TREASURY'S MEDIUM-TERM ECONOMIC PROJECTION METHODOLOGY

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ABSTRACT

Treasury's forecasting framework has evolved over the past 21 years from the outlook for a single financial year to the outlook for the Australian economy 40 years ahead for intergenerational analysis. A constant through this evolution has been the sharp distinction between the methodologies used for near- and longer-term forecasts. The economic estimates underlying Australian Government fiscal projections divide the forecast horizon into two distinct periods: the near-term forecast period which covers the first two years beyond the current financial year; and the longer-term projection period which includes the last two years of the forward estimates, and up to 36 more years for intergenerational analysis. The economic estimates over the forecast period are based on a range of short-run forecasting methodologies, while those over the projection period are based on medium- to long-run rules. Treasury routinely assesses medium- to long-run projection rules in light of new data, improved modelling techniques and structural changes to the economy. The measured cyclical weakness of recent years calls for an enhancement to the existing trend growth rate rules, which recognises the need for an adjustment period over which the economy transitions from a cyclical high or low to its potential level of output. Working towards that end, this paper details changes to the projection methodology that overcome the cyclical limitations of the existing framework. Applying these methodological changes to the economic estimates in the 2014-15 Budget leads to a slight improvement in the Underlying Cash Balance of $0.9 billion (0.05 per cent of GDP) in 2017-18 and $3.4 billion (0.12 per cent of GDP) in 2024-25.

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SECRETARY'S FOREWORD

Nearly twenty-one years ago, the release of the 1993-94 Commonwealth budget saw the first extension of economic estimates beyond the budget year. These additional estimates, based on medium term economic assumptions, underpinned more informative estimates of taxation revenue and the Government's budget balance than had been provided prior to that date.

This change was a manifestation of the extraordinary circumstances of the time; the Australian economy was emerging from recession, activity levels were well below potential and the budget deficit had reached four per cent of GDP. To reach an informed view about longer term fiscal sustainability required an assessment of how the economy might evolve beyond the near-term forecasts.

Treasury's forecasting process and methodologies have evolved substantially since then, but a constant has been the separation of the estimates horizon between near-term forecasts and longer-term projections. While the former take into account cyclical movements in the economy, the latter has been largely underpinned by assumptions that the economy is at its long-run equilibrium.

The economy can diverge far from equilibrium, often for sustained periods of time, with two key external shocks — the terms of trade boom and the global financial crisis — being recent causes. During much of the 1990s and the first years of the 2000s, it was reasonable to assume the economy would be close to equilibrium in the near future.

However, these assumptions need to be questioned and modified when they become unrealistic. A particularly relevant scenario — one which was discussed at-length at the Senate Economics Legislative Committee — Treasury Portfolio in February 2014 — is when, at the end of the forecast period, the economy is some distance from its long-run equilibrium.[3]

An important early example of this reconsideration involved Treasury's medium-term assumptions about the terms of trade, first introduced in the 2005-06 Budget, when the terms of trade had risen to a level viewed as unsustainable over the longer term. From that Budget, it was assumed that the terms of trade would fall significantly over the projection period, rather than remain unchanged, as had been assumed previously. This assumption was modified further in the 2010-11 Budget. Recent history includes two other important steps.

The 2013 PEFO presented an alternative projection assumption showing a gradual closing of the output gap via above-trend growth and gradually falling unemployment, recognising that the real economy would still be operating well below potential by the end of the forecast period.

Subsequently, the 2013-14 MYEFO incorporated an interim assumption for the unemployment rate path and, recognising the importance of the production phase of the mining boom on global markets, a new bottoms-up projection methodology for the terms of trade.

As was discussed in MYEFO and in February 2014 Estimates testimony, these changes were interim steps in an evolving approach to preparing projections, with the expectation that a more comprehensive and consistent approach would be introduced at Budget 2014-15.

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3 Australia. Parliament. Senate. Economics Legislation Committee — Estimates, Hansard, 26 February 2014, www.aph.gov.au/Parliamentary_Business/Senate_Estimates/economicsctte/estimates/add1314/index.

The framework presented in this working paper forms the next step in this evolution. It does so by providing updated estimates of potential output based on supply-side analysis, and specifies the period over which the output gap closes and the path of economic adjustment required for this to be achieved. It therefore provides a more realistic and internally consistent approach to closing output gaps than was possible using previous methodologies.

The publication of this paper also reflects Treasury's continuing commitment to act on the recommendations of the 2012 Review of Treasury Macroeconomic and Revenue Forecasting. In particular, it responds to recommendation 4, that:

> *Treasury should publish technical documentation that describes the data and the conceptual and econometric basis of models used for economic and revenue forecasting.*

The framework laid out in this paper continues the process of ensuring that Treasury's forecasting and projection methodologies are up to date and fit for purpose. Looking ahead, these frameworks will continue to be examined to ensure that remains the case.

Martin Parkinson PSM
Secretary to the Treasury

1. INTRODUCTION

Treasury's forecasting framework has evolved over the last 21 years from the outlook for a single financial year to the outlook for the Australian economy 40 years ahead for intergenerational analysis. A constant through this evolution has been the sharp distinction between the methodologies underlying near- and longer-term forecasts. Economic estimates underlying Australian Government fiscal projections divide the forecast horizon into two distinct periods: the near-term *forecast period* which covers the first two years beyond the current financial year; and the longer-term *projection period* which includes the last two years of the forward estimates, and up to a further 36 years for intergenerational analysis. As documented in the recent review of Treasury macroeconomic and revenue forecasting (Australian Treasury, 2012), estimates over the forecast period are based on a range of short-run forecasting methodologies, while estimates over the projection period are based on medium- to long-run rules developed in large part through the intergenerational reporting process (Australian Government, 2010).

Treasury routinely assesses medium- to long-run projection rules in light of new data, improved modelling techniques and structural changes to the economy. It is fair to say that, with the exception of rules governing terms of trade projections, the medium-term projection methodology has not changed in a significant way over the last 10 years. Treasury has revised its medium-term methodology for the terms of trade in response to the unprecedented rise in Australia's terms of trade caused by the significant increase in demand for non-rural commodities from China, with the most recent change introduced in the 2013-14 MYEFO (see Bullen, Kouparitsas and Krolikowski, 2014, for further details).

Treasury's broader projection methodology was conceived at a time when the Australian economy was operating at or near its long-run sustainable growth path (i.e., at the level of potential output), which led to growth rate rules that assume all real variables grow at their trend growth rate over the projection period. The measured cyclical weakness of recent years, which is expected to continue over the forecast period, calls for an enhanced approach which recognises the need for an adjustment period over which the economy transitions from a cyclical high or low to its potential level of output.

Working towards that end, this paper details changes to the projection methodology that overcome the cyclical limitations of the existing framework. These changes include: a real cyclical adjustment module which is designed to close cyclical output and unemployment gaps over the medium-term; and a complementary nominal cyclical adjustment module which factors in cyclical weakness in goods and labour markets into wage and price projections. This approach effectively divides the projection period into a *cyclical adjustment period* which spans the time it takes to close the real output gap and a subsequent *long-run* where output equals its potential level.

The theory underlying the enhanced framework follows the mainstream growth and business cycle literatures. For ease of exposition to a non-technical audience, and without any loss of generality, the real and nominal cyclical modules are intentionally parsimonious. Where possible the framework draws on published empirical research relating to Australian business cycles, and wage and price determination, with new empirical analysis detailed in this paper.

The remainder of the paper is organised as follows: Section 2 outlines the theory underlying the projection methodology; Section 3 outlines the empirical methods used to estimate the theoretical model's parameters and historical trends; Section 4 applies the methodology using the 2014-15 Budget estimates over the forecast period (2014-15 and 2015-16) and a revised potential output path using updated trend population, participation and productivity assumptions, and provides a detailed comparison with medium-term projections consistent with the 2013-14 MYEFO methodology; Section 5 reports the findings of various sensitivity analyses; and Section 6 concludes the paper with a brief summary of the results.

2. THEORY

The medium- to-long-run real GDP projection methodology developed in this paper follows the approach of the mainstream growth and business cycle literatures. Growth theory is the study of the evolution of the sustainable level of output (hereafter potential output), while business cycle theory studies temporary short-run movements in output away from its potential level. Empirical analysis of growth and business cycles conveniently divides the task of modelling actual economic data into trend and cycle analysis. For a given economic variable, the *trend* component identifies permanent movements (e.g., the trend of a variable which grows over time, such as gross domestic product, is captured by a smooth upward sloping line), while the *cycle* component identifies temporary fluctuations about the trend (Chart 1).

Chart 1: Stylised trend—cycle decomposition
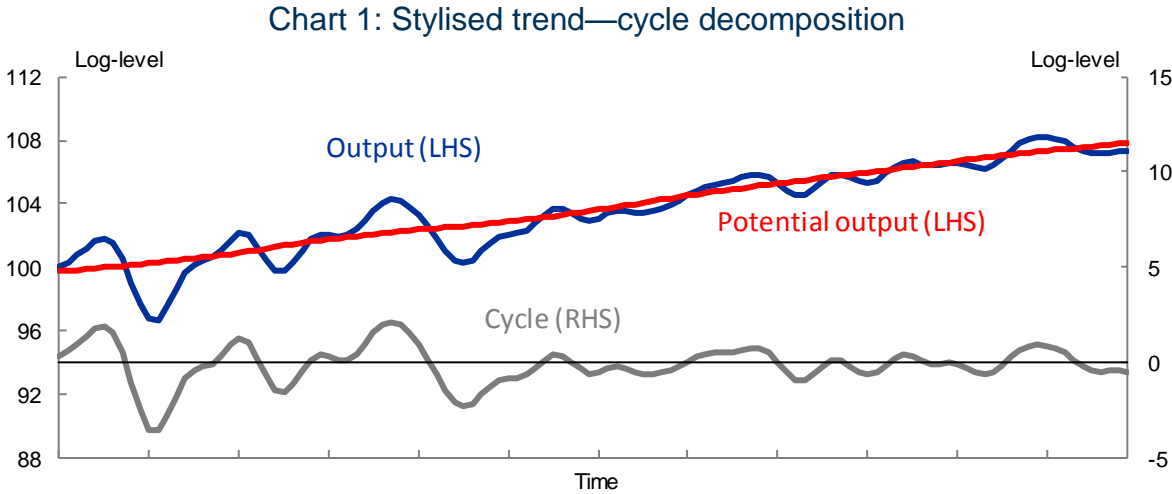
From a theoretical standpoint, potential output (i.e., the trend level of gross domestic production) defines the level of production at which the economy's labour and capital inputs are being used at their long-run sustainable levels of effort or capacity. Potential output can increase as a result of either a one-time innovation that raises the level of production but leaves the growth rate unchanged (known as a level shift) or an innovation that changes the underlying growth rate. Growth theory has devoted most of its attention to differentiating between factors that lead to level shifts of potential and those that influence its growth rate. Some theorists argue that the growth rate of potential output is an exogenous constant determined by technological factors that cannot be influenced by private agents or government, while others argue the growth rate of potential output is endogenous, which means it can

be influenced by the actions of private agents or government.[4] The methodology developed in this paper follows other fiscal agencies, such as the US Congressional Budget Office (CBO) (2001), in assuming an exogenous growth path for potential output.

In contrast to the CBO, which limits its medium-term output projections to forecasts of potential output, the projection methodology developed in this paper incorporates a period of cyclical adjustment over which cyclical gaps estimated at the end of the forecast period, which covers the first two years beyond the current financial year, are closed.

There are many competing theories of the causes of economic business cycles.[5] The predominant approach characterises the cyclical components of the data as temporary short-run movements in output around the trend and assumes the trend and cycle are independent (i.e., they are driven by unrelated shocks). There are, however, many empirical studies that find the trend and cycle are not independent, with cyclical fluctuations implying a permanent shift in the trend.[6] In keeping with Treasury's philosophy that medium-term projections should be based on parsimonious rules, the methodology developed here follows the broader literature in assuming independence of the trend and cycle. This assumption improves transparency and greatly simplifies the computational burden because it means that real output projections can be solved recursively by following these steps:

1   forecast potential output over the forecast and projection periods;

2   forecast output over the forecast period;[7]

3   estimate cyclical output (output gap) at the end of the forecast period;

4   forecast the cyclical adjustment (close the output gap) over the projection period; and

5   combine forecasts of potential output and cyclical output to yield a forecast of real output.

This approach effectively divides the projection period into the *cyclical adjustment period,* which spans the time it takes to close the output gap, and the subsequent *long-run* where output equals its potential level.

Potential output

Estimates of potential output implicitly assume the economy is on its balanced growth path. When combined with the exogenous growth assumption, potential output is characterised by the following conditions:

1   the factors that determine the growth rate of the labour force/population and labour augmenting technological progress are exogenous to the economy;

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4   See Acemoglu (2009), and references therein, for a detailed discussion of growth theory and the basic neoclassical approach that underpins the analysis in this paper.
5   See the extensive survey of business cycle theory and method in King, Plosser and Rebelo (1999), and references therein, for further details.
6   Jaeger and Parkinson (1994), for example, find that changes in the trend unemployment rate are positively correlated with fluctuations in cyclical unemployment.
7   Treasury's estimates over the forecast period are based on a range of detailed short-run forecasting models, including econometric and bottom-up spread sheet analysis. Interested readers can find more detail in the recent review of Treasury macroeconomic and revenue forecasting (Australian Treasury, 2012).

2   all non-labour volumes grow at the same rate, which is equal to the growth rate of the labour force plus the growth rate of labour augmenting technical progress;

3   all relative prices (excluding the real wage) are constant;

4   real wages grow at the same rate as labour augmenting technical progress; and

5   all real variables are tied down by time-invariant ratios to output (e.g., the capital to output ratio) which are typically referred to as *great ratios*.[8]

The balanced growth path of an economy is derived from the supply-side (i.e., it is a production based measure of output). The foundation of this approach is the aggregate production function, which is typically modelled as a linearised function of the following form [throughout the paper lower case letters denote log-levels, while upper case letters denote the level of a variable, that is, $x_t = \ln(X_t)$, $\Delta = x_t - x_{t-1}$, $\Delta_4 = x_t - x_{t-4}$, and the time interval denoted by t is a quarter]:

$$y_t = a_t + \theta(z_t + nh_t) + (1-\theta)k_{t-1} \qquad (1)$$

where at time t; y_t is output (or gross domestic product); a_t is Hicks neutral technological progress, which is zero along the balanced growth path; z_t is labour augmenting (or Harrod neutral) technological progress; nh_t is total hours worked; k_t is the stock of physical capital; and θ is labour's share of output along the balanced growth path.

Following the business cycle literature, Hicks neutral technological progress is modelled as a first-order autoregressive stochastic process:

$$a_t = \rho_a a_{t-1} + \varepsilon_{at} \qquad (2)$$

where $0 < \rho_a < 1$, and the innovation ε_{at} is independently and identically distributed with mean zero and variance $\sigma_{\varepsilon a}^2$. Medium term projections of cyclical productivity are based on the conditional expectation of its level at the end of the forecast period:

$$a_{t+s}^p = E_t(a_{t+s}) = \rho_a^s a_t \qquad (3)$$

where a p superscript denotes a projection and s is the projection interval.

Labour augmenting technological progress is assumed to follow a unit root process with drift:

$$z_t = \lambda/4 + z_{t-1} + \eta_t \qquad (4)$$

where the drift term λ is the annual growth rate of labour augmenting technological progress, and the innovation η_t is independently and identically distributed with mean zero and variance σ_η^2. Medium

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8   The great ratios underlying balanced growth are implied by the so-called Kaldor facts (Kaldor, 1963). Kaldor observed that while per capita output increases over time, the capital output ratio, the real cost of capital and the distribution of income between capital and labour was roughly constant. King, Plosser and Rebelo (1999), and others, show that balanced growth and the Kaldor facts imply the constancy of many other economic ratios, including consumption to output and investment to output, which they collectively refer to as the *great ratios*. These theoretical predictions are supported by empirical estimates for a broad set of countries.

term projections of labour augmenting technical change are based on the conditional expectation of its growth rate at the end of the forecast period:

$$\Delta z^p_{t+s} = E_t(\Delta z_{t+s}) = \lambda / 4 \tag{5}$$

Setting all variables to their trend values implies the following expression for potential output:

$$y^T_t = \theta(z_t + nh^T_t) + (1-\theta)k^T_{t-1} \tag{6}$$

where T indicates the trend level of a variable.

Trend labour input

A key assumption of the basic growth model employed here is that labour force trends are exogenous to the framework (i.e., they are based on assumptions external to model). In particular, the trend labour force is equal to the trend participation rate multiplied by the trend working age population:

$$NLF^T_t = NPR^T_t NAP^T_t$$
$$nlf^T_t = npr^T_t + nap^T_t \tag{7}$$

where at time t, nlf^T_t is trend labour force, npr^T_t is the trend labour force participation rate, and nap^T_t is trend working age population.

Trend employment is implied by the trend labour force and the long-run unemployment rate:

$$N^T_t = (1-U^T)NLF^T_t$$
$$n^T_t = \ln(1-U^T) + nlf^T_t \tag{8}$$

where at time t, n^T_t is the trend level of employment and U^T is the trend rate of unemployment, which is commonly referred to as the non-accelerating inflation rate of unemployment (NAIRU).

When combined with a trend average hours assumption this implies trend total hours worked:

$$NH^T_t = N^T_t H^T_t$$
$$nh^T_t = n^T_t + h^T_t \tag{9}$$

where at time t, nh^T_t is trend hours worked and h^T_t is trend average hours worked.

Trend capital input

The long-run capital to output ratio is assumed to be constant along the balanced growth path. In general this ratio is tied to the real cost of capital. Under the balanced growth rate assumption, all relative prices and the real interest rate are constant, which implies the long-run capital-output ratio is constant. For the purposes of this discussion assume, without loss of generality, that the ratio is α_k:

$$k^T_{t-1} - y^T_t = \alpha_k \tag{10}$$

Substituting equation (10) into (6) implies the following expression for potential output:

$$y^T_t = (z_t + nh^T_t) + (1-\theta)\alpha_k / \theta \tag{11}$$

Trend labour productivity

Equation (11) can be rearranged to show that the level of trend labour productivity is equal to the level of labour augmenting technological progress plus a constant:

$$y_t^T - nh_t^T = z_t + (1-\theta)\alpha_k / \theta$$
$$= q_t^T$$

(12)

Growth rate of potential output

When differenced, equation (11) demonstrates balanced growth and that the annual growth rate of potential output (γ) is equal to the annual growth rate of labour augmenting technological progress (λ) plus the annual growth rate of trend employment, which in turn is equal to the sum of the annual growth rate of trend labour force and trend average hours worked:

$$\Delta y_t^T = \Delta z_t + \Delta nh_t^T$$
$$= \Delta q_t^T + \Delta h_t^T + \Delta n_t^T$$
$$= \Delta q_t^T + \Delta h_t^T + \Delta nlf_t^T$$
$$= \Delta q_t^T + \Delta h_t^T + \Delta npr_t^T + \Delta nap_t^T$$
$$= \gamma_t / 4$$

(13)

The second to last result underpins *the three Ps* framework — productivity, participation and population — used in the Australian Government's Intergenerational Report (IGR) (see Australian Government, 2010). The growth rate of potential output is equal to the sum of the growth rates of labour productivity, labour force participation, average hours worked and the working age population. With estimates of the growth rates of labour augmenting technological progress, labour force and hours in hand, potential output is simply forecast by growing the historical trend level by the estimated growth rate of potential output given by equation (13).

The output gap

In contrast to the strong theoretical assumptions underlying potential output, the methodology relies heavily on empirical methods when modelling cyclical aspects of the framework. For ease of exposition to a non-technical audience, and without any loss of generality, the output gap (i.e., cyclical output) is modelled directly, rather than constructing it in a similar way to potential output as the sum of cyclical labour productivity, hours and employment. The output gap at the end of the forecast period is estimated as the deviation of forecast output from forecast potential output:

$$y_t^c = y_t - y_t^T$$

(14)

where at time t, y_t^c is cyclical output, which is more commonly referred to as the output gap, with a positive/negative gap indicating the economy is operating above/below its potential.

This approach implies the following forecast of real output growth:

$$\Delta y_t = \Delta y_t^T + \Delta y_t^c$$
$$= \gamma_t / 4 + \Delta y_t^c$$

(15)

From this expression it is easy to see that forecasts of real output growth will be above the trend growth rate when the output gap is negative and closing (i.e., $\Delta y_t^c > 0$) and below the trend growth rate when the output gap is positive and closing (i.e., $\Delta y_t^c < 0$).

We assume a simple real output growth rate rule over the cyclical adjustment period, such that:

1   the output gap closes over a fixed period; and

2   with a constant real output growth rate over that time.

The empirical methods employed in this paper generate an asymmetric cycle in which output is more often below potential than above it, so output gaps are largely a reflection of under rather than over utilisation. Historical estimates of Australian output and unemployment gaps suggest the interval from business cycle trough back to trend is around five years, so we assume the cyclical adjustment period is five years. This choice is made irrespective of the state of the business cycle. In doing so, the approach does not assume the end of the forecast period reflects a business cycle trough or peak.

An alternative approach would be to follow Stone, Wheatley and Wilkinson (2005), and many others in the business cycle literature, by assuming that the output gap is a stationary, first order autoregressive process:

$$y_t^c = \rho_y y_{t-1}^c + \varepsilon_{yt} \tag{16}$$

where $0 < \rho_y < 1$, and the innovation ε_{yt} is independently and identically distributed with mean zero and variance $\sigma_{\varepsilon y}^2$. Our empirical analysis suggests the simple output gap rule described above yields roughly similar cyclical forecasts to this alternative approach.

Labour force

Labour force variables, such as the level of employment and the unemployment rate, are key inputs into the medium-term framework.

Employment

The cyclical employment gap at the end of the forecast period is estimated as the deviation of forecast employment from its estimated trend:

$$n_t^c = n_t - n_t^T \tag{17}$$

Over the cyclical adjustment period cyclical employment is forecast conditional on forecasts of the output gap, average hours and labour productivity.

$$\begin{aligned} n_t^c &= n_t - n_t^T \\ &= y_t - h_t - q_t - (y_t^T - h_t^T - q_t^T) \\ &= (y_t - y_t^T) - (h_t - h_t^T) - (q_t - q_t^T) \\ &= y_t^c - h_t^c - q_t^c \end{aligned} \tag{18}$$

As discussed in Hutchings and Kouparitsas (2012), forecasts of labour input over the forecast period are based on a heads rather than total hours worked framework.[9] Specifically, the forecast period methodology assumes average hours are equal to their trend, so cyclical average hours are zero at the end of the forecast period and over the projection period (i.e., $h_t^c = 0$), which implies the following relationship between cyclical output, productivity and employment:

$$n_t^c = y_t^c - q_t^c \tag{19}$$

Cyclical labour productivity at the end of the forecast period is estimated as the deviation of forecast labour productivity from its estimated trend:

$$\begin{aligned} q_t &= y_t - nh_t \\ q_t^c &= q_t - q_t^T \end{aligned} \tag{20}$$

Given that empirical estimates of the trend level of capital deviate little from actual capital, cyclical labour productivity is essentially Hicks neutral technological change. Therefore it is modelled as a first order autoregressive process:

$$q_t^c = \rho_q q_{t-1}^c + \varepsilon_{qt} \tag{21}$$

where 0< ρ_q <1, and the innovation ε_{qt} is independently and identically distributed with mean zero and variance $\sigma_{\varepsilon q}^2$. Medium term projections of cyclical labour productivity are based on the conditional expectation of its level at the end of the forecast period:

$$q_{t+s}^{cp} = E_t(q_{t+s}^c) = \rho_q^s q_t^c \tag{22}$$

Unemployment

Unemployment is forecast via forecasts of the labour force and employment. Following the broader labour supply literature, cyclical labour force adjustment incorporates a discouraged worker effect by modelling cyclical labour force participation as a function of the cyclical employment rate (i.e., employment divided by working age population). For example, the Treasury Macroeconomic (TRYM) Model (Australian Treasury, 1996) employs a relatively simple discouraged worker framework:

$$nlf_t^c - nap_t^c = \psi(n_t^c - nap_t^c) \tag{23}$$

where at time t, ψ>0.

The cyclical labour force and working age population at the end of the forecast period are estimated as the deviation of their forecast from its estimated trend:

$$\begin{aligned} nlf_t^c &= nlf_t - nlf_t^T \\ nap_t^c &= nap_t - nap_t^T \end{aligned} \tag{24}$$

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9   This potential limitation is the subject of ongoing Treasury research along the lines of Dixon, Freebairn and Lim (2005).

Forecasts of the level of employment and the labour force follow from combining their trend and cyclical levels:

$$nlf_t = nlf_t^T + nlf_t^c$$
$$n_t = n_t^T + n_t^c$$

(25)

which in turn implies the unemployment rate:

$$U_t = (NLF_t - N_t) / NLF_t$$

(26)

Through various substitutions it can be shown that Okun's Law is an inherent part of the framework, with the output gap approximately equal to the deviation of unemployment from its trend (i.e., the unemployment gap) divided by the discouraged worker coefficient:

$$y_t^c = y_t - y_t^T$$
$$= \frac{1}{\psi}(U_t - U^T)$$

(27)

Given TRYM's estimate of ψ is around 0.5, this implies the output gap is approximately twice as large as the unemployment gap, which is consistent with empirical estimates.

Prices and wages

Australian Government fiscal projections rely crucially on projections of the level of nominal output and the distribution of income between capital and labour. Given forecasts of real output, forecasts of nominal output require an estimate of the output price, while the distribution of income relies on estimates of employment and the wage level.

Wages

Wages are modelled using a Phillips curve similar to that developed by Gruen, Pagan and Thompson (1999). This approach assumes wages grow in line with labour productivity, expected expenditure price inflation (which could be forward looking based on bond-market expectations or adaptive expectations based on lagged wage and price inflation) and the lagged unemployment gap:

$$\Delta_4 w_t - \Delta_4 q_t - \Delta_4 pgne_{t-1} = \beta_1(\pi_t^e - \Delta_4 pgne_{t-1}) + \kappa(U_{t-1} - U_t^T)/U_{t-1}$$
$$+ \beta_2(\Delta_4 w_{t-1} - \Delta_4 q_{t-1} - \Delta_4 pgne_{t-2})$$
$$+ \beta_3(\Delta w_{t-1} - \Delta q_{t-1} - (\Delta w_{t-4} - \Delta q_{t-4})) + \varepsilon_{wt}$$

(28)

where at time t, pgne$_t$ is the gross national expenditure deflator, w$_t$ is the hourly wage rate, π_t^e is bond-market inflationary expectations, κ<0 and the innovation ε_{wt} is independently and identically distributed with a mean of zero and variance $\sigma_{\varepsilon w}^2$. Gruen, et al. (1999) estimated a slightly more complicated equation which included the contemporaneous unemployment gap and the change in the unemployment rate. There is no loss of explanatory power when these features of the data are modelled jointly via a lagged unemployment gap.

Holding other things constant, a positive unemployment gap will cause wages to grow at a slower rate than the sum of labour productivity and expenditure price inflation. Along the balanced growth path, the unemployment gap is zero and expenditure prices grow in line with inflationary expectations, which implies wages grow at the rate of labour augmenting technological progress plus the rate of expected price inflation:

$$\Delta w_t = \Delta q_t + \pi_t^e / 4$$
$$= \lambda / 4 + \pi_t^e / 4 \tag{29}$$

Prices

The price of aggregate output reflects the prices of goods and services produced for the domestic and export market. To be more specific, the aggregate output price is a weighted sum of the prices of goods sold domestically and exports, with the weights equal to the ratio of their production volume to aggregate output.

$$PY_t = (PD_t D_t + PX_t X_t) / Y_t \tag{30}$$

where at time t, PY_t is price of aggregate output, PD_t is the price of output sold domestically, D_t is the volume of goods sold domestically, PX_t is Australian currency price of exports and X_t volume of goods and services exports.

Consistent with the production function underlying the potential output analysis, the price of output sold domestically is assumed to be determined endogenously via a constant percentage mark-up over nominal unit labour costs (i.e., wages per unit of labour productivity):

$$pd_t = \mu + (w_t - q_t) \tag{31}$$

where μ is the constant percentage mark-up. This rule is applied in difference form so it is not necessary to estimate μ.

The methodology underlying medium-term forecasts of exports volumes and prices is described in detail in a companion paper on long-run forecasts of the terms of trade by Bullen, Kouparitsas and Krolikowski (2014). For the purposes of this paper export volumes are effectively exogenous, while export prices are a by-product of the earlier terms of trade analysis. In particular, their analysis provides a forecast of the terms of trade, which ties the price of exports to the forecast of import prices:

$$px_t = ptot_t + pm_t \tag{32}$$

where at time t, $ptot_t$ is the terms of trade and pm_t is the Australian currency price of imports.

Import prices in Australian currency grow over the projection period at an assumed rate of foreign price inflation and the rate of depreciation of the trade-weighted exchange rate:

$$\Delta pm_t = \pi_t^{ef} / 4 - \Delta e_t \tag{33}$$

where π_t^{ef} is the expected annual foreign inflation rate and e_t is the trade-weighted exchange rate.

Gruen and Wilkinson (1994) find that the terms of trade are a fundamental determinant of the real exchange rate. Their work implies the following forecast rule for the nominal exchange rate:

$$\Delta e_t = \pi_t^{ef} / 4 - \pi_t^e / 4 + \xi \Delta ptot_t \tag{34}$$

which in turn implies the following forecast rules for import and export prices:

$$\Delta pm_t = \pi_t^e / 4 - \xi \Delta ptot_t$$
$$\Delta px_t = \pi_t^e / 4 + (1 - \xi)\Delta ptot_t \tag{35}$$

Again, this approach is only feasible because the terms of trade are assumed to be exogenous to the system — put simply, Australia is assumed to be a price taker on global markets.

In a similar vein to production prices, expenditure prices are a weighted average of the prices of output sold domestically and imports, with the weights equal to the ratio of their expenditure volume to gross national expenditure:

$$PGNE_t = [PD_t D_t + PM_t M_t] / GNE_t \tag{36}$$

where at time t, M_t is the volume of imports and GNE_t is the volume of gross national expenditure.

The wage and price system is effectively closed via the national accounting identity. In a textbook closed economy example the solution is trivial with gross national expenditure equal to gross domestic product. The closure is, however, more complicated in the case of a small open economy because imports are a function of gross national expenditure. Following Beames and Kouparitsas (2013), imports are modelled using a derived demand framework in which imports are a function of the level of gross national expenditure and the relative price of imports:

$$m_t = \alpha_0 + gne_t + \upsilon(pm_t - pgne_t) + \alpha_1 trend_t \tag{37}$$

where at time t, $trend_t$ is a deterministic linear time trend and the coefficient on gross national expenditure is imposed to be one.

There is also a dynamic aspect to closure because expenditure is a function of national wealth, which depends on the level of net foreign assets, and the level of net foreign assets is a function of the path of net exports.[10] Progress can be made on this problem by imposing the stability condition that over the long-run, the net foreign asset to nominal output ratio is constant, which implies a sustainable nominal trade balance to nominal output ratio. Given the path of the real trade balance, real gross national expenditure is calculated as a residual:

$$GNE_t = Y_t - NX_t$$
$$NX_t = X_t - M_t \tag{38}$$

where at time t, NX_t is the real trade balance.

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10 See Schmitt-Grohe and Uribe (2003) for a detailed discussion of the issue.

3. ESTIMATION

Trend parameters

Labour force — population and participation rate

The historical working age population, labour force and participation rate data are sourced from Australian Bureau of Statistics (ABS) Labour Force Australia (Cat. No. 6202.0) and Labour Force Australia Detailed Quarterly (Cat. No. 6291.0.55.003).

Historical trend working age population, trend labour force and the trend participation rate are estimated using a Hodrick-Prescott filter with a filter weight of 1600. To avoid end point issues, projections are based on the estimated trend for June in the year prior to current data — in this instance, June 2012.[11]

Working age population is projected using the methodology employed in the 2010 IGR (see Australian Government, 2010). The population at 30 June each year by age and gender is projected using a standard cohort component model. This model incorporates key assumptions about the fertility rate, the mortality rate and net overseas migration.

For the population projections underlying the 2014-15 Budget, the total fertility rate is assumed to drop from an actual 1.933 in 2012 (ABS Births, Australia 2012, Cat. No. 3301.0) to 1.9 in 2013 and then remain constant. Life expectancy at birth (period method) increases from 79.9 years for males in 2011 to 87.7 in 2051 and from 84.3 years for females in 2011 to 90.3 in 2051. The Net Overseas Migration (NOM) assumption is based on the Department of Immigration and Border Protection's Outlook for Net Overseas Migration (see Department of Immigration and Border Protection, December 2013, for details). Over the projection period, NOM is assumed to be 241,900 in 2013-14, 248,300 in 2014-15, 249,000 in 2015-16, 254,000 in 2016-17, and 250,000 thereafter.

Assumptions about the quarterly shares of births, deaths and net overseas migration are used to generate population projections by age and gender at the end of each quarter based on actual observed quarterly data.

The measure of the working age population used by the ABS in estimating the labour force is the population aged 15 and over excluding defence employees. In contrast to general demographic statistics published by the ABS which measure population as at the end of a quarter, quarterly working age population is measured as the average of the working age population over the three months of the quarter.

Trend participation rates are broadly consistent with the 2010 IGR methodology. For each five year age group, gender and employment status (full-time and part-time) cohort, a participation rate is projected from the historical trend. The historical trend is determined as the ratio of the historical trends of the labour force and the trend working age population.

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11 See Baxter and King (1999), and Ravn and Uhlig (2002) for a detailed description of the Hodrick-Prescott filter, choice of filter weight and end point issues.

For youth (15-24 years of age), participation rate projections are held constant at the last historical trend value. This reflects limited historical information about how these cohorts will behave. For mature age workers (aged 60-64 and over), projected trend participation rates are modelled using cohort analysis, based largely on the methodology described by the Productivity Commission (2005, Technical Paper No. 3: Cohort Analysis). According to the Productivity Commission (2005) labour market behaviour of people born in different years (so-called *cohorts*) can be quite different. Following Productivity Commission (2005, Technical Paper No 2: Growth Curves), labour force participation rates for the remaining cohorts are projected using *Richards' curves*.

Projected trend participation rates by age, gender and employment status are compared to maintain relativities between age groups, between genders, between full-time and part-time status and between birth cohorts. The projected trend total participation rate is the sum of the projected trend participation rates by age group, gender and employment status weighted by their share of the total working age population.

Average hours

Historical trend average hours worked is estimated by applying the Hodrick-Prescott filter to historical data. Trend average hours worked is projected by growing the historical trend in line with the average hours series used in the 2010 IGR. Following the 2010 IGR approach, aggregate trend average hours worked is based on bottom-up analysis by gender, age (15-19, 20-24, 25-34, 35-44, 45-54, 55-59, 60-64, 65 and over), employment type (employer, employee, own account worker, contributing family worker) and whether employed full-time or part-time. The projected trend average hours worked for these 64 series is weighted by the trend number of persons employed in each group to give a projection of trend total hours worked.

Unemployment rate

The historical NAIRU is estimated using the Phillips curve approach of Gruen, Pagan and Thompson (1999), which is explained in greater detail below. In the projection period, the NAIRU is assumed to be 5 per cent, consistent with the 2010 IGR methodology.

Labour productivity

Historical estimates of trend labour productivity are based on ABS labour force and Australian National Accounts (Cat. No. 5204.0) data. Historical quarterly trend labour productivity is estimated using a Hodrick-Prescott filter with a filter value of 1600. To avoid end point issues, projections are based on the estimated trend two years prior to current data. Consistent with the 2010 IGR methodology annual trend productivity growth (λ) over the projection period is assumed to equal the 30-year annual average growth rate of labour productivity, which is now 1.5 per cent (down from 1.6 per cent in the 2010 IGR).

Cyclical parameters

Labour force participation

The empirical model underlying cyclical labour force participation is more complicated than the theoretical model outlined above (equation 23) with the best fit requiring two more lags of the cyclical employment rate and two lags of the dependent variable:

$$nlf_t^c - nap_t^c = \sum_{i=0}^{3} \psi_i (n_{t-i}^c - nap_{t-i}^c) + \sum_{i=1}^{2} \chi_i (nlf_{t-i}^c - nap_{t-i}^c) \qquad (39)$$

Estimated parameters are reported in Table 1. Given the complexity of the time series model it is difficult to point to a single statistic to intuit the phases of the labour force participation cycles. Chart 2 shows that cyclical labour force participation cycles are relatively noisy and persistent, which explains the need for a relatively complex time-series model.

Table 1: Cyclical labour force participation model

Method: Least Squares
Sample (adjusted): 1978Q4 2013Q4

	Coefficient	Std. Error	t-Statistic	Prob.
$\psi0$	0.544596	0.053121	10.25190	0.0000
$\psi1$	-0.774556	0.107611	-7.197756	0.0000
$\psi2$	0.249293	0.067225	3.708318	0.0003
$\chi1$	1.184150	0.090362	13.10449	0.0000
$\chi2$	-0.222666	0.091904	-2.422809	0.0167
R-squared	0.831259	Mean dependent variable	0.059853
Adjusted R-squared	0.826296	S.D. dependent variable	0.507690
S.E. of regression	0.211594	Akaike info criterion	-0.233478
Sum squared residuals	6.088994	Schwarz criterion	-0.128912
Log likelihood	21.46020	Hannan-Quinn criterion.	-0.190986
Durbin-Watson statistic	2.009718		

Chart 2: Actual versus fitted cyclical labour force participation

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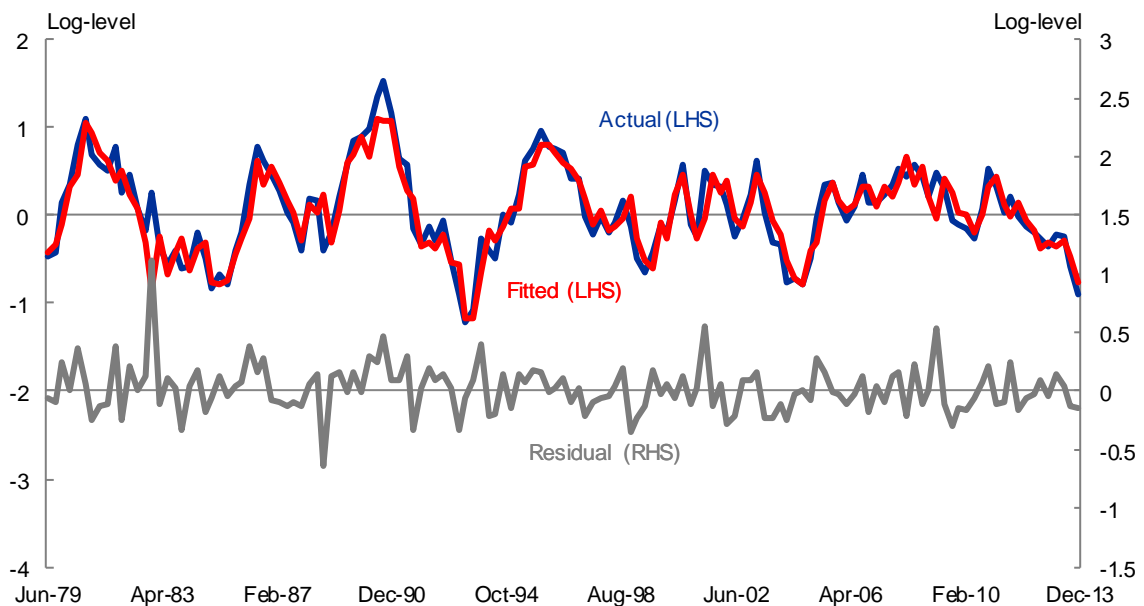
Labour productivity

Parameters underlying the empirical cyclical labour productivity process (equation 21) are reported in Table 2. With an autoregressive coefficient of 0.68, Australian labour productivity displays less persistent cycles than those of other advanced economies, such as the US where the typical autoregressive coefficient estimate is around 0.95.

Table 2: Cyclical labour productivity model

Method: Least Squares
Sample : 1978Q3 2013Q4

	Coefficient	Std. Error	t-Statistic	Prob.
ρ_q	0.676329	0.062005	10.90763	0.0000
R-squared	0.457596	Mean dependent variable		0.010054
Adjusted R-squared	0.457596	S.D. dependent variable		1.080988
S.E. of regression	0.796127	Akaike info criterion		2.388902
Sum squared residuals	89.36840	Schwarz criterion		2.409717
Log likelihood	-168.6120	Hannan-Quinn criterion.		2.397360
Durbin-Watson statistic	1.916896			

Wage and price parameters

Wages and trend unemployment rate

Following Gruen, Pagan and Thompson (1999) the wages model is estimated using maximum likelihood under the assumption that over history the trend unemployment rate is a unit root process (i.e., equal to a lag of itself plus a stationary error). Estimates of the model's parameters (equation 28) are reported in Table 3. With the exception of κ (i.e., the coefficient for the unemployment gap term), the estimates are broadly similar to Gruen, et al. Direct comparison is not possible for κ because Gruen et al. include two labour market slackness terms which are consolidated into one term in equation (28).

Table 3: Wage Phillips curve model

Method: Maximum likelihood
Sample: 1968Q1 2013Q4

	Coefficient	Std. Error	z-Statistic	Prob.
$\beta 1$	0.146793	0.055804	2.630509	0.0085
κ	-0.026233	0.006759	-3.881133	0.0001
$\beta 2$	0.604794	0.036764	16.45050	0.0000
$\beta 3$	0.148349	0.010844	13.68033	0.0000
σ_w	0.013885	0.000737	18.84565	0.0000
Log likelihood	507.5548	Akaike info criterion		-5.462553
Parameters	5	Schwarz criterion		-5.375190
Diffuse priors	1	Hannan-Quinn criterion		-5.427144

Chart 3 plots the time varying NAIRU generated by the Phillips curve model, which is virtually identical to estimates reported by Lim, Dixon and Tsiaplias (2009) using a similar framework and estimation strategy.

Chart 3: NAIRU versus actual unemployment rate
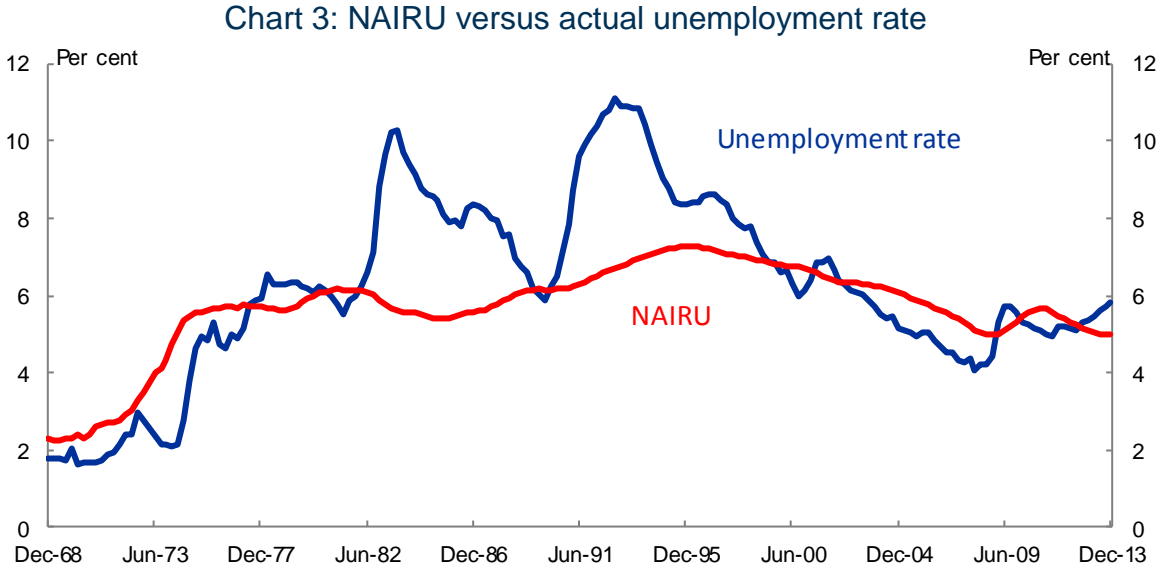
Real exchange rate

The real exchange rate rule is calibrated using the parameter estimates reported by Gruen and Wilkinson (1994), which implies $\xi = 0.6$. Following the 2010 IGR convention, the expected rate of inflation (π_t^e) over the projection period is set at the middle of the Reserve Bank of Australia inflation target band at 2.5 per cent.

Import volumes

Table 4 reports the parameter estimates for the imports volume model (equation 37). These results echo the disaggregated analysis of Beames and Kouparitsas (2013) in estimating a relatively low price elasticity for aggregate imported goods of around 0.42.

Table 4: Import volumes model

Method: Least Squares
Sample: 1980Q2 2013Q4
Included observations: 134

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha0$	-2.803539	0.074113	-37.82810	0.0000
υ	-0.420014	0.057214	-7.341088	0.0000
$\alpha1$	0.005925	0.000339	17.49803	0.0000
R-squared	0.995772	Mean dependent variable	10.15963
Adjusted R-squared	0.995708	S.D. dependent variable	0.690560
S.E. of regression	0.045241	Akaike info criterion	-3.331653
Sum squared residual	0.270171	Schwarz criterion	-3.267092
Log likelihood	227.8866	Hannan-Quinn criterion	-3.305417
F-statistic	15544.37	Durbin-Watson statistic	0.428005
Prob(F-statistic)	0.000000		

Following the companion terms of trade analysis (Bullen, Kouparitsas and Krolikowski, 2014), the deterministic time trend is held constant over the projection period.

4. RESULTS

2014-15 Budget medium-term economic projections

This section applies the methodology outlined in this paper using the 2014-15 Budget estimates over the forecast period (2014-15 and 2015-16) and a revised potential output path using updated trend population, participation and productivity assumptions, with the cyclical estimates of output, employment, productivity and participation calculated as the deviation of the 2014-15 Budget forecast from the revised potential output level.

Applying the methodology described above to estimate and project the trend population, participation rate and labour productivity results in the potential output growth rates reported in Chart 4. Annual potential output growth is expected to slow from an estimate of around 3¼ per cent at the end of the forecast period to around 3 per cent over the projection period, as participation falls with the ageing of the population.

Chart 4: 3Ps contribution to potential output growth
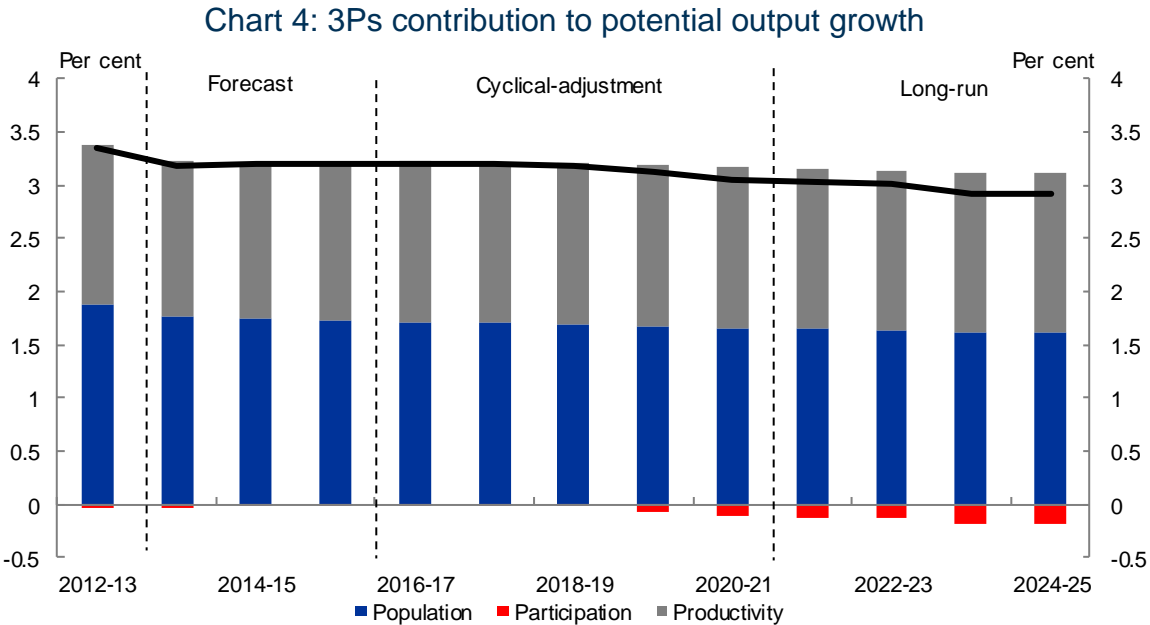
The unemployment gap at the end of the forecast period is estimated to be 1.25 percentage points, while the output gap is estimated to be 2.1 per cent of potential output, which is broadly consistent with empirical estimates of Okun's law. Following the cyclical adjustment methodology these gaps are closed over the five year period from 2016-17 to 2020-21, with both gaps held at zero thereafter (Chart 5).

Chart 5: Output and unemployment gaps
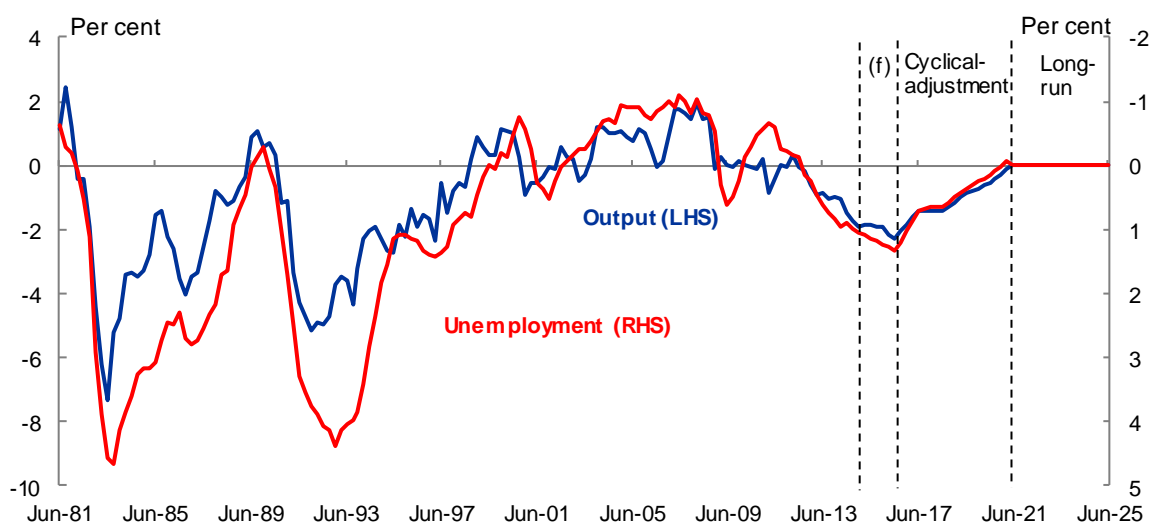
Over the cyclical adjustment period there is strong growth in real output due to the closing of the output gap, with real output projected to grow by 3½ per cent per year (Chart 6).

Chart 6: Nominal GDP growth
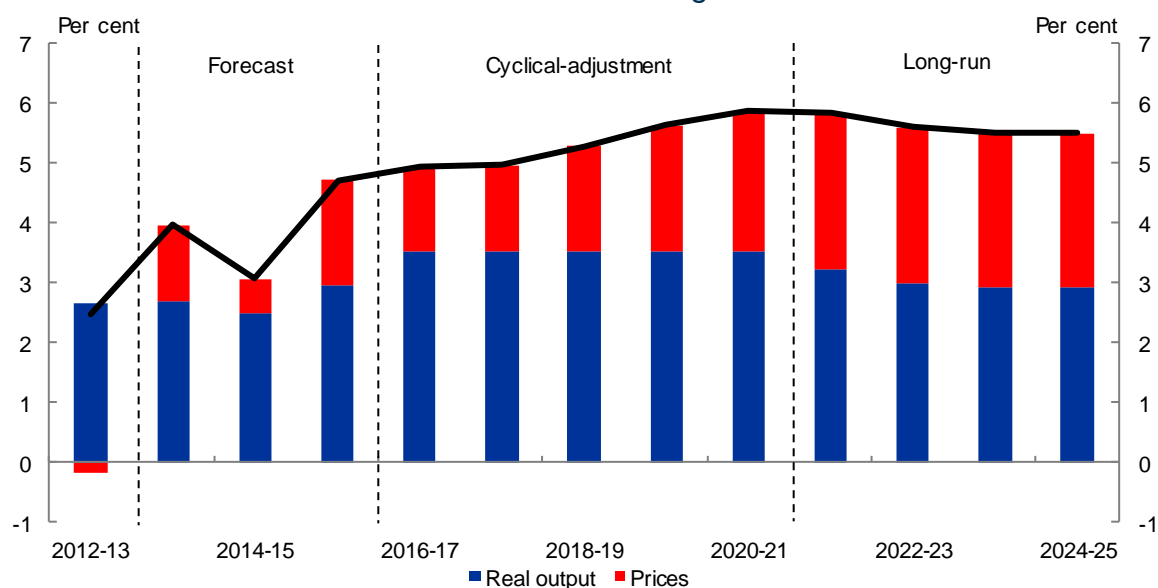
Nominal unit labour costs respond to the unemployment gap and lagged growth in expenditure prices (equation 28). Wage growth is below its long-run rate of 4 per cent over the cyclical-adjustment period (Chart 7). Expenditure prices grow slightly below the expected long-run inflation rate, as a consequence of the relatively weak wages growth due to the employment gap.

Chart 7: Wages growth and unemployment rate
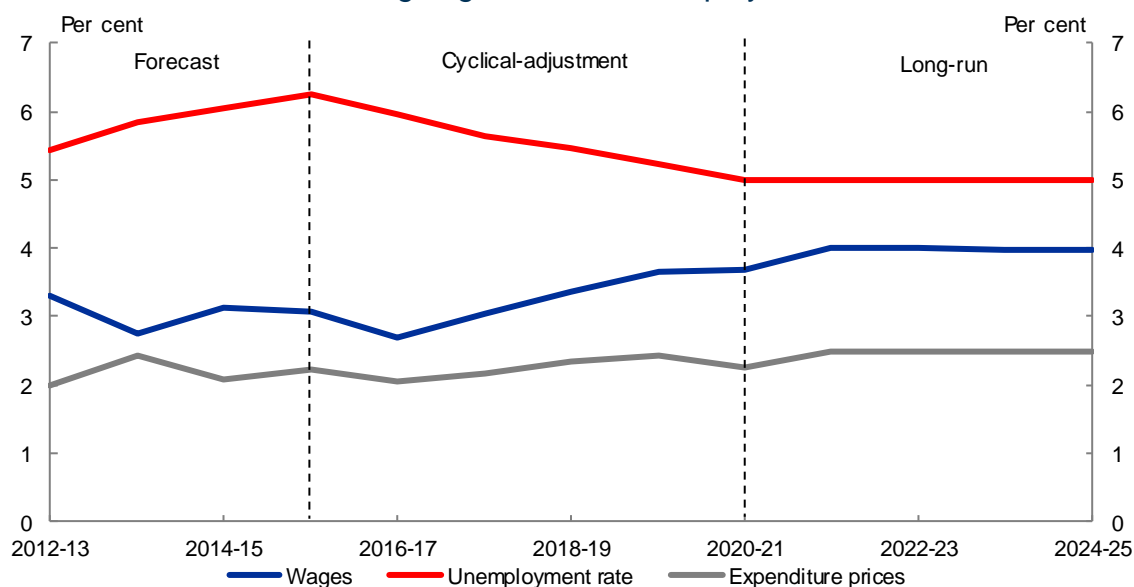
Growth in expenditure prices is driven by growth in prices of output sold domestically, and import prices (equation 36) (Charts 8 and 9). Over the cyclical adjustment period, import prices grow at a rate well above the expected long-run inflation rate due to the projected depreciation in the Australian dollar caused by the weakening terms of trade (equation 35). This offsets the below trend growth of prices of output sold domestically leading to near trend growth in expenditure prices.

Output prices grow below their long-run rate of 2.5 per cent over the cyclical adjustment period, which reflects relatively weak growth in the prices of both exports and output sold domestically (Chart 9).

Chart 8: Expenditure prices
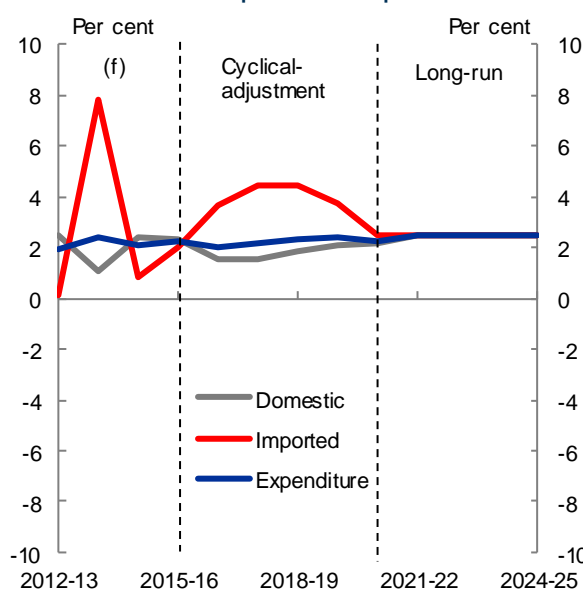
Chart 9: Output prices
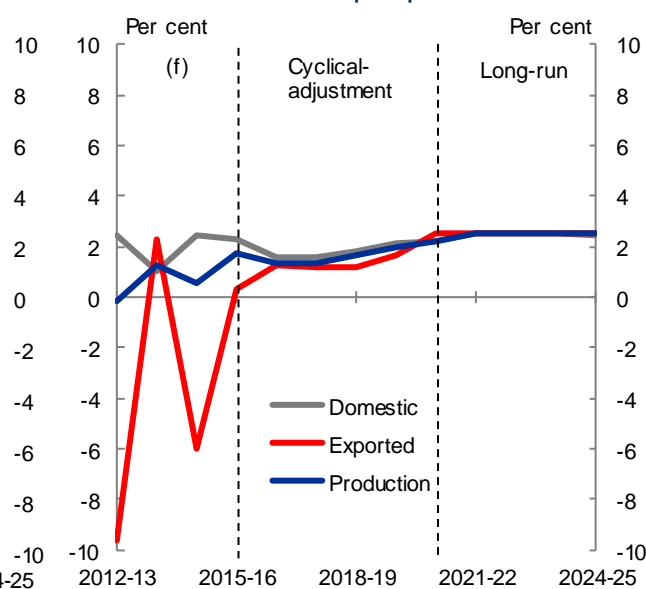
Combining the projections of real output and prices results in nominal GDP growth that gradually increases from around 4¾ per cent at the end of the forecast period to around 5¾ per cent over the cyclical adjustment period then gradually declines to 5½ per cent over the long-run (Chart 6).

The effect of methodological changes on real and nominal output projections

This section identifies the effect of changes in methodology on real and nominal output projections. To assess the impact of the methodological changes the methodology used at MYEFO is applied to the Budget forecast. Changes to the projection methodology since the 2013-14 MYEFO (described in detail below) increase the projected level of nominal GDP by $7.6 billion (0.4 per cent) in 2017-18 and $22.4 billion (0.8 per cent) in 2024-25 (Chart 10).

Chart 10: Change in nominal GDP due to methodological changes
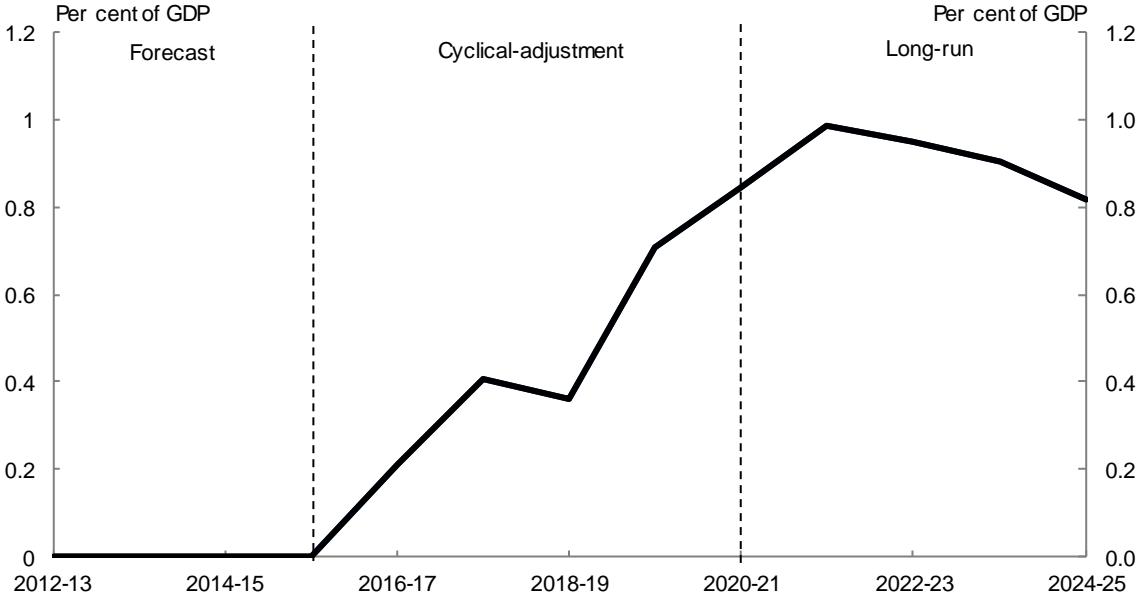
Chart 11: Decomposition of change in nominal GDP due to methodological changes
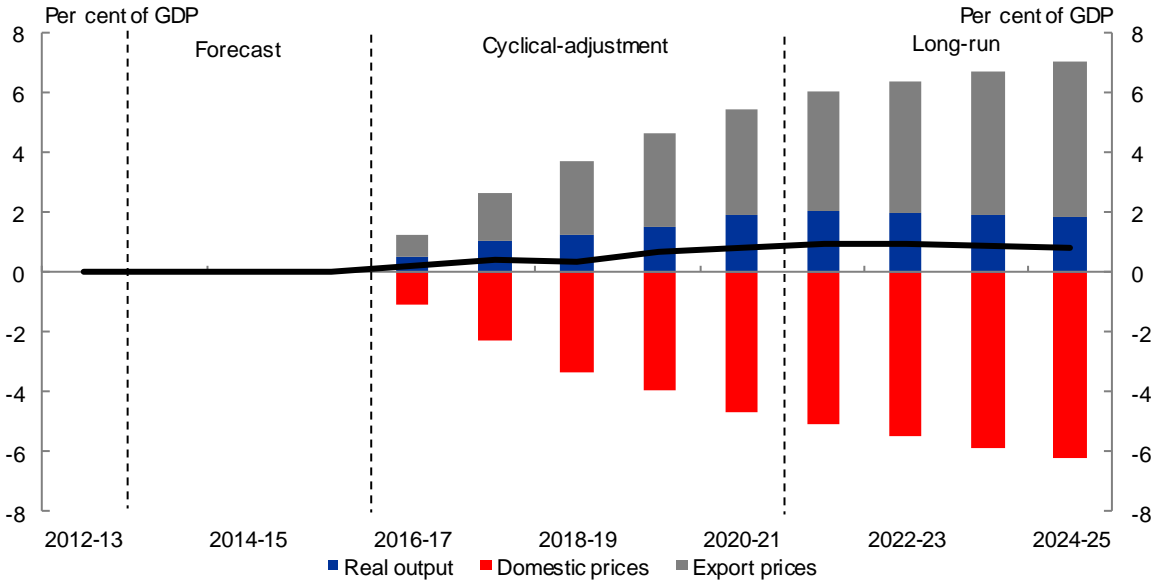
The MYEFO introduced new assumptions for the unemployment rate and the projected path of the terms of trade. This paper further develops the projections methodology through more detailed modelling of the real and nominal aspects of the cyclical adjustment process. Chart 11 decomposes the resulting changes to nominal output into the effect from real output, prices of output sold domestically and export prices. We now discuss each of these effects in turn.

In MYEFO, the unemployment rate was assumed to remain at its last forecast level of 6¼ per cent over the first two projection years. Beyond that, the unemployment rate was assumed to fall (by slightly more than 0.1 per cent each year) over the subsequent 10 years so that it reached the NAIRU in 2027-28 (Chart 12).

For the unemployment rate to fall over the 10 year period, real GDP was assumed to grow above potential over the same period. Real GDP growth was approximately 0.1 per cent above potential output growth while the unemployment gap was being closed (Chart 12). While the MYEFO methodology closed the unemployment gap, the cyclical participation rate and cyclical productivity gap were held constant. This meant that the output gap was only partially closed (Chart 13) — that is, Australia was forever projected to have real activity below the economy's potential level of output (as was also the case using the earlier methodology of assuming trend growth from the end of the forecast period).

In contrast, the projection methodology presented in this paper fully closes the output and unemployment gaps by 2020-21 (Chart 5). Closing the output gap leads to higher projected levels of real GDP, which increase the level of nominal GDP by $19.6 billion (1.0 per cent) in 2017-18 and $50.4 billion (1.8 per cent) in 2024-25 (Chart 11).

Chart 12: GDP growth and unemployment rate using MYEFO methodology
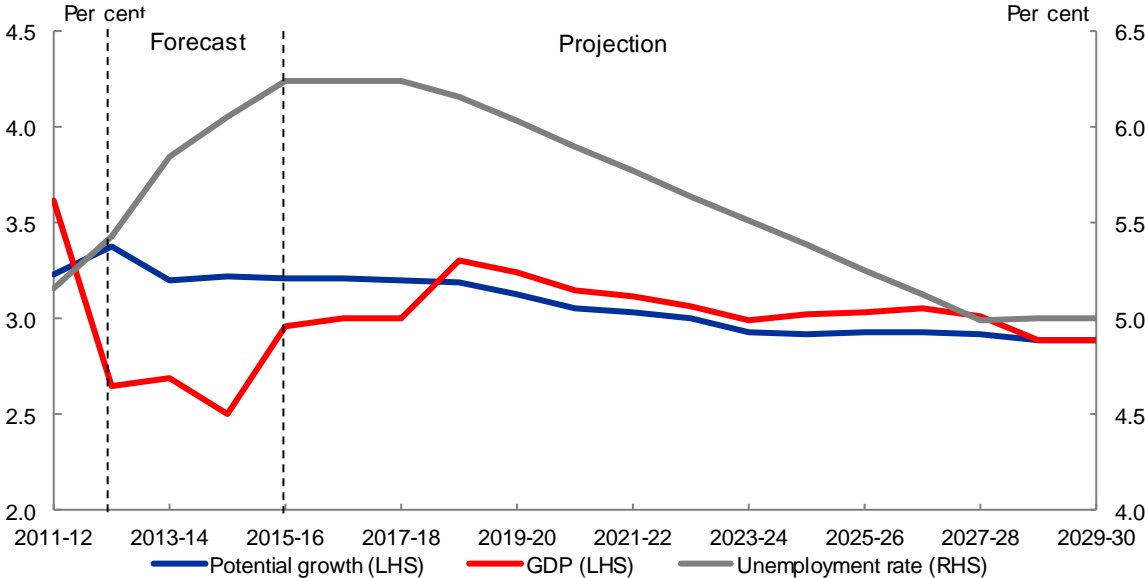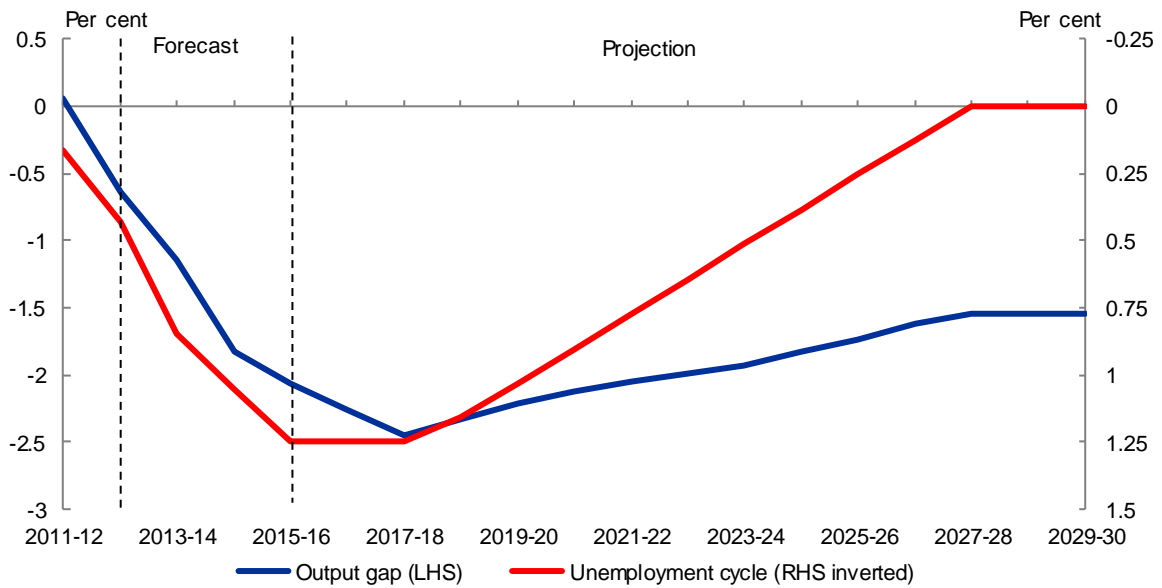

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Chart 13: Output gap and unemployment cycle using MYEFO methodology

In MYEFO, wages and aggregate expenditure prices were assumed to immediately return to their long-run growth rates at the start of the projection period (Chart 14). The projection methodology presented here generates growth in wages and aggregate expenditure prices below their long-run growth rates over the cyclical adjustment period; that is, while output remains below potential (Chart 7).

Chart 14: Wages growth and unemployment rate using MYEFO methodology
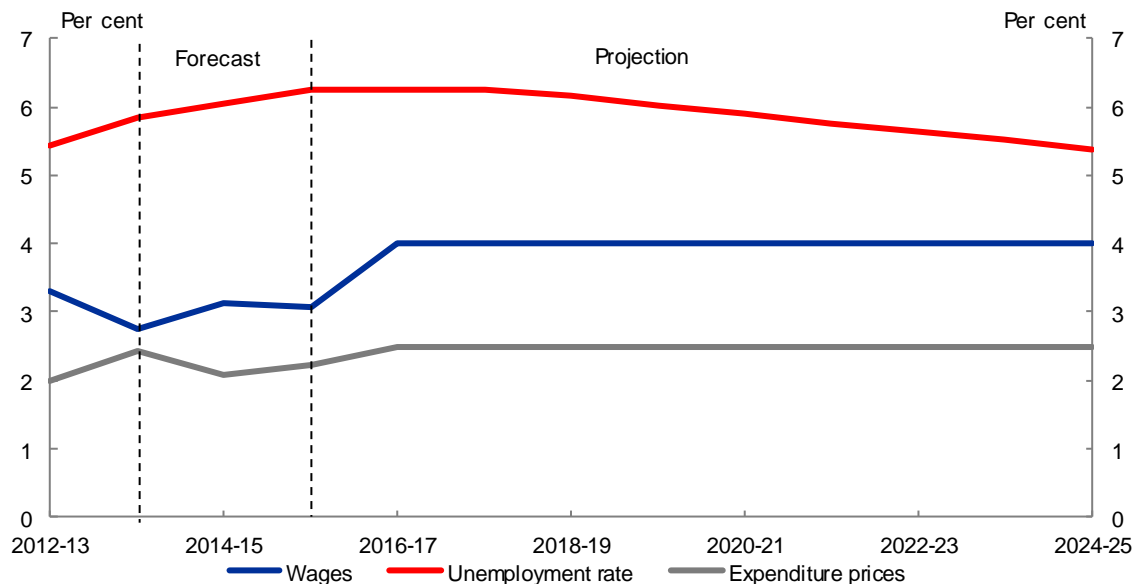
The MYEFO updated the terms of trade assumption over the projection period, based on modelling presented in Bullen, Kouparitsas and Krolikowski (2014). Under the MYEFO assumption, the terms of trade are expected to fall from their level at the end of the forecast period to the level observed in 2005-06 by 2019-20 and remain constant thereafter. In contrast to the methodology reported here, the MYEFO framework assumed the fall in the terms of trade was driven entirely by a fall in export prices, which implicitly assumed no growth in import prices (Charts 15 and 16).

Bullen, et al.'s analysis generated forecasts of the prices of various export categories relative to imports, which did not rely on an explicit exchange rate assumption. For the purpose of their paper they assumed a constant exchange rate and constant growth in import prices equal to the assumed rate of foreign price inflation of 2.5 per cent per annum. In light of equation (34), their analysis implies higher growth in both import and export prices relative to the MYEFO methodology.

The methodology presented in this paper treats the terms of trade profile from Bullen, et al. as an exogenous input and incorporates stronger import and export prices growth owing to the assumed depreciation in the exchange rate from the falling terms of trade. Changes to the projected level of export prices leads to a $30.7 billion (1.6 per cent) increase in nominal GDP in 2017-18 and a $144.0 billion (5.2 per cent) increase in nominal GDP in 2024-25 (Chart 11).

Chart 15: Exports implicit price deflator
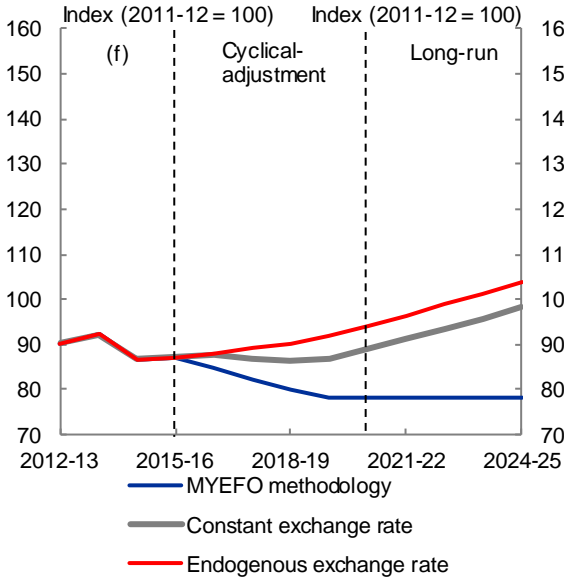
Chart 16: Imports implicit price deflator
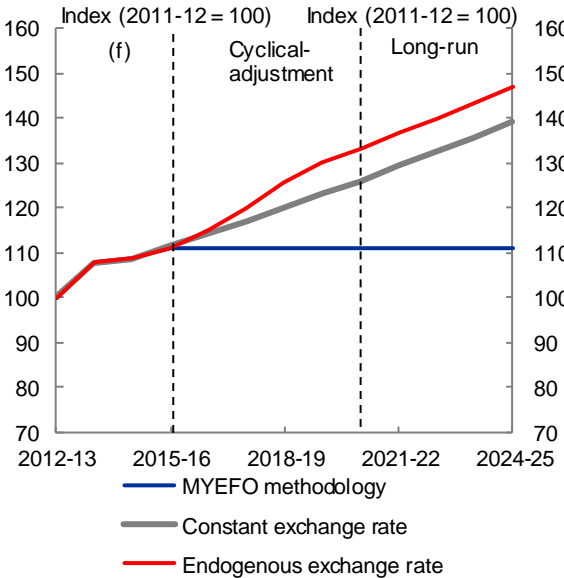
Changes to the projected level of export prices and wages due to methodological changes imply lower prices for output sold domestically, which in turn leads to a $42.6 billion (2.3 per cent) decrease in nominal GDP in 2017-18 and a $171.9 billion (6.2 per cent) decrease in nominal GDP in 2024-25 (Chart 11).

Notwithstanding the higher nominal GDP, these methodological changes have minimal impact on aggregate revenue projections, with receipts projected to be $0.6 billion (0.03 per cent of GDP) lower in 2017-18 and $1.0 billion (0.04 per cent of GDP) higher in 2024-25. Underlying these outcomes are compositional shifts due to changes to the prices and wages methodology. Factoring weakness in the labour market into wages results in a lower share of income accruing to workers, which implies lower individual tax revenue. This effect is largely offset by the rise in company income, which implies higher corporate tax revenue. Similarly, changes to the methodology underlying import prices leads to a shift of corporate income away from the non-mining to the mining sector, which moderates the rise in corporate tax revenue, since the ratio of company tax to gross operating surplus is lower for the mining industry than for non-mining industries taken as a whole. The net effect is to have revenue relatively unchanged.

The methodological changes have a slightly larger effect on aggregate payment projections, with payments projected to be $1.5 billion (0.08 per cent of GDP) lower in 2017-18 and $2.4 billion (0.09 per cent of GDP) lower in 2024-25. This aggregate change reflects lower wage-indexed payments due to changes in the prices and wages methodology, and lower unemployment benefits payments due to closing the unemployment gap over five years rather than the 12 assumed in the 2013-14 MYEFO.

Overall, the methodological change leads to a slight improvement in the Underlying Cash Balance of $0.9 billion (0.05 per cent of GDP) in 2017-18 and $3.4 billion (0.12 per cent of GDP) in 2024-25.

5. SENSITIVITY ANALYSIS

This section assesses the sensitivity of the medium term projections to trend assumptions, the duration of the cyclical adjustment period, and the cyclical position of the economy at the end of forecast period.

Trend assumptions

Growth rate of trend productivity

As demonstrated by the updated trend parameters, the estimated growth rate of trend labour productivity can vary over time. This sensitivity analysis involves a permanent increase in the growth rate of trend labour productivity of 0.1 per cent from 2016-17 (i.e., the start of the projection period). This change increases the level of potential and real output by roughly 0.9 per cent over the 9 year projection period. The growth rate shift requires higher growth of real GDP over the cyclical-adjustment period to close the output gap. In addition, an increase in trend productivity growth also permanently increases the rate of potential output growth and hence output growth in the long-run (Chart 17).

Chart 17: Real GDP growth rate—implications of higher trend productivity growth
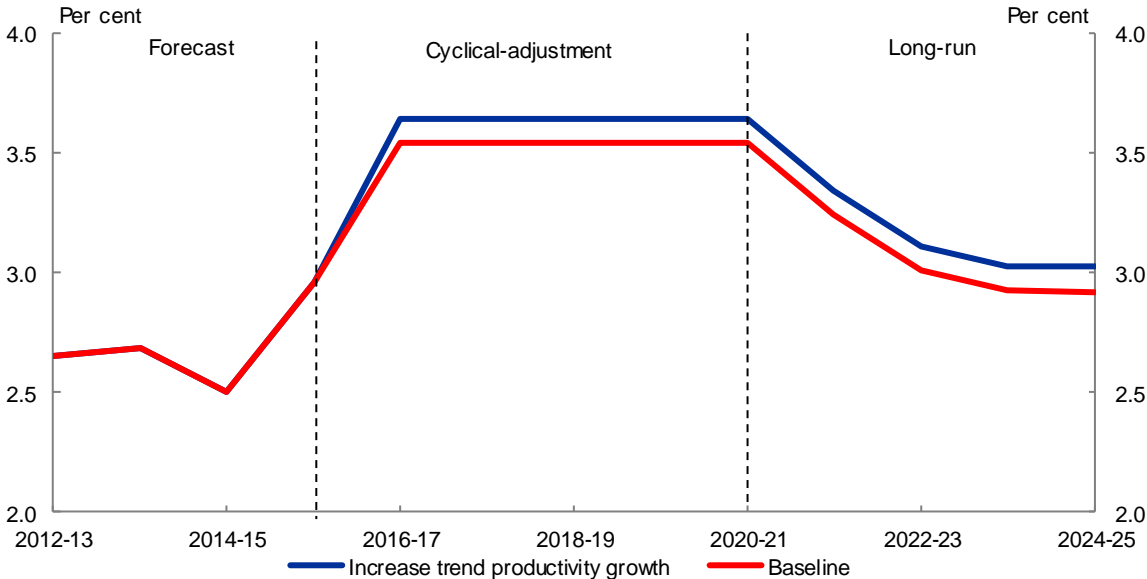
Higher trend labour productivity growth leads to a higher level of real output, while it has a negligible effect on wages and output prices. A permanent increase in productivity growth of 0.1 per cent leads to a $26 billion (0.9 per cent) increase in nominal GDP in 2024-25 (Chart 18).

Chart 18: Change in nominal GDP level—implications of higher trend productivity growth

Per cent of GDP (left axis) / **Per cent of GDP** (right axis)

Forecast | Cyclical-adjustment | Long-run

■ Change in real output   ■ Change in prices
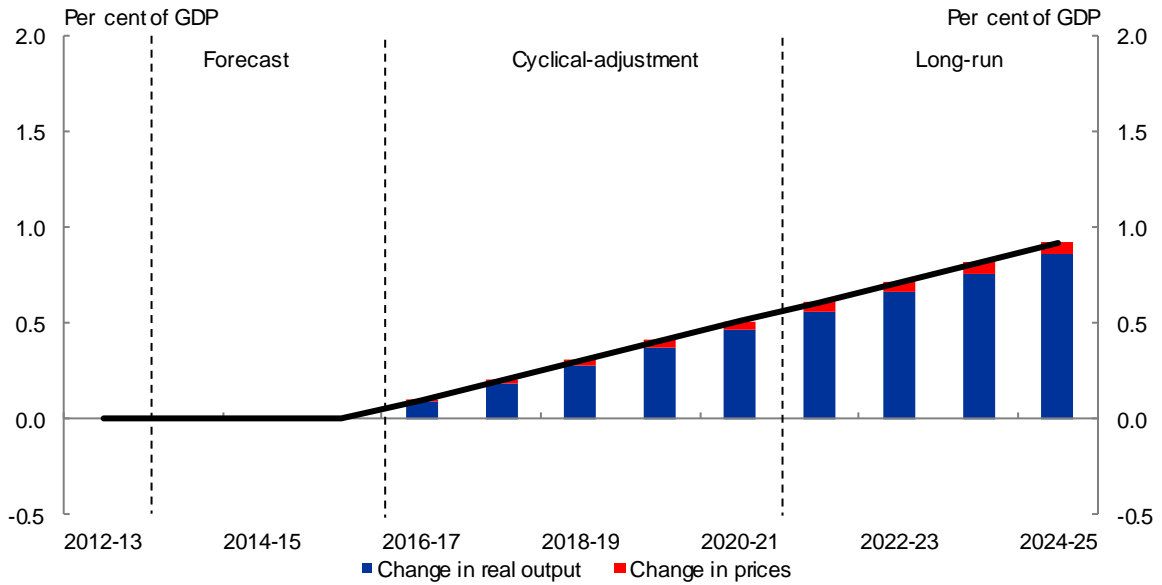
Trend labour force participation rate

This sensitivity analysis involves an increase in the trend labour force participation rate of 0.02 per cent per annum over the cyclical adjustment period, which implies a permanent increase in the participation rate of 0.1 per cent from 2021-22 (Chart 19). A higher trend participation rate leads to a permanently higher trend labour force, a higher level of potential output and a negligible rise in wages and output prices (Chart 21). Overall, the rise in the trend participation leads to a $6 billion (0.2 per cent) increase in nominal GDP in 2024-25.

Chart 19: Participation rate

Per cent (f) | Cyclical-adjustment | Long-run

—— Increase participation rate   —— Baseline
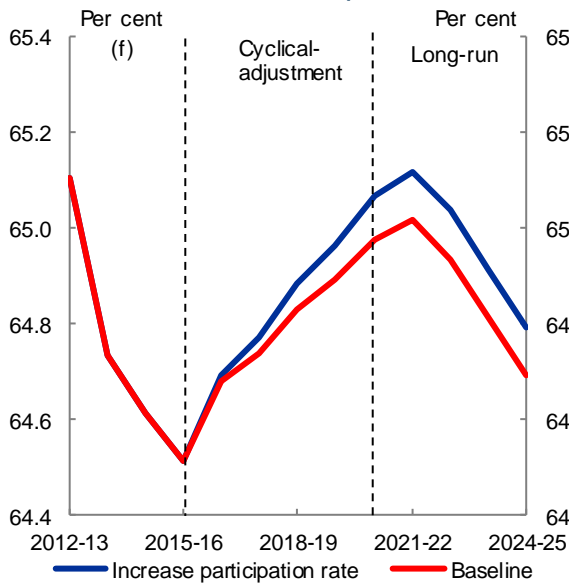
Chart 20: Real GDP growth rate

Per cent (f) | Cyclical-adjustment | Long-run

—— Increase participation rate   —— Baseline
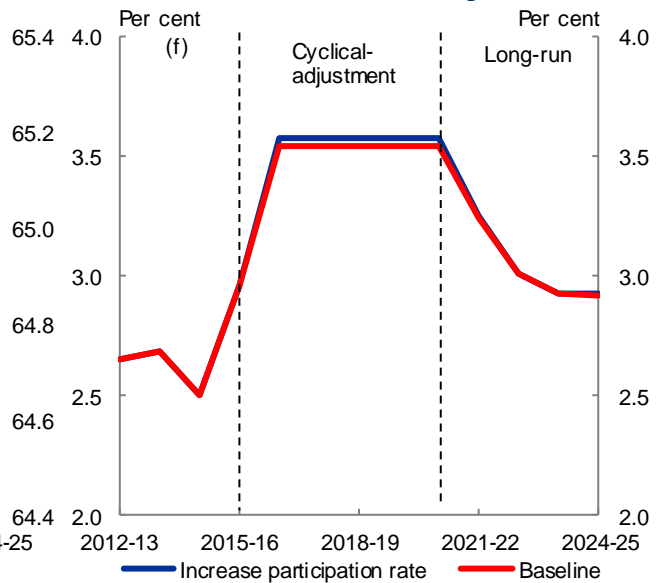
Chart 21: Change in nominal GDP level—implications of higher trend participation
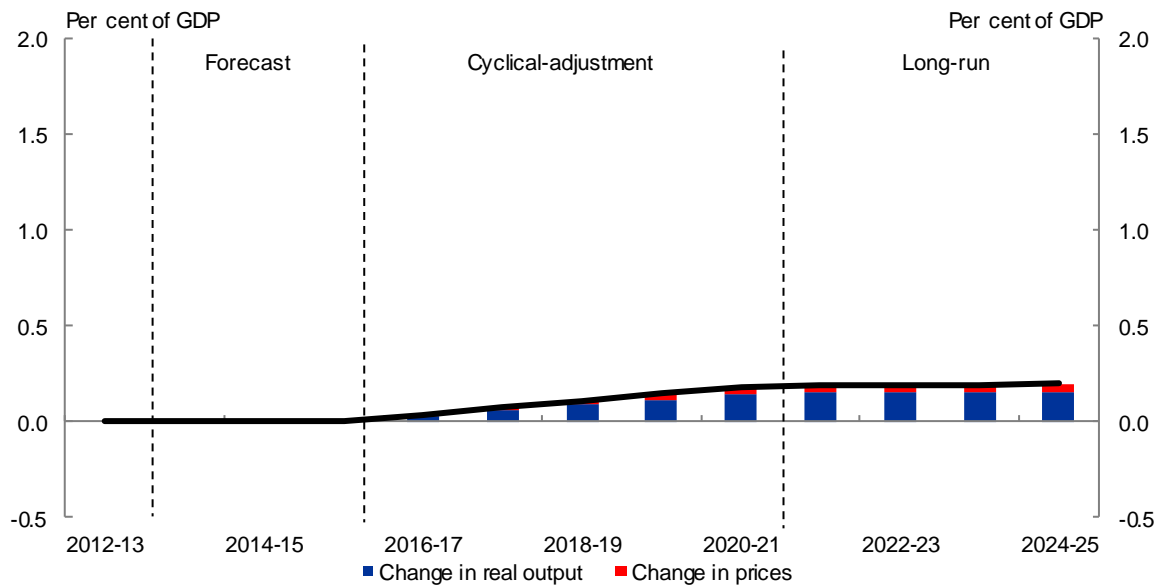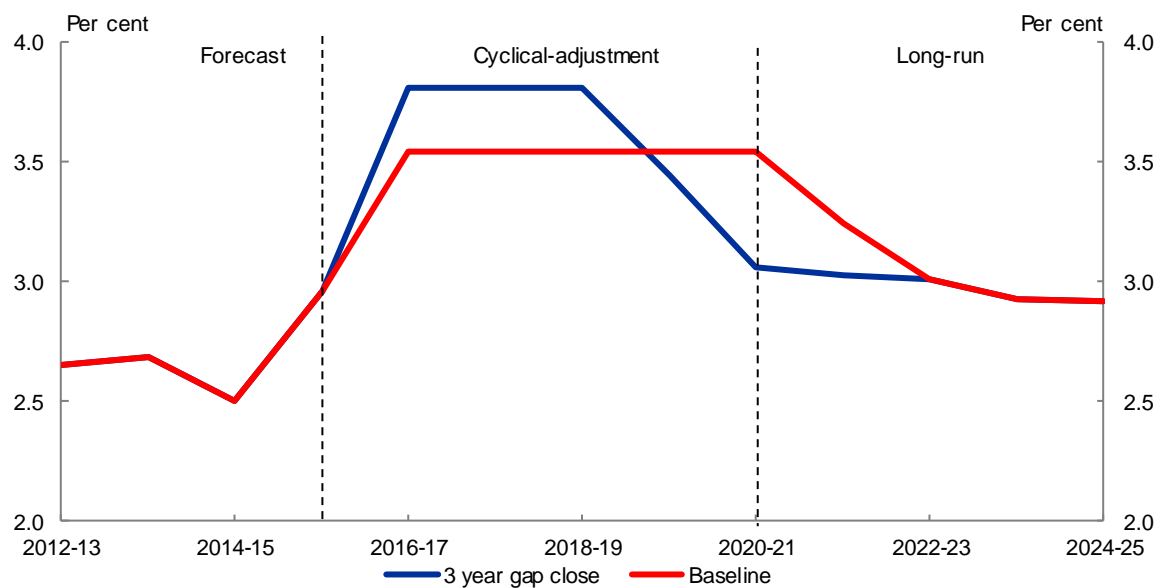

Cyclical adjustment assumptions

A key assumption of the new methodology is the time it takes to close the output gap. This section assesses the sensitivity of nominal GDP projections to closing the gap over three years as against the five years in the new methodology.

Output gap closed over three years

If the output gap were closed over a three year period then the constant year-average growth rate required to close the output gap would increase from 3.5 per cent to 3.8 per cent (Chart 22).

Chart 22: Real GDP growth rate—implications of closing the gap over three years

While the long-run level of potential output remains the same, the faster transition implies a lower unemployment rate over the cyclical-adjustment period (Charts 23 and 24) and hence permanently higher levels for both wages and output prices. Overall, closing the output gap over three years leads to nominal GDP that is $37 billion (1.3 per cent) higher in 2024-25 than it would be if the gap is closed over five years (Chart 25).
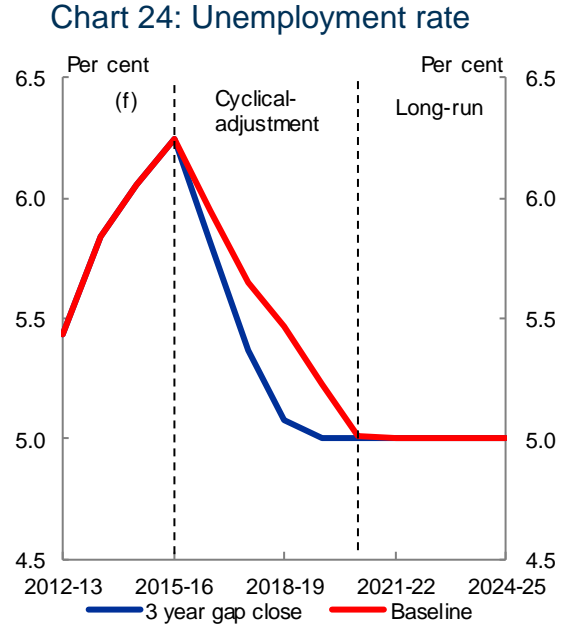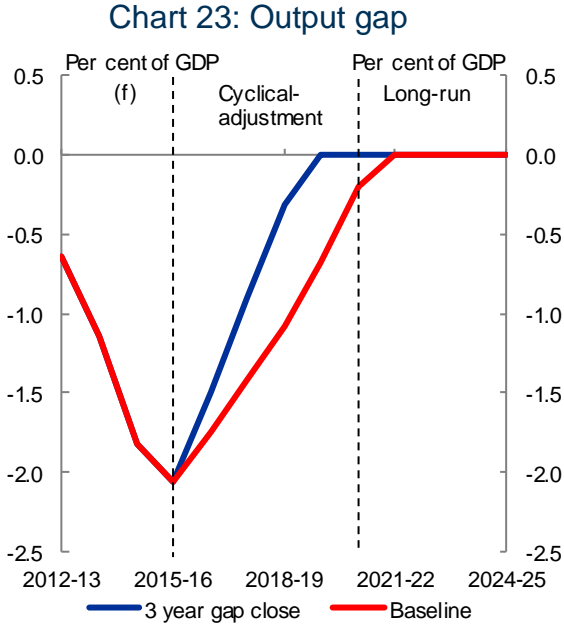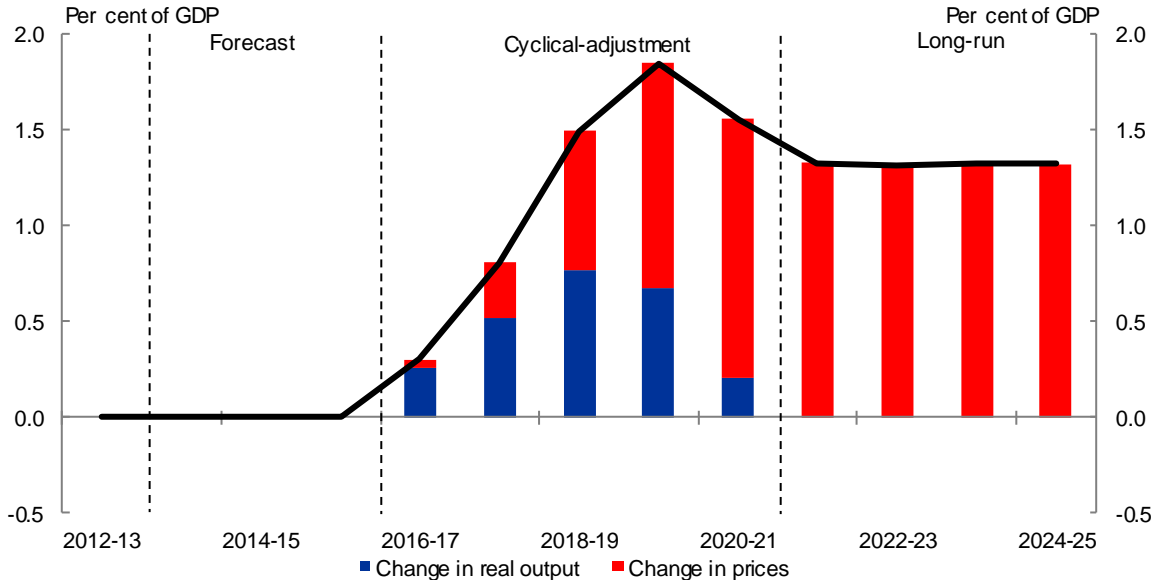
Chart 23: Output gap

Chart 24: Unemployment rate

Chart 25: Nominal GDP level—implications of closing the gap over three years

Cyclical position at the end of the forecast period

There are empirical studies which challenge the predominant approach of the literature by finding that fluctuations in the trend and cycle of real GDP are not independent, with cyclical fluctuations implying a permanent shift in the trend. In keeping with Treasury's philosophy that medium-term projections

should be based on parsimonious rules, the methodology developed in this paper follows the broader macroeconomics literature in assuming independence of the trend and cycle. The main consequence of that assumption is that variations in the cyclical position of the economy at the end of the forecast period have no effect on the long run level of real GDP, but do have a permanent effect on the level of nominal GDP through a changed price level over the medium-term. The size and speed of the cyclical response has no effect on the long-run level of real GDP because output converges to the level of potential output at the end of the cyclical adjustment period, while the size and speed of the cyclical response lead to different long-run levels of nominal GDP because the growth rate of wages and in turn output prices are strongly influenced by the unemployment gap.

This section assesses the implications of changes to the cyclical position of the economy at the end of forecast period on the medium-term projections. The framework is linear so proportionate upgrades and downgrades to the cyclical inputs will raise or lower the medium-term projections by the same amount. For brevity, changes during the forecast period are presented in terms of an upgrade to the forecasts. Similarly, while the analysis isolates the effect of an increase in forecast output or prices on nominal GDP, the impact of a combined increase in both is broadly the sum of the two individual effects.

Smaller (absolute) output gap reflecting a smaller unemployment gap

In the case of an economy operating below potential, higher real output at the end of the forecast period implies a smaller (absolute) output gap. This in turn lowers the constant growth rate required to close the output gap. For instance, a $9 billion increase in the level of real GDP forecast in 2015-16 (which is calibrated to achieve a $10 billion nominal GDP increase in 2015-16) reduces the output gap at the end of the forecast period (in absolute terms) from 2.1 per cent to 1.5 per cent of GDP (Chart 26) and the constant growth rate required to close the output gap falls from 3.5 per cent to 3.4 per cent per annum (Chart 27).

Chart 26: Output gap

Chart 27: Real output growth rate
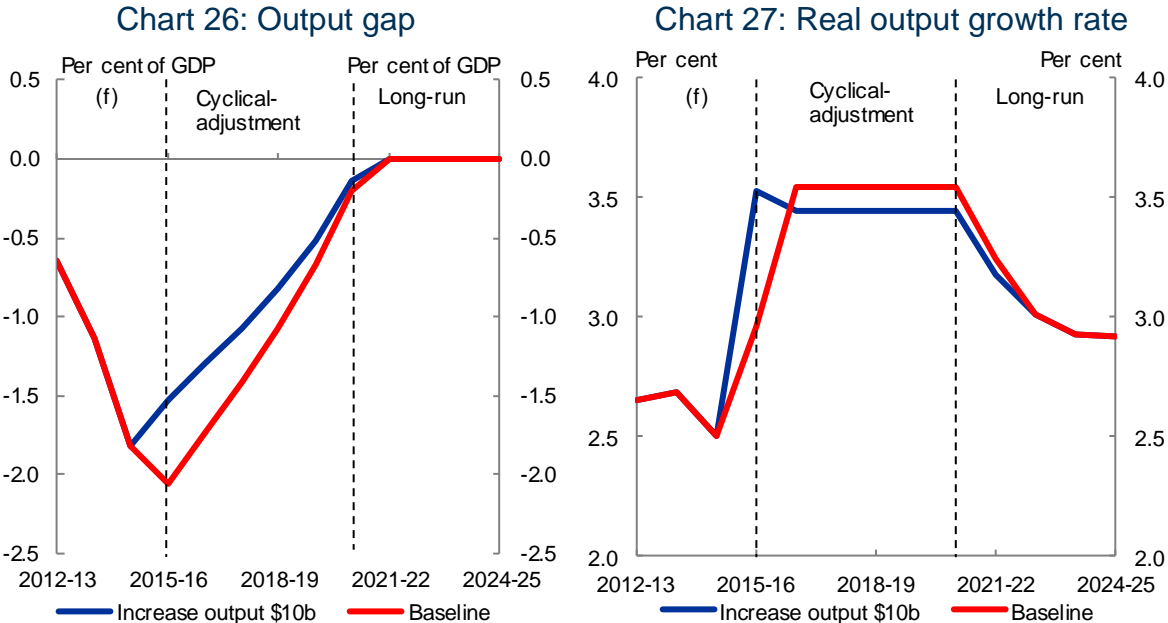
The effect of a change in the level of real output at the end of forecast period on the level of nominal GDP over the medium-term depends on the composition of the change. Assuming no change to potential output, an increase in output over the forecast period could be driven by an increase in cyclical employment, labour force participation or labour productivity. In practice it could be driven by a combination of all three.

Following Okun's law, the 0.6 per cent fall in the output gap is matched by a 0.6 per cent rise in the level of employment and a 0.3 percentage point rise in the participation rate, which implies a 0.3 percentage point fall in the unemployment gap (Charts 28 and 29).
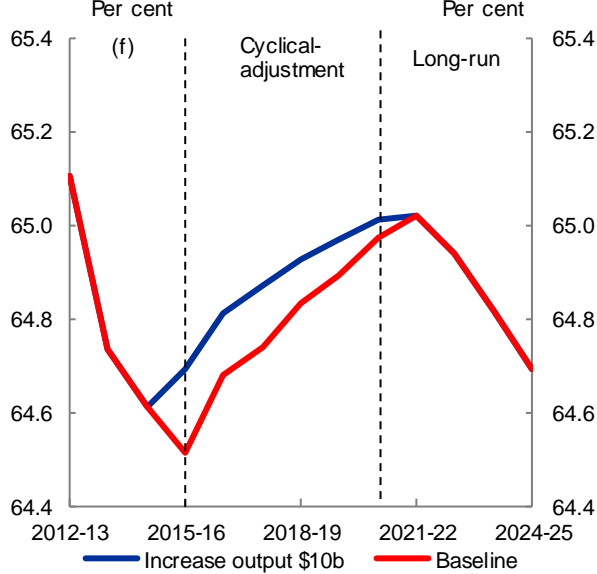
Chart 28: Unemployment rate
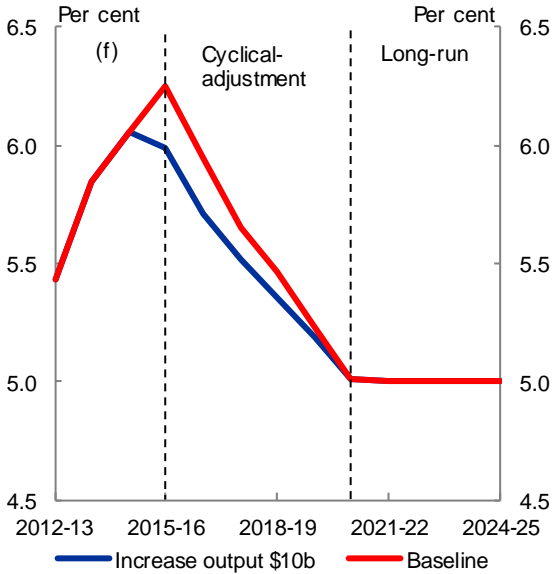
Chart 29: Participation rate

A fall in the unemployment gap places upward pressure on wages growth over the cyclical adjustment period (Chart 30), which leads to a permanent rise in the level of wages and output prices (Chart 31).

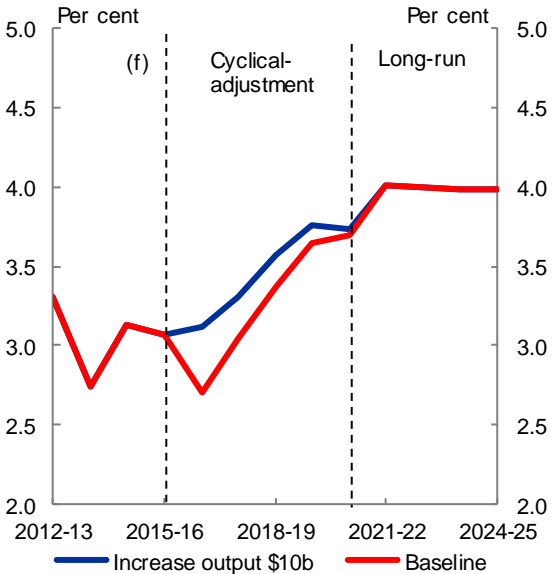### Chart 30: Wages growth rate

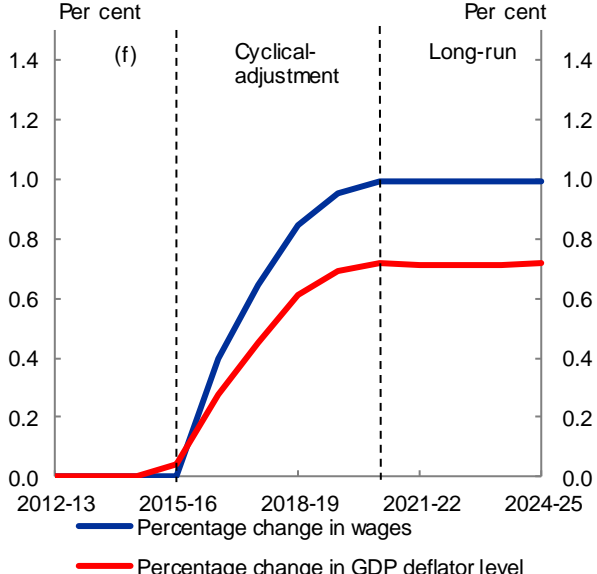### Chart 31: Wages and GDP deflator

Chart 32 demonstrates that changes to the level of real output at the end of the forecast period have no long-run effect on the level of real output, while there is a permanent effect on the level of prices and nominal GDP. In terms of the level of nominal GDP, the higher real GDP forecast implies an increase to nominal GDP of $10 billion (0.6 per cent) in 2015-16 which rises to $20 billion (0.7 per cent) in 2024-25.

Chart 32: Change in nominal GDP level—implications of smaller unemployment gap
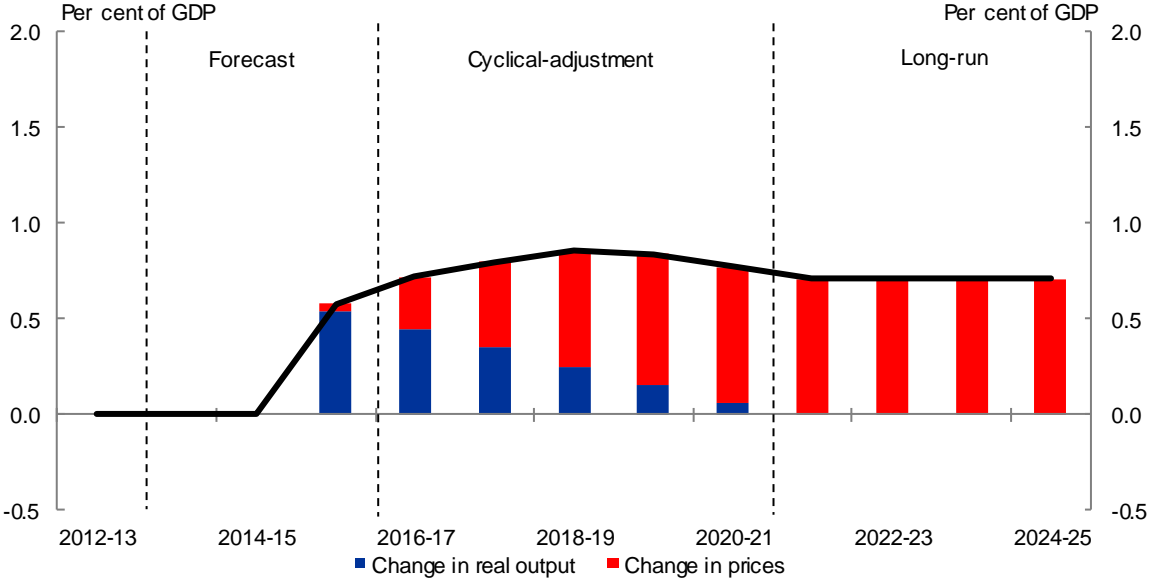
Smaller (absolute) output gap reflecting higher cyclical productivity

An alternative scenario is that the $9 billion increase in the level of 2015-16 real GDP is due to an increase in cyclical productivity. As in the previous scenario this causes the output gap at the end of the forecast period to fall (in absolute terms) from 2.1 per cent to 1.5 per cent (Chart 26) and the constant growth rate required to close the output gap to fall from 3.5 per cent to 3.4 per cent (Chart 27). However, an increase in real output caused by an increase in cyclical productivity implies a smaller change in employment and hence the unemployment rate (Chart 34).

The small increase in employment over the transition period is due to the dynamics of the cyclical productivity shock. Cyclical productivity has low persistence, with an autoregressive coefficient estimated to be 0.68. Cyclical productivity returns back to its trend in roughly two years. Over the remaining three years of the cyclical adjustment period, a higher level of real output is maintained through increased employment.
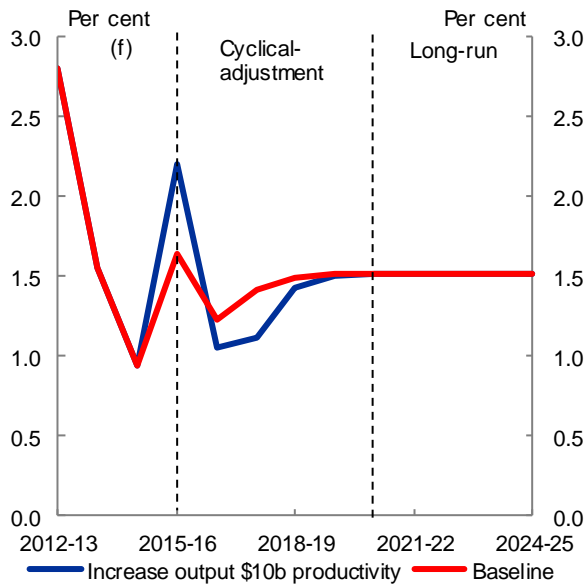
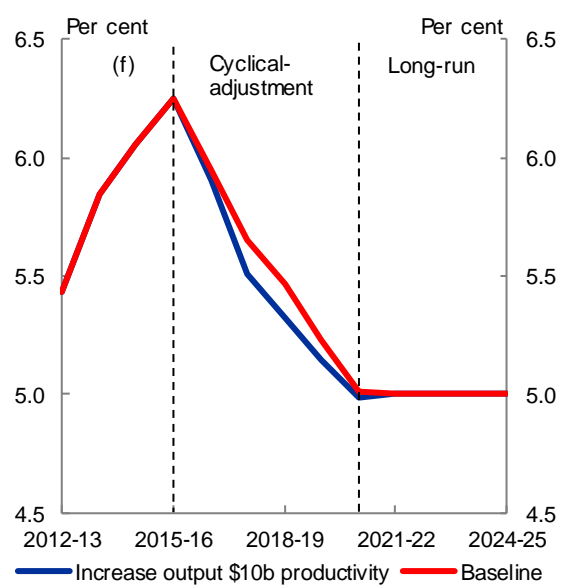## Chart 33: Productivity growth

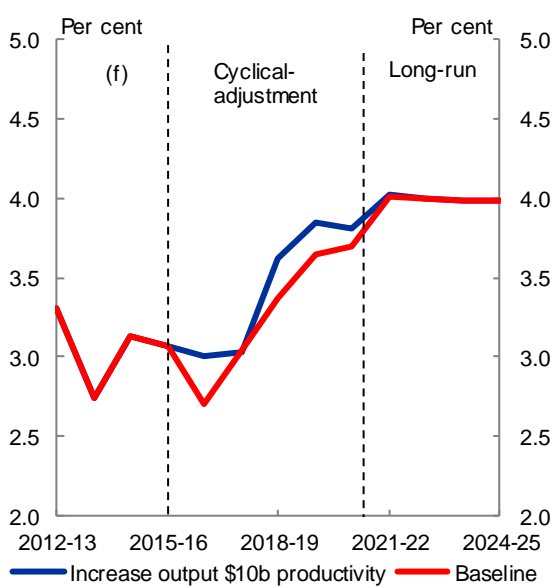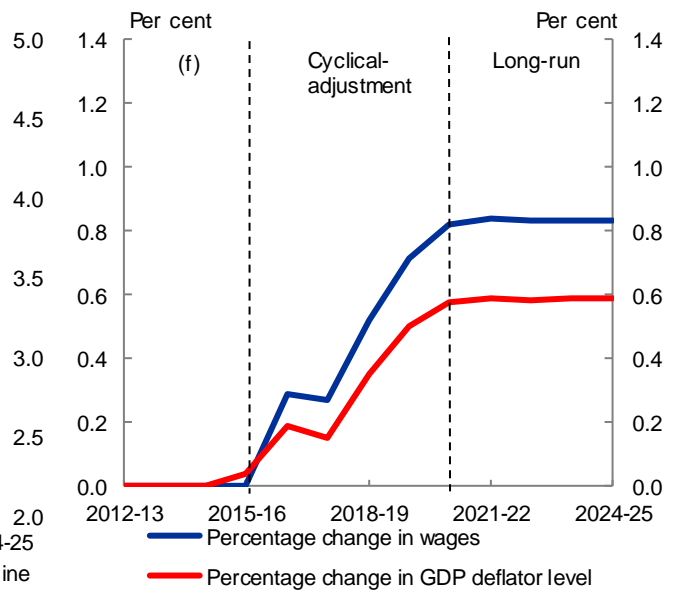## Chart 34: Unemployment rate

Chart 35: Wages growth rate

Chart 36: Wages and GDP deflator

While there is a decrease in the unemployment rate, the decrease is not as large as in the previous scenario. The increase in wages growth and therefore output prices are not as large (Charts 35 and 36). Overall, the effect of the rise in cyclical productivity is an increase in nominal GDP of $10 billion (0.6 per cent) in 2015-16 and $16 billion (0.6 per cent) in 2024-25 (Chart 37).

Chart 37: Change in nominal GDP level—implications of higher cyclical productivity
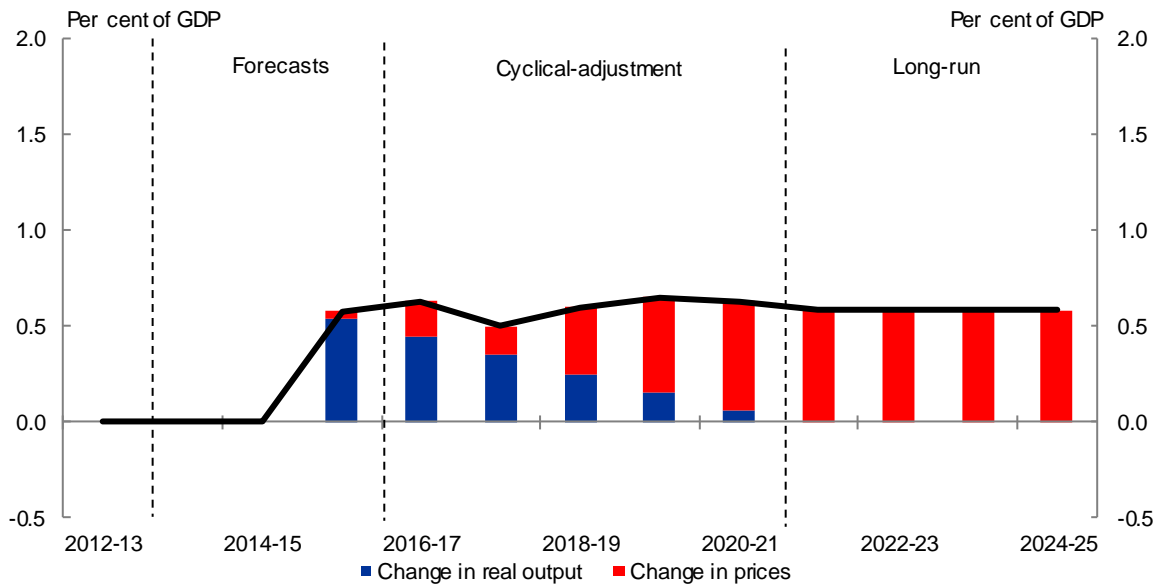
Higher output price

Changes to the level of output prices over the forecast period have a permanent effect. For example, an increase in the forecast level of output prices in 2014-15 that increases to the level of nominal GDP in 2015-16 by $10 billion (0.6 per cent) increases the level of nominal GDP by $16 billion (0.6 per cent) in 2024-25 (Chart 38).

Chart 38: Change in nominal GDP level—implications of higher output price
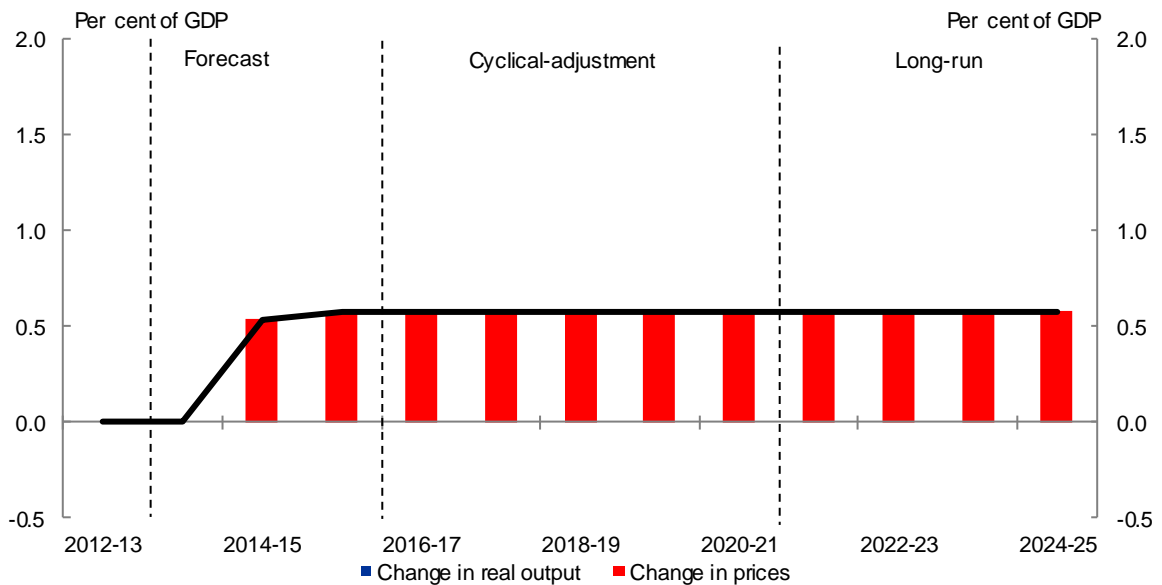
More generally, changes to the growth rate of output prices over the forecast period will also influence the projected growth rate of expenditure prices and in turn wages over the cyclical adjustment period. For example, the dynamics of the wage model (see equation 28) may generate a response in the output price above the initial change. The effect of these dynamics will depend on the timing of the change, with the response of output prices more sensitive to growth rate changes that occur at the end of the forecast period.

6. CONCLUSION

Treasury routinely assesses its medium- to long-run projection methodology in light of new data, improved modelling techniques and structural changes to the economy. The measured cyclical weakness of recent years calls for an enhancement to the existing trend growth rate rules, which recognises the need for an adjustment period over which the economy transitions from a cyclical high or low to its potential level of output. Working towards that end, this paper develops a projection methodology that overcomes the cyclical limitations of the existing framework. Applying these methodological changes to the economic estimates in the 2014-15 Budget generates minimal changes to revenue projections out to 2024-25. The methodological changes have a slightly larger effect on payment projections, with payments projected to be $1.5 billion (0.08 per cent of GDP) lower in 2017-18 and $2.4 billion (0.09 per cent of GDP) lower in 2024-25. Overall, the methodological changes lead to a slight improvement in the Underlying Cash Balance of $0.9 billion (0.05 per cent of GDP) in 2017-18 and $3.4 billion (0.12 per cent of GDP) in 2024-25.

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APPENDIX A: DATA SOURCES

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