recent past well. The forecaster has first to try to identify the reasons for this, and then decide whether the unexplained element of behaviour — the equation ‘residual’ or ‘error’ — will stay the same, get bigger or get smaller.’

[4] Pagan, A. 2003, *Report on Modelling and Forecasting at the Bank of England*, January.
[5] Fukac, M. and Pagan, A. 2009, ‘Structural Macro-Econometric Modelling in a Policy Environment’, *Reserve Bank of New Zealand Discussion Paper*, 2009/16, December.
[6] OBR, 2011, op cit.

Five additional elements inform the macroeconomic forecasts of most agencies. The first three of these are particularly relevant for near-term forecasting horizons.

First are consumer and business surveys, which have been shown to be useful in identifying the likely direction of household spending, and business investment and hiring decisions, in the first few quarters of a forecast period. Surveys contain questions that are forward looking and are generally published in a timelier manner than official data.

Second is business liaison. Maintaining a regular dialogue with the business community is seen as extremely valuable for identifying emerging trends in the economy. Many agencies have established dedicated resources, usually involving staff based away from the head office in major cities, who regularly engage with the business community through one-on-one discussions. Information gained from these engagements is used to inform the final macroeconomic forecasts. Some agencies regularly publish their findings. Examples include the US Federal Reserve's Beige Book, the Bank of England's Agency Report, and the Bank of Canada's Business Outlook Survey. The importance of business liaison was recently highlighted by the RBA:

> 'Over recent years, a couple of examples stand out where this liaison has been particularly important. One was in helping us understand the implications of the much tighter credit conditions in 2008 and 2009. And the other has been helping us understand the scale and the timing of the pick-up in investment in the resources sector. In both cases, our liaison provided us with valuable information that was not available elsewhere and had a significant role in shaping our forecasts.'

Third, is partial economic data and leading indicators, such as the monthly building approval data in Australia, which can help to inform near-term forecasts of construction activity.

Fourth is expert opinion, such as advice from specialist agencies, for example the Australian Treasury draws upon expert advice from its Retirement Income Modelling unit to project the growth in working age population and expert advice from the Bureau of Resources and Energy Economics to inform the forecasts of non-rural commodities.

The fifth and least tangible input to macroeconomic forecasts is judgement, informed by experience and corporate memory.[7] The OBR cite work which suggests that the use of judgement generally improves the accuracy of the forecasts.[8] Indeed, all documentation by agencies on their approach to forecasting refers to the importance of judgement in shaping their forecasts.

Towards the end of the process, macroeconomic forecasts are typically subject to internal review by senior management. Some agencies including the New Zealand Treasury, the Congressional Budget Office (CBO), and the Canadian Ministry of Finance also subject their forecasts to peer review by an external panel of experts.

In short, most agencies draw upon a combination of modelling techniques, surveys, business liaison, expert opinion and judgement to produce macroeconomic forecasts. The differences across agencies lie in the modelling techniques and the weight given to each of the inputs.

Taxation Revenue Forecasting Practices

Countries tend to release only general and limited information on their revenue forecasting methodology and individual head of revenue models. This makes international comparisons more difficult than for macroeconomic forecasting.

[7] Onkal-Antay, D. Thomson, M. and Pollock, A, 2002, 'Judgemental Forecasting', *A Companion to Economic Forecasting* edited by Michael P Clements and David F. Hendry.
[8] OBR, 2011, op. cit.

Modelling techniques

Based on available information, most countries forecast taxation revenue using a 'bottom-up' approach, where individual heads of revenue are forecast and then aggregated to produce a total revenue forecast. This is the general approach taken in the United States, Canada and New Zealand.[9] Some regions forecast total taxation revenue and then disaggregate this figure into heads of revenue, for example Scotland[10], but this tends to be due to data limitations which constrain the use of a bottom-up approach.

In terms of methodology, the main technologies used in revenue forecasting are mapping models, single econometric equations and micro-simulation models. The range of forecasting technologies employed can vary from one head of revenue to another, as noted by the United Kingdom's OBR (2011):[11]

> 'forecasting models are specific to each individual tax and can take a variety of different forms such as econometric equations, micro-simulation models based on samples of individual tax records, projections in line with selected indicators [mapping] or just simply by judgement.'

Mapping models appear to be a widely used technology for countries where revenue forecasts are prepared in conjunction with macroeconomic forecasts. These models are largely accounting frameworks designed to account for the conceptual differences between a taxable base, which reflects taxation law principles, and an economic base, which reflects national accounting principles (for example the difference between economic and taxable income for companies).[12] Econometric techniques are not usually required as the elasticity of revenue to its taxable base is one for heads of revenue with a flat tax rate, as is the case for many taxes. The macroeconomic forecasts are used to grow the economic base, ensuring consistency between the macroeconomic and revenue outlooks. The New Zealand Treasury relies heavily on mapping technology to produce revenue forecasts.[13]

Mapping technologies tend to be supplemented by the use of econometric models to estimate tax revenue elasticities, for example, for progressive taxes, and in some instances by micro-simulation. Micro-simulation models operate at the level of the individual behavioural entity, such as a person, family, or firm. Such models simulate large representative populations of these low-level entities in order to draw conclusions that apply to higher levels of aggregation such as an entire country. This type of model is distinct from aggregate models whose explanatory variables already represent collective properties. Micro-simulation has been applied in the United States and United Kingdom to forecast personal income tax revenue, using large data sets to develop detailed micro-simulations.

Data limitations are a constraint on revenue forecasting methodology. In particular, there are typically long lags in receiving income tax return data, and items in individual tax returns tend to be aggregated, particularly for corporate tax payers, with the effect of concealing drivers of assessable income for revenue forecasting purposes.

Additional inputs into the forecasting process

As with macroeconomic forecasting, forecasts generated by revenue head models are supplemented by other information to produce a final taxation revenue forecast. The first of these is business liaison with companies, often undertaken by the revenue collection agency. The second, and least tangible input to revenue forecasts, is judgement, informed by experience.

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[9] O'Neil, T. *Review of Canadian Federal Fiscal Forecasting: Processes and Systems,* pg 40.
[10] *Scottish Tax Forecasts,* March, 2012.
[11] OBR, *Forecast Evaluation Report,* 2011, pg 32.
[12] NZ Treasury, *Treasury's Forecasting Performance 2011 Report,* pg 2.
[13] NZ Treasury, 'An Analysis of Tax Revenue Forecasting Errors', *Working Paper,* 07/02, pg 3.

2.2: Treasury's Approach to Macroeconomic Forecasting

Summary

- Treasury's forecasting approach draws upon the full range of modelling techniques and information used by comparable official agencies overseas, including structural macro econometric models and equations; spread sheet analysis and accounting frameworks; supplemented by survey data, business liaison, expert opinion and judgement.

- Broadly speaking, GDP forecasts are built up from forecasts of the components of the expenditure measure of GDP. Single structural econometric equations are the principal technical input to Treasury's macroeconomic forecasting approach, providing an empirical framework for forecasting key variables. National account identities are preserved within a spread sheet system (the National Accounts Forecasting Framework or NAFF), and consistency between the elements of the forecasts is achieved by iteration between sector specialists.

- Treasury's structural macro econometric model (TRYM) is effectively a one-sector, small-open-economy, neoclassical growth model. TRYM is currently under redevelopment, and upon completion will be used to produce macroeconomic forecasts and sensitivity analysis as an input into the NAFF-derived forecast. Treasury has taken the view that the substantial costs of developing and maintaining the latest generation of macroeconomic models could not be justified, in particular in terms of improved forecast accuracy.

- Business liaison information is an important input into the development of the forecasts. The information is used to inform judgement of the short-term forecasts and to identify key emerging trends in the economy. The program has been refocussed to target critical sectors on an ongoing basis, as well as sector-specific issues that arise in a particular forecast round.

- Macroeconomic forecasts are subject to internal review, ahead of formal peer review by other government agencies at the Joint Economic Forecasting Group (JEFG) meeting, where the forecasts are discussed with representatives from the RBA, Australian Government central agencies and the Australian Bureau of Statistics (ABS). Treasury also maintains an ongoing dialogue on the macroeconomic outlook with private sector forecasters.

- Treasury's forecasting methodologies operate in an environment of continuous internal evaluation and development. In recent years, Treasury has hired an in-house technical specialist to quality assure the rigour of its modelling techniques, and to ensure that they are at the cutting edge of forecasting practice, within the overall modelling strategy adopted by Treasury.

Context

Treasury is the principal economic advisory agency of the Australian Government. As part of this role, Treasury provides expert advice and analysis of domestic and international economic developments. The Domestic Economy Division (DED) is responsible for preparing the Australian Government's macroeconomic forecasts and briefing the Government on the current state of, and the outlook for, the domestic economy. DED has around 30 staff.

Treasury generally has two major forecasting rounds in the year. One is used as the basis for the Australian Government's forecasts published in the budget each May. Another forms the basis for the revised forecasts published in the *Mid-Year Economic and Fiscal Outlook* (MYEFO) in October-January. Two other rounds are also held, around June and December. As they come soon after the intensive forecasting for the budget and MYEFO respectively, these rounds tend to be less formal. Treasury also prepares an extensive commentary and analysis of economic developments to accompany the 'official forecasts, released in the Budget and MYEFO.

The range of Treasury's macroeconomic forecasting responsibilities reflects its role in the process of preparing budget estimates of taxation revenue and expenditure. Treasury is required to produce disaggregated nominal GDP forecasts to underpin taxation revenue estimates and labour market and CPI forecasts to underpin expenditure estimates. Forecasts are usually generated for the remainder of the current fiscal year, the budget year and the subsequent year, with projections prepared for the subsequent two years. Forecasts take into account cyclical variation in economic activity, whereas projections are based on long-term average growth rates and technical assumptions (for example, CPI growth is assumed to be 2½ per cent in the projection years, in line with the mid-point of the inflation target band).

The International Economy Division prepares the economic outlook for 19 countries (largely forecasts of GDP growth). These countries cover 77 per cent of global GDP on a PPP basis, and account for around 90 per cent of Australia**'**s merchandise trade exports. For a few of the country forecasts, specifically the United States and China, a bottom-up framework examining each of the national accounts components is used to derive GDP forecasts. For all other countries, forecasts are developed at the aggregate level. The forecasts are compiled by looking at the latest economic data, the policy and external environment and the associated balance of risks, and applying judgment. These forecasts are strongly influenced by other reputable and timely forecasts, notably Consensus Economics' forecasts and the IMF World Economic Outlook.

Forecasting approach and process

Treasury's forecasting framework (the NAFF) is a large spread sheet system structured according to the methodological framework used by the ABS in producing national accounts' statistics. The system provides a comprehensive, detailed and consistent set of forecasts of the components of demand and output, the external accounts, the labour market, prices and wages. This framework has been used for many years.

Treasury's forecasting approach is structured around sectoral teams and is overseen by a central coordinating unit (the NAFF unit), containing around five staff. This unit manages the NAFF, oversees the forecasting process, ensures the quality and consistency of the sectoral team forecasts and produces forecasts of the economic series that underpin the Australian Government Budget. The NAFF unit is staffed by analysts with experience in one or more sectoral units.

The NAFF unit is also accountable for the technical assumptions that underpin Treasury's macroeconomic forecasts (for example, there are technical assumptions for interest rates, exchange rates and oil prices). These assumptions are reset at the start of each forecasting round. The usual assumption is that exchange rates and oil prices will remain around recent average levels, and that interest rates will evolve in line with market expectations. These assumptions are not always applied mechanically — for example, if the path for interest rates implied by market yields is diverging from the forecasts made by market economists, then weight may be given to both sources of information in arriving at a technical assumption. The assumptions are revisited throughout the forecasting round if there are significant movements in any of these variables.

Once the quarterly National Accounts have been released, sectoral teams produce forecasts for the components of the expenditure measure of GDP — that is, for consumption, private investment, government spending, exports and imports. These forecasts are aggregated in the NAFF to provide an estimate of GDP. It is also necessary to produce forecasts of the components of the income measure of GDP — such as compensation of employees and company gross operating surplus — in order to forecast taxation revenue. The NAFF unit has the main responsibility for generating these income forecasts. They are derived by decomposing the estimate of GDP (constructed from the expenditure forecasts), drawing upon the outlook for series, such as employment and wages. Interest and dividend income forecasts are also produced by the NAFF unit, which are used to forecast taxation revenue.

Forecasts produced by sectoral teams and the NAFF unit are prepared using a mix of:

- single structural econometric equations;
- partial and leading indicator data (for example, retail sales for private consumption and building approvals for dwelling investment);
- business surveys (for example, the ABS survey of capital expenditure intentions),
- business liaison information,
- information on general government expenditure received from Treasury's budget division, the Department of Finance and Deregulation (Finance) and State Treasuries; and
- information from specialist agencies such as the Bureau of Resources and Energy Economics (BREE) (on the outlook for non-rural commodities) and the Australian Bureau of Agricultural and Resource Economics and Sciences (on the outlook for rural commodities).

The weight placed on each of these inputs is informed by economic theory, evolving economic trends, liaison information and forecasting experience. These factors all inform the judgement applied to pure model-driven forecasts. The analysts discuss their forecasts with their colleagues and management before presenting them to a meeting of all economists within the DED, where they are subjected to rigorous review.

An iterative process is used to ensure consistency between the various elements of the forecasts (for example, employment is an important influence on consumption and hence GDP, but GDP also strongly influences employment). The individual sector forecasts are currently linked together using the NAFF, rather than in an econometric model, although Treasury's TRYM macroeconomic model has been used as a consistency check. The model has not been used in this capacity for the past two years due to its redevelopment which is detailed later in this section.

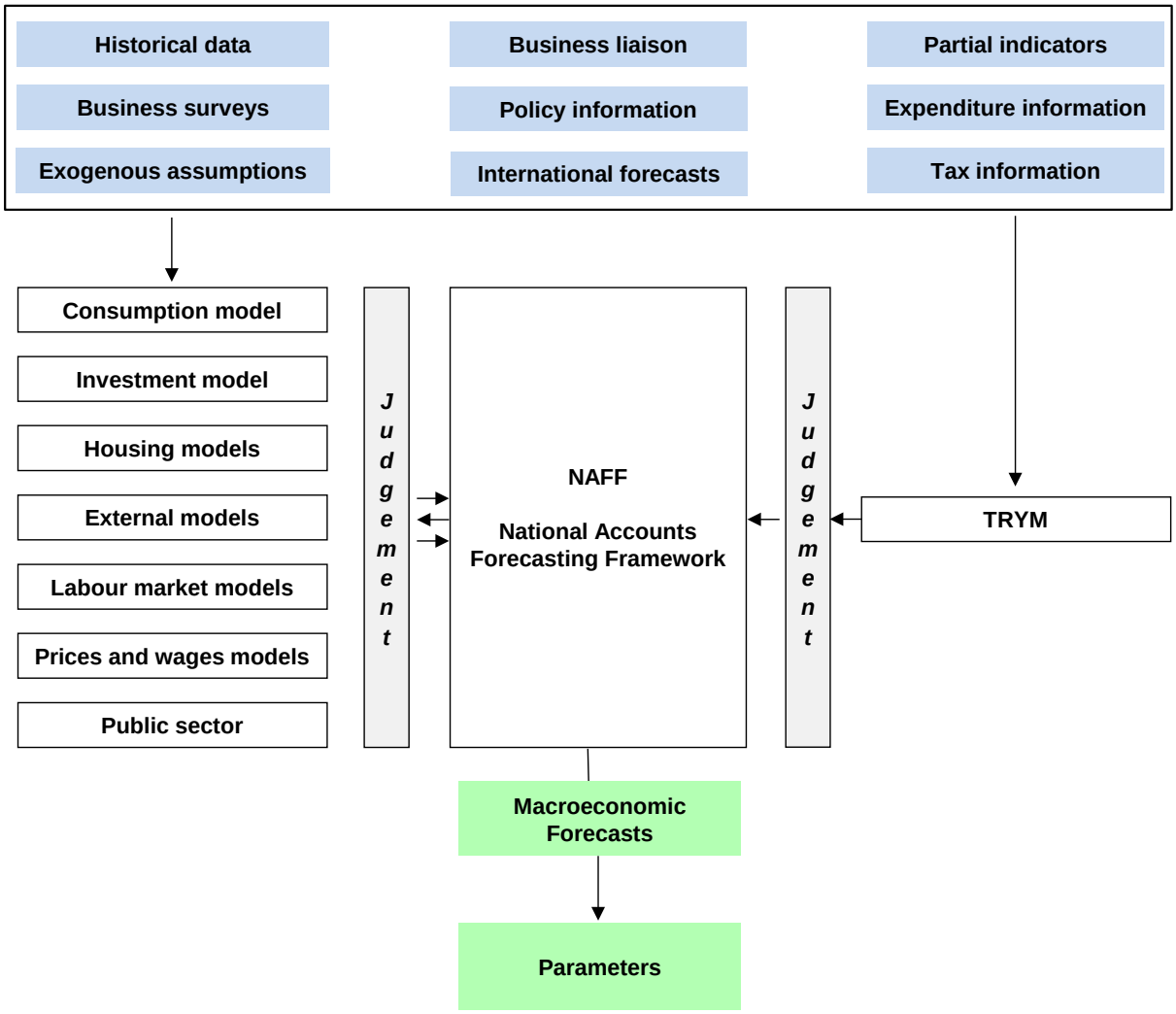
Treasury's macroeconomic forecasts are informed by discussions held at three formal committee meetings during each forecasting round: in particular;

- the international committee meeting to discuss the global outlook (comprising Treasury and the RBA);
- the public committee meeting to discuss the general government forecasts (comprising Treasury, the RBA, Finance and the ABS); and
- the balance of payments meeting to discuss the export forecasts, predominantly the outlook for non-rural commodity exports (comprising Treasury, the RBA, the ABS and BREE).

An internal quality test of the forecasts follows by presenting them to senior management within Treasury. They are then subject to formal peer assessment at the Joint Economic Forecasting Group (JEFG) meeting, which meets three times a year (but not during the June round), where the forecasts are discussed with representatives from the RBA, the Department of the Prime Minister and Cabinet, Finance and the ABS. Treasury also maintains an ongoing dialogue on the macroeconomic outlook with private sector forecasters, particularly those employed in financial markets.

A stylised schematic of the macroeconomic forecasting framework is provided in Figure 2.1, below.

Figure 2.1: Macroeconomic Forecasting Framework



Recent improvements to macroeconomic forecasting methodology

Treasury is continuously looking to improve forecasting methodology and processes to enhance the quality of its macroeconomic forecasts, the efficiency with which they are produced, and to incorporate the latest advances in forecasting technologies. In the current constrained budget environment this approach has even greater relevance. For the purposes of this review, it is important to highlight the following areas of recent focus.

Technical Adviser

Treasury established a dedicated technical advising role in DED in mid-2009. The Technical Adviser is in effect DED's Chief Knowledge Officer, and is responsible for administering knowledge management practices in the division, which includes:

- developing, an overall framework that guides, and actively promotes, macroeconomic technical skills development and training within, and beyond, DED;
- overseeing the documentation of forecasting methodology; and
- facilitating collaboration, coordination and communication within, and beyond, DED.

The Technical Adviser is an SES Band 1 with a PhD in economics, a research track-record (including publications in top general and field journals), post-graduate teaching experience, extensive peer-review experience, and over 10 years professional experience in a macroeconomic policy advising/forecasting role.

The knowledge management framework developed by the Technical Adviser is purpose-built to deliver effective development, dissemination and documentation of macroeconomic knowledge. Most elements have been in place for two years. This framework has allowed DED to move its training and econometrics and modelling to leading edge practices, which have been incorporated into producing the macroeconomic forecasts.

Attachment B provides more information on the role of the technical adviser.

Single-equation econometric models

As indicated above, single-equation econometric models are the principal input to Treasury's macroeconomic forecasting approach, providing an empirical framework for forecasting key variables. With assistance from the Technical Adviser, DED has been through a process over the past two years of refreshing, testing and documenting the suite of models used to produce macroeconomic forecasts. This has led to tangible improvements in the modelling of household consumption, new dwelling investment, elaborately transformed manufactured exports, services exports, endogenous imports and employment, wages and the CPI.

Treasury has also developed a coincident indicator which combines around 20 different economic data series to provide a timely summary measure of domestic economic activity. The coincident indicator is used as an input into the preparation of the near-term forecasts.

Business Liaison

Treasury's Business Liaison Program has maintained contact with organisations across Australia for over a decade and is an integral part of the forecasting process. Companies from major industry sectors participate in the program, ranging in size from large multinationals to smaller localised firms. As part of the JEFG process, Treasury also consults with the RBA and BREE on the key insights from their liaison programs, given the RBA runs a much larger program than Treasury, and the BREE's program is more targeted towards mining and energy sector companies.

The information collected from liaison is used to inform analyst judgement of their near-term forecasts and to test and identify key emerging trends in the economy.

There are two distinct purposes of the Treasury program. The first, and most substantive part of the program, is to develop a detailed understanding of the economic conditions being faced by business and their likely response to evolving economic conditions. The second is to gain information as a specific input into the macroeconomic forecasts, including for capital expenditure and export volumes.

Liaison rounds are conducted each quarter, approximately two weeks before the start of each forecasting round, with major rounds held in February and August, prior to the preparation of forecasts for the Budget and the MYEFO. The program is managed within DED with between 120 and 150 face-to-face interviews conducted each year.

The program was refocussed at the beginning of 2012 and divided into two streams, a core and a revolving stream. The core stream involves around 20 companies across a range of critical sectors of the economy, including miners, manufacturers, retailers and key suppliers of intermediate goods and services (such as law firms, recruitment firms, palette makers, and transport and logistics providers). It is intended that Treasury SES officers maintain contact with the same firms each quarter, with a

focus on relationship building and discussions around current activity and the outlook, as opposed to a set of structured questions.

The revolving stream is a new flexible component of the program. Prior to each forecasting round, key challenges and particularly important sectors of the economy are identified. Liaison contacts in those specific sectors or regions are then targeted to provide more qualitative information to inform the forecasts.

Treasury continues to look at innovative ways to connect with more businesses through existing networks and channels. For example, building on past work with Business Chambers to set up roundtables with a range of their members across diverse sectors and firms. And, drawing upon other Government agencies, such as Enterprise Connect, who regularly meet with business.

Recommendation 1:

Given the importance of information on economic conditions obtained from business liaison — and the capacity of this source to inform the forecasts — Treasury should investigate with the Reserve Bank of Australia more formal channels through which to exchange insights from their respective programs, such as during the quarterly joint forecasting rounds (without compromising the confidentiality of liaison contacts). Similarly, Treasury should also investigate whether further information can be drawn from the Australian Taxation Office's liaison with large corporate taxpayers for revenue forecasting purposes.

Treasury Macroeconomic Model (TRYM)

TRYM is effectively a one-sector, small-open-economy neoclassical growth model. DED has employed TRYM as a forecasting tool to varying degrees over the past 20 years. TRYM has been used primarily to provide a consistency check on the NAFF-derived forecast, with divergences at an aggregate and component level identified and analysed by the sectoral specialists. TRYM is also useful as a tool to run 'what if' scenarios where the model is shocked and the resulting output compared with a baseline.

Following a review in 2010, DED, in collaboration with the Macroeconomic Modelling Division, has undertaken a major redesign of TRYM, with a view to simplifying the computational environment and harmonising the data and assumptions. This work has progressed along a number of dimensions. A joint DED-ABS working group has been established to:

- transfer ownership to the ABS of numerous series currently constructed/inferred by Treasury for macroeconomic modelling purposes using ABS data; and
- regularly peer-reviewing Treasury's macroeconomic modelling and data construction.

Sectoral analysts in DED are responsible for the development and maintenance of TRYM's structural behavioural equations. On-going work is aimed at making TRYM consistent with 'best practice' structural vector auto-regression methods by removing all ad-hoc forward-looking elements.

At the conclusion of this redevelopment, TRYM will be used to produce macroeconomic forecasts and sensitivity analysis as an input into the NAFF. Treasury is aiming for the redeveloped TRYM to be fully operational for the Budget 2013 forecast round.

Further information on the TRYM model is provided at Attachment B.

Recommendation 2:

A detailed assessment of the role, and appropriate type, of Treasury's macro econometric model was beyond the scope of this Review. However, the Review believes it is important to embed the redeveloped TRYM model into the economic forecasting process, both as a complement to the existing forecasting framework and to facilitate analysis of the impact of shocks to the domestic economy.

Odysseus database

To undertake its forecasting and modelling work, DED uses a large number of economic time-series imported from many external sources. The Treasury data holdings contain over 80,000 time-series. At monthly and quarterly intervals, new time-series are retrieved and linked to historical data. The manual effort required to undertake this process and maintain data integrity was particularly onerous.

Given the core nature of this work, DED has made a significant investment in a comprehensive database management program, the Odysseus database. The development of this database followed an independent review into data management and information practices within DED that identified a number of problems associated with using Microsoft Excel as the data management, storage and analysis program. Many of the data management problems faced by DED related to the size and complexity of the time series being maintained, including the great number of links between Excel worksheets and workbooks. Most of the time-series data used in Treasury are provided in Excel format.

While mitigation strategies were put in place to deal with known risks, these strategies were resource intensive and relatively inefficient. The Odysseus database has reduced operational risks; improved data quality and integrity; provided more efficient mechanisms for data capture and processing; improved analytical capability and enabled analytical staff to spend more of their time on economic analysis instead of data checking.

2.3: Treasury's Approach to Revenue Forecasting

Summary

- Treasury revenue forecasting methodology is similar to comparable official agencies overseas. Forecasts of taxation revenue are built up from forecasts of individual revenue heads, which are based on Treasury's macroeconomic forecasts of the relevant economic base, and mapping models, which account for the differences between taxable and economic bases.

- Revenue forecasts are subject to internal review, ahead of formal peer review at revenue conferences held with the Australian Tax Office and Customs.

- Treasury overhauled its revenue forecasting methodology in response to the recommendations of the 2005 Review. The 2005 Review found that Treasury was underestimating revenue, in large part because Treasury had an inadequate understanding of the relationship between the nominal economy and revenue and, related to this,observation, Treasury had underinvested in taxation revenue data.

- Treasury is continually looking at ways to improve its forecasting methodology, including in response to forecast errors. It is currently investigating the use of micro simulation models to forecast individual income tax revenue.

Context

Treasury is responsible for preparing the Australian Government's taxation revenue forecasts. The Revenue Analysis Unit (RAU) has around 10 staff to perform this task, significantly less than the macroeconomic forecasting area, reflecting the revenue forecasting area's narrower forecasting focus and less onerous briefing work load.

Treasury prepares revenue forecasts twice a year, as well as the associated extensive commentary and analysis of revenue developments to accompany the Government's official forecasts, released at Budget and MYEFO. Forecasts are usually generated for the remainder of the current fiscal year, the budget year and the subsequent year, with projections prepared for the subsequent two years. Forecasts take into account cyclical variation in economic activity, whereas projections are based on long-term average growth rates.

The revenue forecasts are presented in the Budget documents on a cash basis. Under cash basis reporting, tax receipts are accounted for at the time a tax payment is received by the Australian Taxation Office (ATO). This is in contrast to the macroeconomic series which are reported in the National Accounts on an accrual basis, to reflect the time when the economic activity occurred. Timing adjustments are made to the economic base as part of the revenue forecasting process, in order to take into account the likely lag between the timing of the economic activity and the associated receipt of tax revenue by the ATO.

Forecasting Approach and Process

Similar to many countries, Treasury's revenue forecasts are generated using a 'bottom up' approach, where forecasts for individual revenue heads are prepared based on macroeconomic forecasts of the relevant economic base and then aggregated to produce a total revenue forecast. Treasury also maintains econometric approaches to estimating aggregate revenue. Over time, investments have enabled the development of improved models of individual heads of revenue which, in turn, has seen Treasury place more weight on these models to generate revenue forecasts and less weight on more aggregate approaches.

The revenue forecasting methodology can be best described as 'mapping', rather than modelling. This is because, firstly, the revenue head models are largely accounting frameworks, with an elasticity of one typically applied to forecasts of the taxable base (the reasons, for which, are discussed below). And, secondly, the macroeconomic forecasts supplied by DED are typically used to grow the taxable base without being subject to judgemental adjustment (also discussed further, below).

The revenue forecasting models are largely accounting frameworks designed to account for the conceptual differences between the taxable base, which reflects Taxation Law principles, and the economic base, forecast by DED, which reflects National Accounting principles. These differences are most pronounced for the income tax heads of revenue, in particular corporate income tax. For this head of revenue, gross operating surplus (GOS) is the relevant National Accounts measure of economic income. However, many adjustments need to be made to GOS to account for conceptual differences with taxable corporate profits before it can be used for revenue forecasting purposes. For example, corporate GOS is measured before deducting depreciation charges and debt-servicing interest expenses. It also excludes holding gains or losses in trading stock and realised capital gains or losses in the assets and liabilities of the corporate sector. For other revenue heads, such as excise, forecasts of the economic base supplied by DED can be used more directly, with less adjustment, because the taxable and economic bases are more closely aligned.

Econometric techniques are not usually required to uncover the quantitative relationships between a head of revenue and its taxable base. This is because, conceptually, the elasticity of revenue to its taxable base is one for revenue heads with a flat tax rate. This is the case for most Commonwealth

taxes. Intuitively, this means that taxation revenue increases by one per cent for each increase of one per cent in the taxable base. The main exception is Treasury's model for income tax withholding, which incorporates an elasticity which has been econometrically estimated, to capture the progressivity of the individuals' income tax system.

The revenue forecasting models generate forecasts on an income year or accrual basis. These forecasts need to be adjusted for the revenue head's payment arrangements to generate forecasts on a cash basis. The payment arrangements introduce a lag between the timing of the economic activity and the receipt of the associated revenue — for example, 60 per cent of corporate income tax is typically received in the year that the profit is generated, with the remaining 40 per cent received in the following year. Further adjustments are made to take into account any information on recent taxation collections provided by the ATO.

It follows from this approach to forecasting that the focus of Treasury's model development is improving its understanding of each taxable base. The models mimic, as closely as possible, the structure of the relevant income tax returns and payments systems. RAU works closely with the ATO to improve its technical understanding of the taxable bases and the tax payments system. It also works closely with DED to improve its understanding of the difference between the taxable and economic bases, and to identify and resolve instances where taxation receipts and economic data are providing conflicting signals about the state of the nominal economy. Several improvements to the information flows and knowledge transfer between these areas are described at Attachment C.

Once a new set of macroeconomic forecasts have been received, revenue head analysts prepare preliminary revenue forecasts on an accruals (income-year) basis by updating their models for the latest forecasts of the economic base. Adjustments may be made to individual components of the taxable base where additional information indicates that they are unlikely to grow in line with the forecast of the economic base provided by DED. The analyst then adjusts accruals (income year) forecasts for timing issues, to generate revenue forecasts on a cash basis. As mentioned, further adjustments are made to take into account any information on recent tax collections from the ATO.

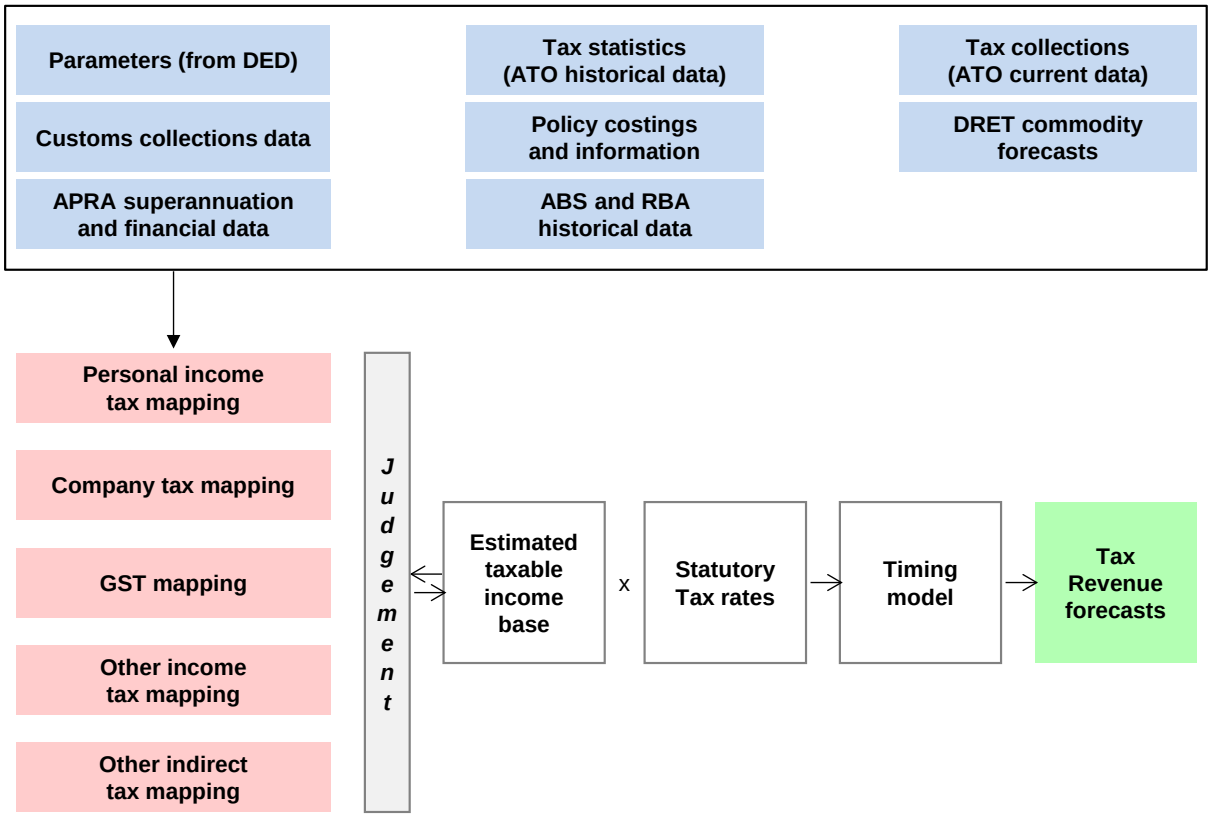
The cash tax revenue forecasts are then adjusted for the estimated impact of government policy decisions, court decisions and ATO compliance activity, to produce a forecast for each head of revenue.

The analysts discuss their forecasts with their colleagues and management. The forecasts are also subject to formal peer review at revenue conferences held with the ATO and Customs.

Judgement is employed in Treasury's revenue forecasting process generally to deal with issues where there are little data or historical precedent — for example, the likely profile of the recovery in capital gains tax receipts following the global financial crisis. The main reason for this approach is to prevent inconsistencies between the macroeconomic and revenue forecasts, which could result in the Budget presenting one view on the nominal economy and a conflicting view on taxation revenue. It would also reduce the transparency of the forecasting process.

A stylised schematic of the revenue forecasting framework is provided in Figure 2.2, below. It shows the external data inputs into the forecasting process (highlighted in blue), the major categories of head of revenue mapping model (highlighted in red) and the forecast outputs (highlighted in green).

Figure 2.2: Revenue Forecasting Framework



Data limitations are a constraint on the modelling techniques and tools that can be employed in revenue forecasting. They include:

- the long lags in receiving detailed income tax return data (the main detailed publication, 'Taxation Statistics', is published with a lag of close to two years, in order to allow the majority of taxpayers to be captured in the data);
- the aggregated nature of items in tax returns, particularly for corporate tax payers, with the effect of reducing information on drivers of assessable income for revenue forecasting purposes; and
- data completeness issues — for example, each edition of Taxation Statistics is based on tax returns lodged up until a certain date, so the data needs to be scaled up to attempt to account for all eventual taxpayers (including those likely to lodge beyond that date).

To assist in overcoming these data limitations, Treasury utilises a variety of sources of unpublished partial data in the revenue forecasting process, including:

- monthly tax collection outcomes from the ATO;
- matched tax return data (the ATO extrapolates tax revenue outcomes for the current year by comparing a sample of taxpayers who have already lodged against these taxpayer's returns from the previous year);
- advanced release of information from Taxation Statistics;
- Business Activity Statement data;

- ATO business liaison information. The ATO advise Treasury of 'one off' noteworthy information they receive from their business liaison teams. The advice is largely commercial-in-confidence in nature, relating to the expected timing and value of specific companies taxation liabilities; and

- Australian Prudential Regulation Authority (APRA) data on superannuation funds; and Customs duty collection reports.

A more detailed description of the revenue forecasting process and governance is at Attachment C.

2005 Forecasting Review

The most recent major internal review of Treasury's forecasting performance was the 2005 Review. It was commissioned in response to significant upward revisions to successive published forecasts of Australian Government taxation revenue over a number of years, which had drawn into question the quality of Treasury's forecasts at the time.

The major findings of the 2005 Review related to the revenue forecasts and revenue forecasting methodology and included that:

- the underestimation in the Treasury's revenue forecasts appeared to reflect a series of conservative biases in the revenue forecasting process, combined with technical assumptions that implied that forecast revenue growth was insufficiently sensitive to nominal GDP growth;

- Treasury had an inadequate understanding of the relationship between the nominal economy and taxation revenue; and

- Treasury's capacity to undertake meaningful analysis of taxation revenue had been severely hampered by underinvestment in taxation revenue data.

In response to these findings, Treasury's Executive Board established a dedicated team to implement the recommendations of the Review that were designed to overhaul the data and methodology used to forecast taxation revenue. The team subsequently made major investments in the quality of data sets and forecasting methodology over an eighteen month period, with the assistance of the ABS and the ATO. This work underpinned the construction of the new income tax revenue head mapping models. This included constructing, and scaling, time series of income tax return data and preparing an accounting mapping between taxable income and economic income (in practice, between data published in Taxation Statistics and the National Accounts). The team also carefully prepared models of income tax payment arrangements.

The 2005 Review also made a number of other recommendations designed to improve macroeconomic and revenue forecasting methodology. These recommendations are at Attachment A, together with an assessment of progress made towards their implementation.

Recent Improvements to Revenue Forecasting Methodology

The work of the implementation team has been continued by RAU. The mapping models are now designed to mirror the tax payments system as closely as possible — for example, the personal income tax model includes each of the income and expense items (wages and salaries, dividends, interest income, work related expenses etc) that feed into the taxable income base.

Some recent improvements to the main mapping models are detailed below:

Improving the model alignment with the economic base

Examination of some revenue head models has found that the data was of insufficient quality to justify the level of disaggregation. The general approach, now taken, is to forecast at the level of the broad head of revenue, rather than at greater levels of disaggregation. This is guided by the principle that the forecast accuracy of total revenue depends on the forecast accuracy of the broad revenue heads, not on the breakdown or 'splits' of particular revenue heads into sub components of revenue, which are of only residual interest. The splits can then be estimated based on recent trends or other information.

For example, total alcohol excise is now modelled, with the forecast then split into the sub components of alcohol excise, such as beer excise. This approach has had the effect of improving the model alignment with the economic base. For example, beer excise has no discernible historical relationship with total private consumption of alcohol — the economic base forecast by DED. A higher level of aggregation has also been applied to the modelling of tobacco excise.

The superannuation and capital gains tax models have also been rebuilt based on the balance sheet for the relevant tax entity, rather than a flow of income approach. This more closely mirrors the process by which capital gains are generated. It allows for capital losses to be calculated separately and taken into account in calculating the taxable income base.

Improvements to data sources

Some of the head of revenue models have been improved through the use of data from additional or better sources. For example, the superannuation model has been enhanced using data from APRA, which cover around two-thirds of Australia's superannuation funds, and are timelier than Taxation Statistics (as at July 2012, APRA data are available for 2010-11, compared with 2009-10 for Taxation Statistics). In addition, the capital gains tax model has also been enhanced by making better use of asset price data from the RBA, the ABS and the ASX.

Use of micro simulation techniques

RAU is currently exploring the use of micro-simulation techniques in personal income tax models. While data limitations had previously constrained the use of micro-simulation techniques, arrangements have now been put in place to allow RAU to access detailed confidentialised personal income tax data from the ATO, with appropriate safeguards in place. Some other countries, including the United States, employ micro-simulation techniques in their personal income tax revenue forecasting.

Micro simulation models operate at the level of the individual behavioural entity, such as a person, family, or firm. Such models simulate large representative populations of these low-level entities in order to draw conclusions that apply to higher levels of aggregation such as an entire country. This type of model is distinct from aggregate models whose explanatory variables already represent collective properties. Certain types of modelling problems are best dealt with using micro simulation, whereas for others an aggregate approach is more appropriate.

In particular, the application of micro-simulation techniques to personal income tax may improve the revenue forecasts by helping to identify and forecast characteristics of the taxpayer population that are changing over time. Some examples are provided below.

- The distribution of various forms of income varies markedly. For example, interest and dividend income is generally earned by those facing higher income tax scales, whereas pension income is generally earned by those at the lower end. Being able to apply different rates to different income items would provide more robust forecasts.

- Dis-equiproportional growth in income distributions could be explicitly factored into the analysis and forecasts, rather than indirectly, via econometric techniques.

- The impact of population ageing on personal income tax revenue could be better quantified.

Recommendation 3:

Treasury should examine the feasibility of constructing a micro simulation model for forecasting personal income tax, as is the practice in the United States and United Kingdom.

2.4: Strengthening the Governance of Treasury's Forecasting Processes

Notwithstanding the generally robust nature of existing practices, the Review has made some recommendations that would strengthen existing governance arrangements in order to improve the credibility and transparency of Treasury's forecasting processes. These recommendations would also bring these arrangements more in line with the practices of official agencies overseas.

The importance of credible and transparent forecasts in supporting public confidence has been highlighted by current global economic uncertainty. Publishing forecasting models, data, and technical assumptions in order to open them up to external scrutiny provides greater transparency. It also allows for feedback and testing of assumptions, leading to model improvements over time, as well as enhancing the credibility of the model's forecasts.

These considerations lead the Review to recommend:

Recommendation 4:

Treasury should publish technical documentation that describes the data and the conceptual and econometric basis of models used for economic and revenue forecasting. A number of official agencies overseas have published technical documentation of their forecasting models.

Large forecasting errors can reduce the credibility of forecasts, particularly as they are viewed with the benefit of hindsight (which reveals information that was not available to the forecaster at the time the forecasts were prepared). In this regard the Review notes that forecasting is an inherently difficult exercise and, on occasion, large forecasting errors are inevitable, especially at times of economic volatility. Regular public reviews of forecasting performance can help to provide perspective on forecast errors. They can also improve the transparency of the forecasting process.

These considerations lead the Review to recommend:

Recommendation 5:

Treasury should include in the Budget papers a high level review of the economic forecast errors (nominal and real GDP) for the previous financial year, as a complement to the existing discussion of revenue forecasting errors.

Recommendation 6:

Reviews of Treasury's forecasting performance should be undertaken at least every five years to examine the causes of forecast errors and to help identify areas in which Treasury's forecasting methodology could be improved. These Reviews should be overseen by an independent external reference group.