Arndt-Corden Department of Economics

Crawford School of Public Policy

ANU College of Asia and the Pacific

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Chris Murphy

Arndt-Corden Department of Economics

Centre for Applied Macroeconomic Analysis

Tax and Transfer Policy Institute

Crawford School of Public Policy

Australian National University

Chris.Murphy@anu.edu.au

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Chris Murphy*

Abstract

The health policies the government introduced in March 2020 to contain the COVID-19 pandemic led to recession in the restricted industries. This recession was treated with a very large expansion of fiscal policy and the monetary policy interest rate was reduced to its assessed effective lower bound (ELB). This paper evaluates this macro policy response from the three related perspectives of pandemic macro policy principles, scenario analysis and optimal control of unemployment and inflation. Using scenario analysis, we find that the macro policy response was successful initially, reducing the peak rate of unemployment in mid-2020 by 2.0% points. However, the stimulus lingered for too long, in the end providing $2 of compensation for every $1 of private income lost to COVID. Under the macro policy principles for a pandemic, a *shorter stimulus* scenario is developed in which fiscal stimulus provides $1 for $1 compensation for income lost to COVID and the policy interest rate begins rising a year earlier, in May 2021. This reduces the peak inflation rate during 2022 by a simulated 2.1% points. Using optimal control, we find that the macro policy stimulus continued for too long irrespective of whether we place a high or low weight on controlling unemployment relative to inflation. In future pandemics, fiscal policy should compensate, but not over-compensate, economic agents for income losses due to restrictions and should not stimulate aggregate demand.The monetary authorities should focus on inflation in the industries not subject to restrictions.

JEL classification: E37, E52, E62, E63

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1 Introduction

In March 2020 the COVID-19 pandemic reached Australia. This paper evaluates the very large macro policy response that followed from the three related perspectives of macro policy principles for pandemics, scenario analysis and optimal control of unemployment and inflation.

In a key public health response to COVID-19, the government introduced mandatory social distancing in the "unsafe" industries believed to pose the highest risk of infection. This, combined with voluntary social distancing, led to an economic downturn concentrated in the unsafe industries. Although the unsafe industries account for only one out of six jobs, they accounted for two out of three job losses when social distancing was introduced. The worst-affected unsafe industries included food and beverage services, accommodation, air transport and airports, travel agencies, sports and recreation services, and personal care services.

This deliberate reduction in economic activity in the unsafe industries caused two economic problems. First, workers and business owners in the unsafe industries faced losing some or all of their incomes, leaving them bearing an unfair share of the cost of supporting public health. Second, in response to such income losses, participants in the unsafe industries could lower their spending, causing the recession to spread to the safe industries. Such concerns led to a fulsome macro policy response including a massive fiscal expansion and a reduction in the monetary policy interest rate to its assessed effective lower bound (ELB).

These policy responses to COVID raise two broad policy questions. First, was the level of mandatory social distancing optimal? Second, was the fulsome macro policy response, including for both fiscal and monetary policy, appropriate in size, nature and duration.

On the first question, social distancing was so successful in supporting public health that the Australian Bureau of Statistics (2023) reports that Australia experienced *negative* excess mortality during the COVID period of 2020 and 2021[1]. Wang (2022) finds that Australia was one of only five economies with that positive health outcome, the other four being Iceland, Singapore, New Zealand and Taiwan[2].

Determining the optimal amount of mandatory social distancing is complex. It involves balancing the health benefits against the economic costs at the margin, which is best done using integrated epidemiology and macroeconomic models. Eichenbaum, Rebelo and Trabandt (2021) do this for the United States, but we leave it to others to do that for Australia. Instead, we take the level of social distancing as given, and focus on the second question.

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[1] Excess mortality in Australia was –2,000 deaths for 2020 and 2021 combined, although it rose to +20,000 deaths in 2022 (ABS, 2023).

[2] All five of these economies had the advantage of isolation that comes from being an island and the advantage in funding public health that comes from being an advanced economy.

The aim of this paper is to use the benefit of hindsight to draw lessons for how macro policy can be better conducted in future pandemics. The aim is not to evaluate the performance of policymakers in March 2020 with the limited information, time and options available to them.

Our evaluation of the macro policy response to COVID is in three parts, corresponding to the different perspectives we use of macro policy principles, scenario analysis and optimal control. These perspectives are complementary as they each have different strengths and limitations.

Macro policy principles

In the first part of this paper, we evaluate the Australian macro policy response to COVID against the principles for macro policy in pandemics recently developed in two landmark papers. Woodford (2022) and Guerrieri, Lorenzoni, Straub and Werning (2022) show rigorously that national economic welfare can only be maximised[3] if economic agents that incur income losses due to pandemic restrictions are fully compensated using targeted fiscal transfers. Guerrieri et al. (2022) also show that monetary policy should look passed the economic downturn deliberately created in the unsafe industries to support public health, and instead target employment/inflation in the safe industries.

Full fiscal compensation is important for both horizontal equity and macro stability. Full compensation means that the workers and business owners in the unsafe industries who suffer income losses due to containment policies are not required to bear an unfair share of the cost of supporting public health, thus maintaining horizontal equity. Full compensation also means that those same workers and business owners can maintain their spending so that the economic downturn does not spread to the safe industries, thus supporting macro stability.

Murphy (2023a), Breunig and Sainsbury (2023) and Jordà and Nechio (2023) have all shown that there was fiscal over-compensation for COVID income losses in Australia, and Jordà and Nechio (2023) have also shown that Australia was one of the few countries where this occurred. At the aggregate level, Murphy (2023a) found there was $2 of compensation for every $1 of private income lost to COVID, even though some workers and business owners were under-compensated. We make two contributions in the first part of our evaluation.

First, we highlight the findings of the two landmark papers and use them to evaluate not only the size of the Australian macro policy response, but also its nature. For example, this evaluation favours fiscal programs that to some extent targeted COVID income losses, such as JobKeeper, over fiscal programs that simply stimulated aggregate demand, such as the bringing forward of the stage 2 personal income tax cuts. Second, we show that in 2020 the size of the macro policy response was broadly appropriate, but fiscal over-compensation and

[3] National economic welfare depends positively on current and expected future consumption of the products of the safe and unsafe industries and negatively on the risk of infection.

excessive monetary stimulus arose when the response extended beyond the end of COVID restrictions.

The second and third parts of our paper use an Australian macro-econometric model to quantify how unemployment and inflation would have been controlled under alternative approaches to macroeconomic policy during COVID. We now introduce the macro-econometric model.

Macro-econometric model

We use the same detailed model of Australia as Murphy (2023a), updated for the latest data and further refined. Like earlier versions of our model dating back to Murphy (1988), our model can be described as New Keynesian. While it has much in common with DSGE models, it differs in that it does not assume that household consumption decisions are based on intertemporal optimisation.

For analysing the COVID recession and the macro policy response to it, our model has three advantages over two prominent Australian macro-econometric models. Those two models are the Treasury's EMMA model (Bullen, Conigrave, Elderfield, Karmel, Lucas, Murphy, Ruberl, Stoney and Yao, 2021) and the RBA's MARTIN model (Ballantyne, Cusbert, Evans, Guttmann, Hambur, Hamilton, Kendall, McCririck, Nodari and Rees, 2020).

First, with six industries, our model better captures how COVID impacted unevenly across the economy. Second, our model contains more fiscal detail to better differentiate the economic effects of the programs included in the fiscal policy response. Third, our model captures the macro effects of COVID social distancing using indicators of geographic immobility.

Without those three advantages, other forecasters were unable to foresee in 2021 the outbreak of inflation that occurred in 2022. The Treasury (Australian Government, 2021b), the RBA (Reserve Bank of Australia, 2021) and a panel of non-government forecasters (Martin, 2021) all forecast that inflation would fall within the RBA's band of 2 to 3 per cent. In contrast, using the modelling approach of this paper, Murphy (2021b) forecast that inflation would reach a peak of 6.2 per cent. The inflation outcome in 2022 was even higher at over 7 per cent.

Macro policy scenarios

In the second part of this paper, we evaluate the Australian macro policy response to COVID using multiple policy scenarios. These scenarios include a *baseline* scenario that uses the actual policy response, and a *shorter stimulus* scenario that uses the macro policy principles for a pandemic that were described in the first part of this paper. We assess how well unemployment and inflation are controlled in each scenario. Our broader purpose is to quantify the potential public benefit from using a better approach to macro policy in future pandemics.

Murphy (2023a) used scenario analysis to quantify how unemployment and inflation outcomes would have been different under a *default policy* response to COVID that is relatively passive. After updating his results for the latest data and some modelling improvements, we find that, compared to the *default policy* scenario, the actual policy response captured in the *baseline* scenario reduced the peak in the unemployment rate in mid-2020 by 2.0 percentage points, but added 3.4 percentage points to the peak in the inflation rate during 2022.

These unemployment and inflation effects are based on a comparison of macro policy extremes. At one extreme, under the actual fiscal policy of the *baseline* scenario, fiscal stimulus provided $2 of compensation for every $1 of private income lost to COVID, as noted above. At the other extreme, under the *default policy* scenario, there is $0 of compensation for every $1 of lost income. Murphy (2023a) argued that fiscal policy should chart a course between these two extremes by using full compensation, that is, $1 of compensation for every $1 of lost income. However, Murphy (2023a) does not model such a scenario.

This paper fills that gap by adding a scenario with full compensation[4], a *shorter stimulus* scenario. As noted above, this scenario is designed to be broadly consistent with the macro policy principles for a pandemic. This involves shortening the length of the fiscal stimulus to reduce compensation to the targeted $1 for $1 rate and reducing by one year the length of time that the policy interest rate is at the ELB. This policy approach does not require that policy makers have foresight. Rather, the fiscal policy response is tailored to the duration of pandemic restrictions and a backward-looking Taylor rule is used for monetary policy.

We find that the *shorter stimulus* scenario is better for macro stability than both the *baseline* scenario and the *default policy* scenarios. Peak unemployment in mid-2020 is 1.6 percentage points lower than under the *default policy* scenario, while peak inflation during 2022, at 5.0 per cent, is 2.1 percentage points lower than under the *baseline* scenario. Thus, with its $1 for $1 compensation for COVID income losses, the *shorter stimulus* scenario finds the fiscal policy sweet spot, being well-designed for both horizontal equity and macro stability.

How confident can we be in our estimate that over-prolonged macro policy stimulus added 2.1 percentage points to peak inflation in 2022? Among Australian macro-econometric models, our model is best placed to provide such an estimate because it forecast an outbreak of inflation in 2022, and this was associated with the three structural advantages it has in modelling macro policy under COVID that were noted above. We also consider other evidence on the magnitude of this inflation effect, beyond that available from Australian macro modelling.

First, the fiscal inflation multiplier under accommodating monetary policy implied by our results is similar to comparable multipliers from leading macro models of the USA and the EU, as reported in Coenen et al. (2012). Second, an international study of fiscal policy and

[4] I would like to thank Angela Jackson for the important suggestion of adding a full compensation scenario.

inflation under COVID conducted at the US Federal Reserve (Jordà and Nechio, 2022) implies an inflation effect for Australia matching our estimate of 2.1 per cent. Third, the CPI analysis method developed by Shapiro (2022) of the US Federal Reserve applied to the associated Australian data in Beckers, Hambur and Williams (2023) implies that demand factors added 2.3 percentage points more than usual to inflation in 2022. These leading examples of other approaches provide further evidence that excessive macro policy stimulus under COVID added about 2.1 percentage points to peak inflation in Australia.

Optimal control of macro policy

In the third part of this paper, we evaluate the Australian macro policy response to COVID using open-loop optimal control. We find the macro policy response that best controls unemployment and inflation. We then compare the resulting *optimal control* scenario with the *shorter stimulus* scenario and evaluate the relative merits of the two scenarios.

The *optimal control* scenario controls unemployment and inflation only a little better than does the *shorter stimulus* scenario. However, it does this using a macro policy mix that clearly under-compensates for COVID income losses, and thereby reduces horizontal equity. Overall, it is judged that the *shorter stimulus* scenario achieves the better outcome for national economic welfare, as expected under the macro policy principles for a pandemic.

In using optimal control, we follow Brayton, Laubach and Brayton (2014) of the US Federal Reserve by assigning the same weight to controlling both inflation and unemployment. We test the sensitivity of the *optimal control* scenario to that equal weight assumption. The peak inflation rate is 5.5 per cent under a policy dove who places four times more weight on control of unemployment than of inflation, and 4.5 per cent under a policy hawk who places all the weight on control of inflation. Both the dove and the hawk agree that the macro policy stimulus was continued for too long, leading to the higher actual peak inflation rate of 7.1 per cent.

Finally, we evaluate monetary policy under COVID against two alternative policy benchmarks, one backward-looking and one forward-looking. Both benchmarks target gaps between inflation and its target of 2.5 per cent and the unemployment rate and its sustainable rate. We begin by considering the backward-looking benchmark, similar to Gross and Leigh (2022).

Gross and Leigh (2022) find that the RBA outperformed a backward-looking benchmark for monetary policy in the 2001 slowdown and in the Global Financial Crisis, in both cases by using a more expansionary monetary policy. However, they find that it under-performed that same benchmark during the pre-pandemic period of low inflation from 2016 to 2019, this time by using a less expansionary policy. This paper finds that the RBA again under-performed a backward-looking benchmark in 2021-22, this time by using a more expansionary policy.

This underperformance of monetary policy added 0.7 percentage points to the peak inflation rate. The over-compensating nature of the fiscal policy response added a further 1.4 percentage points. Thus, as found in the second part of our evaluation, macro policy added

2.1 percentage points to peak inflation during 2022, compared to our preferred *shorter stimulus* scenario.

Our forward-looking benchmark for monetary policy assumes perfect foresight. With such foresight, the RBA would have been able to neutralise 0.7 percentage points of the contribution to peak inflation of 1.4 percentage points from fiscal policy. In reality, perfect foresight about factors such as the future course of the pandemic is unobtainable. However, the results illustrate the point that better forecasting of the effects of fiscal policy on inflation can lead to better macroeconomic control.

This paper is organised as follows. In the first part of our evaluation, we set out the principles for macro policy in pandemics in section 2 and use those principles to evaluate the Australian macro policy response in section 3. In the second part of our evaluation, we provide an overview of our macro-econometric model in section 4, explain its default and optimal control macro policy regimes in section 5 and present the scenarios for macro policy under COVID in section 6. In the third part of our evaluation, we present the main optimal control scenario in section 7, the hawk and dove variants in section 8 and the evaluation of monetary policy under COVID in section 9. In section 10 we draw lessons for macro policy in future pandemics.

2 Principles of Macro Policy in a Pandemic

This first part of our evaluation of the Australian macro policy response to COVID assesses that response against the principles for macro policy in a pandemic. This section sets out the principles for macro policy in a pandemic, which are then applied in section 3 to evaluate the Australian policy response.

The need for a macro policy response to a pandemic arises mainly from the recession induced by voluntary and mandatory social distancing. Hence, to put the macro policy response in context, we begin by briefly considering the economics of social distancing. After reviewing that literature, in the remainder of this paper we take the extent of social distancing as given.

Our main concern in this section is to understand the appropriate macro policy response to the recession caused by social distancing of whatever type. From the post-COVID literature on the macroeconomics of pandemics, we will see that the ideal fiscal policy response compensates workers and business owners in the affected industries for their income losses caused by government containment policies.

If that principle is valid, we should observe that countries that ran excessively expansionary fiscal policies by *over*-compensating for their COVID income losses tended to experience higher inflation post-COVID than the countries that avoided over-compensation. This section concludes by reporting on studies that have tested that proposition.

2.1 Optimal Mandatory Social Distancing

Eichenbaum, Rebelo and Trabandt (2021) take an epidemiology model and extend it using a macroeconomic model. This innovative blending of models allows them to study the interaction between economic decisions and epidemics in the USA. Their aim is to find the best pandemic containment policy.

Disease transmission is modelled in the epidemiology model, while in the macroeconomic model individuals maximise their own intertemporal utility. In an epidemic, uninfected individuals voluntarily socially distance by cutting back on consumption and work, simultaneously reducing the transmission of disease and inducing a recession. In macroeconomic terms, voluntary social distancing shifts labour supply and consumer demand curves to the left.

A market failure arises because infected individuals don't bear the full costs of infecting others. This negative externality means that infected individuals socially distance less than is socially optimal. To address this, it is appropriate to have a government containment policy that mandates additional social distancing. However, such a containment policy deepens the recession. Eichenbaum et al. (2021, p. 5151) conclude that "we are confident that the central message from our current analysis will be robust: there is an inevitable trade-off between the severity of the recession and the health consequences of the epidemic". In Eichenbaum et al. (2021) mandatory social distancing takes the form of restrictions on industry, so it shifts consumer supply curves to the left[5].

Eichenbaum et al. (2021, p. 5173) find that the optimal containment rate, or degree of mandatory social distancing, is approximately proportional to the infection rate. The reason for this is that "containment measures internalize the externality caused by the behavior of infected people". Treasury (2021a) points out that the average cost of becoming infected is lower under higher vaccination rates. Hence, under higher vaccination rates, a given infection rate should lead to less mandatory social distancing.

Eichenbaum et al. (2021) distinguish between voluntary and mandatory social distancing so they can reach policy conclusions on the optimal amount of mandatory social distancing or containment. However, we wish to reach policy conclusions on another important policy issue, the response of macroeconomic policy to a pandemic. Thus, like the studies we discuss below, we do not need to distinguish between voluntary and mandatory social distancing.

What is important for our study is that Eichenbaum et al. (2021) find that the combination of voluntary and mandatory social distancing causes negative shocks to household consumption demand and supply and labour supply. We find the same effects in further developing our macroeconomic model of Australia to account for COVID, as explained in section 4. However,

[5] In practice, mandatory social distancing can also include stay-at-home orders, which have macroeconomic effects similar to voluntary social distancing.

our use of a larger model means that we can take other COVID-related effects into account as well.

2.2 Optimal Macro Policy Response

In May 2022, the American Economic Review (AER) published a collection of three important papers modelling the nature of the COVID economic shock and the appropriate macro policy response. In modelling COVID, all three papers recognise that health considerations resulted in lower activity in specific industries that were at higher risk of spreading the disease. Hence, the papers distinguish between those "unsafe" industries and the other "safe" industries and factor in that lower economic activity in the unsafe industries had not only an economic cost, but also a health benefit.

Earlier COVID studies generally used macro models that had only a single industry and/or did not recognise the health benefit. For example, Eichenbaum et al. (2021) use a model that recognises the health benefit of restrictions but only contains a single industry.

When recessions arise from a deficiency in aggregate demand, as they often do, they are appropriately countered with policies that stimulate aggregate demand. But when a recession emanates from health considerations in specific industries, the AER papers show that the appropriate macro policy response is different.

Woodford (2022) observes that the COVID pandemic resulted in an unusual type of recession "with some activities having to shut down completely for the sake of public health, while others continue almost as normal". This first round effect can lead to a second round effect when "the cessation of payments for the activities that are no longer safe interrupts the flow of payments that would ordinarily be used to finance other activities". For example, when restaurants and theatres are closed for public safety, some of their stood down staff will be forced to spend less, leading to lower employment in other industries. In this second round effect, unemployment spreads from the unsafe to the safe industries.

To study this COVID economic shock and the optimal response to it, Woodford (2022) develops a tailored theoretical model of a national economy. This multi-industry model distinguishes between safe industries that continue to operate during COVID and unsafe industries that suspend operations and stand down their workers. These stood down workers temporarily lose their incomes, and in Woodford's model this forces them to halt their consumption of the products of the safe industries, because workers are assumed not to have access to finance. Lower demand causes unemployment in the safe industries because wages are assumed to be sticky. Thus, without a government policy response, the first round effect of unemployment in the unsafe industries leads to a second round effect of unemployment in the safe industries.

Taking these COVID effects into account, Woodford (2022) uses his model to find the macro policy response that maximises national economic welfare. The measure for national economic welfare is constructed in two steps. In the first step, individual economic welfare depends on the time-discounted sum of utility obtained in each time period from consumption of the products of the safe and unsafe industries, adjusted for the risk of infection. In the second step, national economic welfare is obtained by summing individual economic welfares.

Woodford (2022) finds that national economic welfare is maximised by using a fiscal transfers policy. This optimal policy taxes the would-be buyers of the products of the unsafe industry an amount equal to the value of their blocked purchases and then uses the proceeds to fully compensate suppliers of the unsafe products for their loss of income from those blocked purchases. This fiscal transfers policy restores payments in the economy to what they would be in the absence of a pandemic. This avoids the "significant disruption of the 'circular flow' of payments" that would otherwise occur. This optimal policy eliminates the second round effect in which unemployment spreads from the unsafe industries to the safe industries.

Guerrieri, Lorenzoni, Straub and Werning (2022) use a broadly similar modelling approach to Woodford (2022) but there are some significant differences, and we highlight three of those differences here. On the one hand, they simplify by recognising only two industries, a single safe industry and a single unsafe industry. On the other hand, they add realism by taking into account that some workers do have access to finance. Finally, they add further realism by assuming that income compensation for the unsafe industries is funded by issuing additional government debt rather than by the contemporaneous tax proposed by Woodford (2022)[6]. Post-COVID, there is a tax increase in perpetuity to fund the interest on this additional debt.

In the Guerrieri et al. (2022) model, recognising that some workers have access to finance changes the results. When workers in the unsafe industry are stood down and temporarily lose their incomes, the workers without access to finance are forced to halt their consumption of the product of the safe industry, as in the Woodford model. However, workers with access to finance will be better able to maintain their consumption of the product of the safe industry, lessening the job losses in the safe industry. Those smaller job loss can be eliminated with less than full income compensation for the unsafe industry.

It is not surprising that full income compensation of the unsafe industry is not needed to maintain activity in the safe industry, once more realistic assumptions about consumer behaviour are made. Full income compensation for the unsafe industry would restore private incomes to their pre-COVID level. But the pre-COVID level of private income is more than is needed to maintain demand for the product of the safe industry, because the product of the unsafe industry is no longer available for purchase.

Thus, in the Guerrieri et al. (2022) model, employment in the safe industry can be maintained by only partially compensating workers in the unsafe industry for their income losses. However, full income compensation is needed to maximise economic welfare. This is because

[6] Woodford's tax on the value of suppressed consumption is an ingenious idea at the conceptual level, but probably both impractical and politically infeasible.

maximising economic welfare requires horizontal equity: the economic cost of suspending activity in the unsafe industry must be spread equitably rather than met disproportionately by workers unlucky enough to work in the unsafe industry.

Guerrieri et al. (2022) extend their modelling to the case where an industry is shut down partially rather than fully. Using their extended model, they determine the three principles for macroeconomic policy in a pandemic that are "first best for a utilitarian social planner". The three principles are set out in the paper as remark 3 (Guerrieri et al., 2022, p. 1462).

1) Choose levels of restrictions on the unsafe industries that optimally balance the health costs from consumption of their goods against the economic benefits.
2) With fiscal policy, fully compensate participants in the unsafe industries for their income losses from those restrictions. This is particularly important for participants who do not have access to finance.
3) Set the policy interest rate to target employment/inflation in the safe industries.

These three principles provide the health, fiscal and monetary authorities with their separate targets to be pursued with their separate instruments. A first best outcome is only obtained if all three authorities do their job. This requires co-ordination because health restrictions generate the need for fiscal compensation payments and fiscal compensation payments mean that monetary policy should be less expansionary than otherwise.

In practice, applying the first principle to determine the appropriate level of restrictions at each point in time is complex. However, the Eichenbaum et al. (2021) study establishes a methodology for this and applies it to data for the USA. We leave it to other authors to apply a similar methodology to evaluate the COVID restrictions in Australia. This study is concerned with the macro policy response to COVID, and so we focus on the second and third principles.

The second principle requires that the fiscal compensation is paid to the economic agents who incur the income losses. Only aiming to compensate the private sector as a whole, with over-compensation of some balanced by over-compensation of others, is too blunt a policy. There are two reasons it is important to properly target compensation payments.

First, targeting compensation at those who lose income because of COVID restrictions is necessary to maintain horizontal equity. Second, targeting compensation at that group, especially those members who do not have access to finance, is necessary so that they can maintain their spending on the products of the safe industries, thus supporting macroeconomic stability. Untargeted compensation payments are more likely to be saved in the first instance. The theoretical models of Woodford (2022) and Guerrieri et al. (2022) take this into account.

This ideal fiscal policy response of full compensation for COVID income losses does not involve fiscal policies to stimulate aggregate demand. The pandemic is a sectoral shock that impacts on the unsafe industries and is best met by replacing their lost income.

In their modelling of an ideal fiscal response, both Woodford and Guerrieri et al. (2022) include a method for funding their compensation payments to participants in the unsafe industries, although their methods differ, as noted above.

The third principle requires that the monetary authorities look passed lower employment in the unsafe industries, because it has been deliberately created for the benefit of public health. Rather, the monetary authorities should target employment/inflation in the safe industries.

Both Woodford (2022) and Guerrieri et al. (2022) make the simplifying assumption that labour is industry-specific and hence is immobile between industries. In reality, there would be some movement of labour from the unsafe industries to the safe industries during a pandemic and then back to the unsafe industries after the pandemic. However, given that COVID outbreaks lasted for months rather than years, the amount of this back-and-forth movement of labour is likely to be small[7]. Abstracting from these movements is a reasonable short run assumption, particularly compared to the assumptions made in some earlier macroeconomic COVID studies that make no distinction between safe and unsafe industries and instead model an economy as a single industry.

A key proposition from these international studies is that macro stability and horizontal equity are best achieved by fiscal authorities exactly compensating for COVID income losses. If that is the case, we should observe that countries that ran excessively expansionary fiscal policies by *over*-compensating for their COVID income losses tended to experience higher inflation post-COVID than countries that avoided over-compensation. We now consider the evidence on whether that was the case.

2.3 International Comparisons

There have been two main studies, both conducted at US Federal Reserve Banks, that test whether differences in inflation outcomes between countries post-COVID are systematically linked to differences in their fiscal policy responses during COVID.

In a simpler study, de Soyres, Santacreu and Young (2022, 2023) used IMF data for 52 countries in a cross-country regression. They regressed "excess inflation" in the 12 months to February 2022 against the rate of fiscal stimulus during 2020 and 2021. Their results imply that domestic fiscal stimulus added 2.6 percentage points to annual inflation in the United States. Australia was not included in their study.

In a more advanced study, Jordà and Nechio (2023) model inflation in 17 OECD countries using quarterly panel data extending from 2007 to 2021. They investigate the link to inflation from fiscal overcompensation for COVID income losses. Under their approach, fiscal over-compensation occurs when fiscal support pushes real household disposable income above

[7] In reality, these inter-industry shifts in employment are likely to be small in the very short run because the existing industry pattern of capital stocks will limit flexibility in the industry pattern of employment, and businesses will seek to avoid unnecessary hiring and firing costs.

trend despite the income loss from COVID itself. This approach to modelling the effect of fiscal policy on inflation is superior to that of de Soyres et al. (2022, 2023) in that it takes into account that the size of the appropriate fiscal stimulus depends on the size of the COVID income loss.

Jordà and Nechio (2023) find that five of the 17 OECD countries engaged in fiscal overcompensation, which they describe as aggressive fiscal support. The five countries are the United States, with the highest degree of fiscal over-compensation, followed by Canada, Australia, Ireland and Norway. There was fiscal under-compensation in the remaining 12 OECD countries, which Jordà and Nechio (2023) describe as the passive group and which they use as their control group[8].

In their regression analysis using their panel data, Jordà and Nechio (2023) employ a difference-in-differences approach with country and time fixed effects. This is designed to control for differences between countries in their normal inflation rates and in time-based effects that are common to all countries, such as the pandemic itself and global economic cycles.

Using their regression results, Jordà and Nechio (2023, p. 9) develop the rule-of-thumb that COVID fiscal over-compensation involving a positive real income gap of 5 per cent adds nearly 3 percentage points to the peak rates of wage and price inflation. Jordà and Nechio (2023) do not control for monetary policy and acknowledge that their estimates refer to a period in which "monetary policy was specially accommodating almost everywhere". Thus, their rule-of-thumb refers to the effect of fiscal policy on inflation under accommodating monetary policy.

Applying this rule-of-thumb to their calculated COVID real income gap for Australia at the June quarter 2021 of 3.6 per cent, implies that fiscal over-compensation under accommodating monetary policy subsequently added 2.1 percentage points to our inflation rate. In the Australian modelling presented in the second part of this study, we obtain an identical estimate for the effect of excessive macro policy stimulus in Australia on peak inflation.

3 Australian Macro Policy Response to COVID

This section applies the pandemic policy principles set out in section 2 to evaluate the Australian macro policy response to COVID. The fiscal and monetary policy responses are summarised and evaluated in turn. We also refer to Treasury and RBA perspectives on the macro policy response.

[8] The control group is Netherlands, Finland, Belgium, Sweden, France, Germany, the United Kingdom, Italy, Portugal, Denmark, Austria and Spain.

3.1 Fiscal Policy

Here we assess the size, nature and duration of the fiscal policy response to COVID against the pandemic policy principle of fully compensating workers and businesses owners in the unsafe industries for their income losses from COVID social distancing.

The Fiscal Response

During the COVID era of 2020 and 2021, the Federal Government announced a very large expansion of fiscal policy. The total net budget cost over the Forward Estimates of policy measures announced in those two years was $428 billion (Figure 1). This was in sharp contrast to the mildly expansionary fiscal policy of the surrounding years. The net cost of policy measures announced annually before the pandemic in 2019, and in 2023 and in 2024 after the pandemic was over, fell in the range of $20 billion to $30 billion (Figure 1).

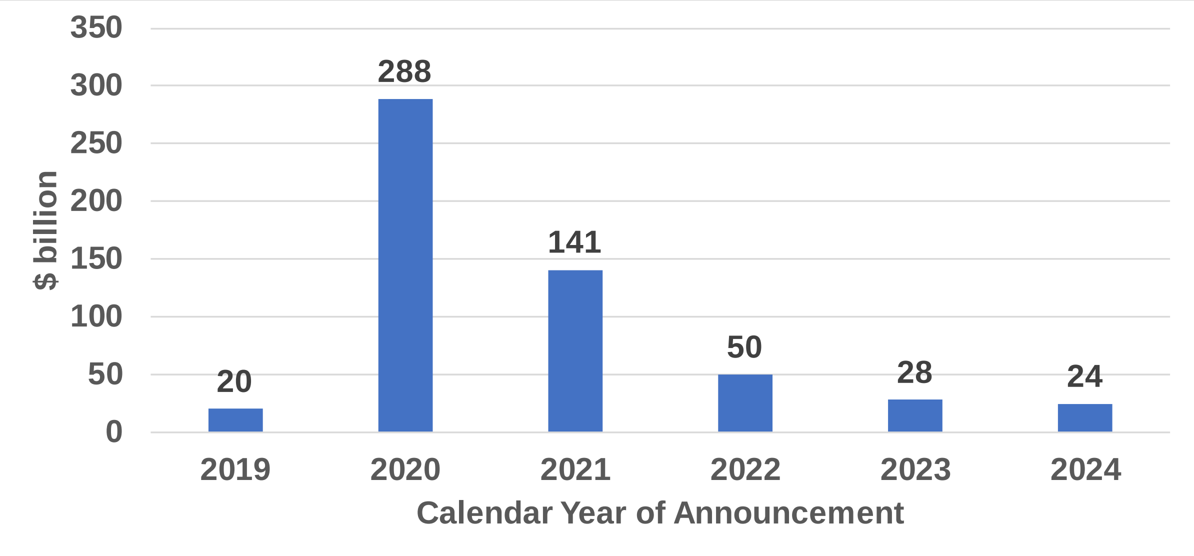


Figure 1. *Net Cost of Policy Measures Over Forward Estimates*

In presenting the Federal Government fiscal response, the Treasury draws a distinction between pandemic and non-pandemic fiscal measures. Specifically, the Australian Government (2021b) states that during 2020 and 2021 it announced "$337 billion in direct economic and health support to manage the pandemic"[9]. Combining this with $91 billion in non-pandemic measures announced during the same two years gives the total COVID era fiscal stimulus of $428 billion referred to above and shown in Figure 1. This is a very large fiscal stimulus, equivalent to 20.5 per cent of GDP in 2020-21.

We also need to consider the fiscal response to COVID of state and territory governments. The IMF (2021a) summarises the state fiscal response up to 1 July 2021 as follows.

[9] This figure rises from $337 billion to $343 billion if measures announced from January to March 2022 are included (Treasury, 2023b). However, here we focus on measures announced in 2020 and 2021.

> State and Territory governments also announced fiscal stimulus packages, together amounting to A$50 billion (2.5 percent of GDP), including payroll tax relief for businesses and relief for households, such as discount utility bills, cash payments to vulnerable households, support for health spending, construction, infrastructure packages, and green investment (renewable energy and technologies).

Subsequently, state governments added a further $7 billion to this fiscal response as their 50 per cent share of the cost of the business support package. On that basis, the total state and territory fiscal response to COVID was $57 billion according to the IMF (2021a).

Treasury (2023b) gives a much higher estimate for the state and territory fiscal response as follows.

> As at 24 March 2022, states and territories had announced approximately $234 billion, 12 per cent of GDP, in direct economic and health support since the beginning of 2020.

From a footnote in Treasury (2023b), it is apparent that their estimate for the state fiscal response has a broad scope. It appears to include both pandemic and non-pandemic measures and to refer to the gross cost of budget measures without netting off savings measures.

> State and territory spending estimates are largely based on the total value of new policy decisions, including for revenue, expenses and capital investment, since states' and territories' 2019-20 mid-year reviews (which capture the impact of policy decisions in the period from late 2019 until 2023-24). This approach uses information from state and territory 2020-21 budgets and budget updates where possible. The estimates are total values and do not account for savings, offsets or reprioritisations. Per cent of GDP is based on the 2019-20 actual. Treasury (2023b, p. 5)

In any case, there is a surprisingly wide range in these published estimates for the size of the state government fiscal response to COVID, from $57 billion by the IMF (2021a) to $234 billion by Treasury (2023b).

Given this uncertainty about the size (and nature) of the state government fiscal response, we have decided to base the modelling on the Federal Government response, for which there is relatively good information. To balance the omission of the state government response, we have included all of the Federal Government response, including the pandemic component of $337 billion and the non-pandemic component of $91 billion.

In any case, the large size of the non-pandemic component can be viewed as part of COVID-era fiscal policy. There was a widespread view at the time that it was appropriate to respond to the pandemic by stimulating aggregate demand. In a more normal fiscal environment, it is likely that some of the non-pandemic measures, such as the government's response to the Aged Care Royal Commission, would have been funded from budget savings to avoid an accompanying fiscal stimulus.

Table 1 shows that about one-half of the federal fiscal stimulus of $428 billion was delivered in 2019-20 and 2020-21, with the remaining one-half delivered when the worst of the COVID economic downturn was over, from 2021-22 to 2024-25. Table 1 also identifies the expenditures on each of the main economic support programs, which are now discussed in turn.

JobKeeper and Related Programs

The JobKeeper program cost the budget $89 billion, and its pair of successor programs known as the COVID disaster payment and COVID business support cost a further $21 billion (Table 1). One of the objectives of JobKeeper was to compensate for COVID income losses, consistent with the fiscal policy principle for pandemics. To achieve this, businesses were only eligible for payments if they expected or experienced a sufficient loss of turnover under COVID social distancing.

Table 1. Federal Budget Cost of COVID-era Fiscal Policy Measures ($billion)

Policy Measure	19-20	20-21	21-22	22-23	23-24	24-25	total
JobKeeper	21	68	0	0	0	0	89
COVID disaster payment & business support	0	0	21	0	0	0	21
JobSeeker supplements	6	15	2	2	2	2	29
boosting cash flow for employers	15	21	0	0	0	0	36
accelerated depreciation	0	5	17	17	3	6	49
bring forward of stage 2 income tax cuts	0	7	17	2	0	0	26
payments to support households	6	6	0	0	0	0	12
other policy measures	12	31	47	35	28	15	167
Total	58	153	104	55	33	24	428

Sources: Australian Government (2020, 2021a, 2021b)

In its first phase from April to September 2020, the JobKeeper program paid businesses with a sufficient loss of turnover a flat amount per employee. That amount was similar to the national minimum wage for full-time adult workers.

The payments for stood down employees were passed on to those inactive employees as a superior alternative to them becoming unemployed and receiving the JobSeeker payment. The aim was to keep inactive employees connected to their employers. The payments for active employees were retained by business owners as compensation for lost profits.

There were exclusions to eligibility that prevented the program from compensating for some COVID income losses, as noted by the "Independent Evaluation of the JobKeeper Payment".

> There were exclusions to JobKeeper eligibility based on employee and employer characteristics. Around 2 million employees were excluded based on their status as a short-term casual or because they were employed on a temporary visa. Many

> employers who were significantly government funded were also excluded, along with employers owned by foreign governments and sovereign entities. (Treasury, 2023a)

Some of the employees who were ineligible for JobKeeper but lost their jobs due to COVID would have received the JobSeeker payment. That payment was increased during COVID through the JobSeeker Supplement at a cost of $29 billion (Table 1). The JobSeeker Supplement meant that those on JobSeeker received more than otherwise, although less than those on JobKeeper. The JobSeeker Supplement can be viewed as a second-best policy to partly address some of the eligibility exclusions in the JobKeeper program.

Analysis of JobKeeper

The JobKeeper program has been extensively reviewed. Treasury (2020, 2021b) conducted two reviews of its own. It also commissioned a third review, The Independent Evaluation of the JobKeeper Payment (Treasury, 2023a), which was mentioned above.

Murphy (2023a, 2023b) reviewed JobKeeper against the objective of providing compensation for COVID income losses. Although income compensation was one of the objectives of JobKeeper, its primary objective was that suggested by its name, namely keeping inactive employees attached to their employers. That primary objective largely drove the design of JobKeeper, and as a result the program's compensation for COVID income losses was quite uneven.

The payment of a flat amount to stood down workers, irrespective of their usual wage, resulted in uneven compensation for labour income losses. Full-time workers on median earnings were only compensated for 47 per cent of their lost wages. In contrast, an estimated 60 per cent of part-time workers were over-compensated for their lost wages. This harmed work incentives because over-compensated part-time workers were better off remaining inactive on JobKeeper, than finding an active job on their usual pay.

The effectiveness of JobKeeper in compensating for COVID income losses was also reduced by the exclusions to eligibility. The Independent Evaluation of the JobKeeper Payment found that "exclusions based on employee characteristics such as being a short-term casual or temporary migrant compromised the efficacy of JobKeeper and led to worse outcomes" (Treasury, 2023a).

Compensation of business owners for lost profits was even more uneven. An estimated 57 per cent of JobKeeper payments were made to business owners who were not experiencing the minimum loss of turnover specified by the program. This occurred partly because some businesses received payments on the basis of expected losses in sales that did not eventuate (in the first phase of the program) or received continuing payments from a loss of turnover that had occurred in the past (in the second phase of the program) (Murphy, 2023a, 2023b).

Even when payments were made to business owners who were experiencing the minimum loss of turnover specified by the program, the compensation for lost profits was quite uneven.

An average smaller business able to operate at the eligibility ceiling for JobKeeper, with a loss in turnover of only 30 per cent, received about $2 in compensation for every $1 in lost profits, and hence was over-compensated. Murphy (2023a, p.127) notes the disincentive problem from this: "this overcompensation means that many smaller businesses that were not affected by COVID nevertheless had a profit motive to limit operations to 70 per cent of normal to enjoy unusually high profits under JobKeeper". In contrast, if a business was forced to suspend operations entirely, it lost all of its profits and yet received no compensation.

This perverse pattern of compensation for lost profits arose because compensation of business owners was tied to the number of employees who remained active. Hence, when a business was forced to shrink its operations further so that its losses rose, its compensation actually fell.

In future pandemics, replacement programs are needed that better target income compensation. This is necessary to maintain horizontal equity and macro stability and to avoid disincentive effects.

The perverse pattern of compensation for lost profits, including over-compensation in many cases, was because JobKeeper program was a single program, making it ill-equipped to properly target wage compensation and profit compensation at the same time. In future pandemics, the all-in-one approach of JobKeeper should be replaced with two separate programs, one for wage compensation and one for profit compensation. Indeed, that approach was followed in 2021 when a pair of successor programs, the COVID disaster payment for wage compensation and COVID business support for profit compensation, were used.

During COVID many countries used a short-term work (STW) program for wage compensation. A STW program directs compensation to workers by only subsiding hours not worked, whereas a wage subsidy (WS) program, such as JobKeeper, compensates business owners as well by also subsiding hours worked. While many countries using STW programs during COVID had existing STW programs that they ramped up, the UK introduced a STW program for the first time (Pope and Hourston, 2020), known as the Coronavirus Job Retention Scheme (CJRS), and discontinued it after the pandemic. See the OECD (2021) study and the ILO study of Eichhorst, Marx, Rinne and Brunner (2022) for detailed reviews of the performance of STW and WS programs in different countries during COVID.

Borland (2023) advocates that Australia use a STW program in future pandemics. A well-prepared Australian STW program could better calibrate payments to individual workers to their wages lost to COVID, as was the case under the UK's CJRS compared to Australia's JobKeeper[10]. A STW program, like a wage subsidy program such as JobKeeper, is designed to

[10] The original CJRS gave employers a grant to fund the wages of their employees who were on furlough, equivalent to 80% of usual wages up to £2,500 per month (UK Treasury, 2023), whereas the original JobKeeper funded a flat amount per employee for both furloughed and active employees.

support job retention so as to help limit the risks of labour and capital becoming scarred or stranded.

Remaining Programs

To some degree, the JobKeeper payment, the COVID disaster payment and business support, and the JobSeeker supplement all targeted COVID income losses. However, the remaining programs listed in Table 1 generally did not.

The Boosting Cash Flow for Employers program had a Budget cost of $36 billion (Table 1). Two payments were made totalling between $20,000 and $100,000 per business. These payments were targeted at businesses with an annual turnover of up to $50 million but were made irrespective of whether those businesses experienced COVID income losses.

The fiscal response also included introducing accelerated depreciation for business investment under a series of three programs at a total cost over the forward estimates of $49 billion (Table 1). Eligibility did not depend on whether a business was experiencing COVID income losses. However, because this program only brings forward the timing of depreciation deductions, its cumulative direct cost to the budget gradually declines, and by 2032-33 is only $11 billion.

The government also brought forward previously planned personal income tax cuts. The stage 2 personal income tax cuts were introduced in 2020-21 instead of 2022-23, while maintaining the original timetable for abolishing the Lower and Middle Income Tax Offset (LMITO) in 2022-23. The budget cost of the bringing forward of the stage 2 tax cuts was $26 billion (Table 1).

The fiscal response also included payments to support households. Eligible households received four payments between March 2020 and March 2021 totalling $2,000 at a budget cost of $12 billion (Table 1). These payments were made to social security recipients, including pensioners and family tax benefit recipients.

The final category in Table 1, other policy measures, had a large budget cost of $167 billion. This includes health support measures of $23 billion and some smaller economic support programs. However, the largest component is non-pandemic policy measures. Some of these measures were clearly worthwhile, such as expenditure for the government's response to the recommendations of the Aged Care Royal Commission. These non-pandemic policy measures were not funded from the budget.

Analysis of Remaining Programs

These remaining programs fall into three categories.

The first category consists of the Boosting Cash Flow for Employers program, which did not target COVID income losses. After its introduction, the government developed the JobKeeper program, which was better targeted. When JobKeeper was announced on 30 March 2020, the second payment under Boosting Cash Flow for Employers, which was not due until June 2020 at the earliest, was not cancelled but arguably should have been.

The second category is a group of three programs that are similar in nature to the programs used to respond to earlier recessions. The three programs are for accelerated depreciation for business investment, personal income tax cuts and social security payments to support households. Such programs are used to stimulate aggregate demand when a recession is caused by a deficiency in aggregated demand. However, the COVID recession was instead caused by restrictions on a narrow group of industries for health reasons. As we saw in section 2, the appropriate fiscal response for that pandemic type of recession is to compensate economic agents in the restricted industries for their income losses. Programs that are designed to stimulate aggregate demand should not be part of the fiscal response to pandemic-induced recessions, as their main effect is likely to be to cause higher inflation and higher interest rates.

The third category is "other policy measures", which are dominated by non-pandemic measures but also include health support and smaller economic support programs. The non-pandemic measures stimulated aggregate demand because they were not funded from the budget. Further, the fiscal stimulus from these measures extended well beyond the end of COVID (Table 1). In future pandemics, normal good fiscal practice should be maintained under which non-pandemic measures are funded from the budget.

More generally, the fiscal measures announced during 2020 and 2021 and costing $428 billion over the forward estimates were not accompanied by any funding announcement. This contrasts with the ideal fiscal responses of both Woodford (2022) and Guerrieri et al. (2022), which stipulated how and when their pandemic compensation payments would be funded from higher taxes. In a future pandemic, the government should specify how and when its compensation payments will be funded through the tax system, both to better discipline the size of its fiscal response and to support fiscal sustainability and an efficient tax system.

Treasury Views

In summarising its Submission to the COVID-19 Commonwealth Government Response Inquiry, Treasury (2023b) made five points.

- "The COVID-19 pandemic had extraordinary health and economic implications globally and in Australia."
- "Australia's economic response was large and consistent with that of other advanced economies, providing direct support to households and businesses, as well as economic support through the financial sector."
- "The Reserve Bank of Australia (RBA) lowered its cash rate target by 0.65 percentage points to 0.1 per cent and undertook large scale asset purchases."

- “Treasury's role during the crisis was broad, providing forecasts and analysis to government on the economic impacts of the pandemic and advising on the overall size and composition of the fiscal and broader economic policy response.”
- “While Treasury played a significant role helping to manage the effects of the pandemic, its contribution was part of a much larger whole-of-government response.”

Those observations are reasonable, apart for the second observation concerning the size of Australia’s fiscal response. Treasury (2023b) explains its view as follows.

> The scale of Australia's fiscal response measures was comparable to other advanced economies. According to IMF estimates at October 2021, Australia's discretionary fiscal response measures to the initial impacts of the pandemic - including both Commonwealth and state responses - were estimated to be similar to the size of responses in countries like Canada, Germany, Japan, the United Kingdom and New Zealand, and less than the United States. Treasury (2023b, p. 5)

This explanation is based on Treasury’s interpretation of the IMF “Database of Fiscal Policy Responses to COVID-19” (IMF, 2021b). However, if we consider the levels of COVID fiscal support of all 37 advanced economies in that database, as displayed in Table 2, Australia’s fiscal support was 6th highest out of the 37 advanced economies. It was equivalent to 18.4 per cent of GDP compared to the simple average of 11.8 per cent for all 37 countries. Hence, Australia’s fiscal support seems large compared to other advanced economies.

Furthermore, the appropriate level of a country’s fiscal support depends on the depth of the COVID recession that it faced. The IMF (2021b) recognises this.

> The database is not meant for … comparison across economies as responses vary depending on country-specific circumstances, including the impact of the pandemic and other shocks.

The study of Jordà and Nechio (2023) discussed in section 2.3 takes into account the IMF observation that the size of fiscal support should depend on how much a country has been affected by COVID. It does this by balancing the size of the fiscal support against the size of COVID income losses. Fiscal support is classed as aggressive when it pushes real household disposable income above trend despite the income loss from COVID itself. Table 2 displays the real disposable income (RDI) gaps as at the June quarter 2021.

Using RDI gaps, Australia’s fiscal support was 3rd highest out of 17 OECD countries (Table 2). COVID income losses were moderated in Australia partly because, as an island advanced economy, we were relatively well placed to control the pandemic. The Jordà and Nechio (2023) measure of real household disposable income relative to trend provides a useful comparison between the 17 OECD countries of the extent of fiscal compensation for COVID income losses. The full historical data can be access in graphical form here.

From Table 2, there are only three countries that stand out as having both a positive RDI gap and an above average level of fiscal support. They are the United States, Canada and Australia.

Table 2. Fiscal Response and Real Disposable Income Gaps

	IMF Fiscal Response (% of GDP)	RDI gap (% of trend RDI)	IMF Rank	RDI gap rank	RDI gap rating
Macao SAR	45.4		1		
United States	25.5	6.4	2	1	aggressive
New Zealand	19.3		3		
United Kingdom	19.3	-1.7	4	12	passive
Singapore	18.4		5		
Australia	18.4	3.6	6	3	aggressive
Greece	17.5		7		
Japan	16.7		8		
Hong Kong SAR	16.0		9		
Canada	15.9	4.4	10	2	aggressive
Germany	15.3	-1.6	11	11	passive
Austria	15.2	-4.3	12	16	passive
Ireland	11.5	3.3	13	4	aggressive
Italy	10.9	-1.7	14	12	passive
Malta	10.7		15		
Latvia	10.6		16		
Israel	10.3		17		
The Netherlands	10.3	-0.1	18	6	passive
Iceland	10.1		19		
France	9.6	-1.2	20	10	passive
Slovenia	9.4		21		
Czech republic	9.2		22		
Spain	8.4	-6.3	23	17	passive
Cyprus	8.3		24		
Belgium	8.2	-1.0	25	8	passive
Switzerland	7.9		26		
Lithuania	7.9		27		
Norway	7.4	1.3	28	5	aggressive
Korea	6.4		29		
Portugal	6.0	-2.9	30	14	passive
Slovak Republic	5.9		31		
Estonia	5.8		32		
Finland	4.8	-0.9	33	7	passive
Luxembourg	4.2		34		
Sweden	4.2	-1	35	8	passive
Denmark	3.4	-3.8	36	15	passive
San Marino	0.7		37		
Simple Average	11.8	-0.4			

3.2 Monetary Policy

Here we assess the monetary policy response to COVID against the pandemic policy principle of using monetary policy to target employment and inflation in the safe industries.

The Monetary Response

Gross and Leigh (2022) assess monetary policy in the lead up to COVID as follows.

> With the benefit of hindsight, it is clear that monetary policy was suboptimal in the period 2016–19. The cash rate was held too high for too long, leading to inflation undershooting the RBA's inflation target band and a large unemployment gap opening up.

The RBA seems to have drawn the same lesson. Hence, before COVID struck in March 2020, monetary policy was already become expansionary, with the overnight cash rate target, which is the policy interest rate, at 0.75 per cent. This expansionary monetary policy was appropriate because inflation was below its target rate of 2.5 per cent, and the unemployment rate was above the NAIRU, which was generally thought to lie between 4 and 5 per cent.

During March 2020, the Reserve Bank of Australia (RBA) responded to COVID by reducing the policy interest rate from 0.75 to 0.25 per cent. It reduced the cash rate further to 0.1 per cent in November 2020. Commenting on that, Debelle (2021, p.47) states that "the Reserve Bank Board has reduced the cash rate target to what it assesses to be the effective lower bound".

The RBA also took other measures during 2020 that were consistent with a belief that the cash rate was likely to remain at the assessed effective lower bound (ELB) of 0.1 per cent for at least three years. The same low interest rate was adopted as the yield target for 3-year government bonds maturing in April 2024. That low yield target was supported by RBA purchases of government bonds as necessary. Further, the RBA provided a Term Funding Facility (TFF) to the banks offering them funds under certain conditions at the same low interest rate of 0.1 per cent and for the same term of three years. Finally, the RBA provided forward guidance on the policy interest rate. It would not increase that rate from 0.1 per cent until actual inflation was sustainably within the target range of 2 to 3 per cent. In February 2021 the RBA stated that it did not expect this to occur until 2024 at the earliest. The Reserve Bank of Australia Review describes this as "calendar-based" forward guidance and is critical of it given the major uncertainties in forecasting inflation three years ahead (de Brouwer, Fry-McKibbin and Wilkins, 2023).

In addition, in November 2020 the RBA announced a new bond purchase program. Bond purchases were already being made to achieve the low target of 0.1 per cent on the yield for 3-year government bonds. The additional purchases were designed to reduce yields on longer-term bonds, to bring them closer to yields in other advanced economies that were already using such bond purchase programs (Debelle, 2021, p. 52).

The RBA also welcomed the fiscal policy response to COVID.

> The fiscal policy response has been very large and has been welcomed by the RBA. It has provided substantial support to the incomes of households and businesses, as well as support to aggregate demand through government spending. In addition to conversations between the RBA and the government at senior levels, the Secretary of the Australian Treasury is a member of the Reserve Bank Board, which provides another channel of communication. (Debelle, 2021, p. 56)

This RBA expectation that the policy interest rate would remain at the ELB for three years was not realised. In their RBA Review, de Brouwer, Fry-McKibbin and Wilkins (2023) explain how events unfolded.

> Throughout 2021 and 2022, economic conditions improved much faster than the RBA had expected when additional monetary policy tools were first introduced. In response, the Reserve Bank Board began unwinding its additional monetary policy tools in June 2021 (with the closure of the Term Funding Facility). The rate of bond purchases was tapered in July 2021 (and purchases ceased in February 2022). In November 2021, the yield target and calendar-based forward guidance was discontinued. The Reserve Bank Board started raising the cash rate target in May 2022. (de Brouwer et al., 2023, p. 51)

Thus, the policy interest rate only remained at 0.1 per cent for 18 months rather than for three years, because inflation returned to target sooner than the RBA had expected and continued to climb. The RBA steadily increased the policy interest rate from May 2022 so that it reached 4.10 per cent in June 2023. There was a further increase to 4.35 per cent in November 2023.

Analyses of Monetary Policy Response

The RBA Review presented an analysis of the monetary policy response to COVID. We begin by summarising the Review's analysis and then present our own analysis.

The RBA Review commends the initial response to COVID.

> The RBA and Reserve Bank Board deserve considerable credit for the initial response to the pandemic. They were decisive at a time of national crisis and extreme uncertainty and the collective actions of government and the RBA avoided the worst. (de Brouwer, Fry-McKibbin and Wilkins, 2023, p. 43)

The RBA was surprised by the inflation outbreak and initially thought that it would be short-lived. The RBA Review considered whether this reaction was reasonable.

> But even among those that did identify risks to inflation early on, the magnitude of the increase in inflation (both in Australia and globally) was surprising.
>
> To some extent, this reflects the fact that the increase in inflationary pressures has been partly driven by major supply disruptions – notably disruptions to energy and food

> supply from Russia's invasion of Ukraine and natural disasters – that were inherently unpredictable. However, other factors that contributed to the pick-up in inflation were arguably more foreseeable, particularly as the economic recovery progressed into 2021. For example, while the Review (and many consulted by the Review) considers the strong and rapid fiscal and monetary policy response at the onset of the pandemic to be appropriate given the threat to lives and livelihoods, the cumulative effects of the measures over time contributed to the overshoot of inflation in Australia. Indeed, Murphy (2022) found that, combined, the fiscal and monetary stimulus added 3.0 percentage points to inflation during 2022. Of this, 0.6 percentage points were attributable to monetary policy being more accommodative than would normally be the case given prevailing economic conditions. (de Brouwer et al., p. 58)

In the second part of this paper, we update and extend the estimates in Murphy (2023a) of the contribution of macro policy to the inflation outbreak. We also assess it against a more appropriate benchmark, using a *shorter stimulus* scenario rather than a *default policy* scenario. The RBA, like the Treasury, did not forecast that the very large fiscal policy response to COVID would lead to an inflation outbreak.

The RBA Review also comments, somewhat critically, on the RBA's use of the monetary policy tools besides the policy interest rate itself. These tools include the yield target, the forward guidance on the policy interest rate, the TFF and the bond purchase program. These tools are not directly represented in the modelling presented in the second part of this paper. However, they do indirectly affect the modelling. For example, expectations for the policy interest rate influence both the government bond rate and the exchange rate in the model.

Our own analysis of the monetary policy response to COVID is from the perspective of the macro policy principles in a pandemic developed by Guerrieri et al. (2022). Under that national welfare maximising approach, the Treasury would have compensated for income losses in the unsafe industries, while the RBA would have targeted macro stability in the safe industries.

With the benefit of hindsight, we can broadly assess macro stability in the safe industries using Figure 2. It shows the percentage of the population aged 15 years and over who were employed in the safe and unsafe industries. To measure labour demand more accurately, employment is measured on a full-time equivalent basis using the ABS approach, under which part-time employment is giving a weighting of 0.5 and full-time employment a weighting of 1.

Industries are classified as either safe or unsafe at the level of the 86 industry subdivisions identified in the ANZSIC classification used by the ABS. Of these subdivisions, 14 are classified as unsafe and the remaining 72 are safe. A subdivision is classified as "unsafe" if it was substantially suppressed by public health restrictions during COVID, as judged from the nature of the restrictions and falls in employment after the restrictions were introduced in March 2020.

In the year before COVID struck, nearly 44 per cent of the working-age population were employed in the safe industries and nearly 9 per cent in the unsafe industries (Figure 2). Hence, five out of six jobs were in the safe industries. Despite this, when COVID struck in the June quarter 2020, twice as many jobs were lost in the unsafe industries than in the safe industries (Figure 2). Thus, employment losses were highly concentrated in the unsafe industries. Employment fell by 23 per cent in the unsafe industries but only 2 per cent in the safe industries.

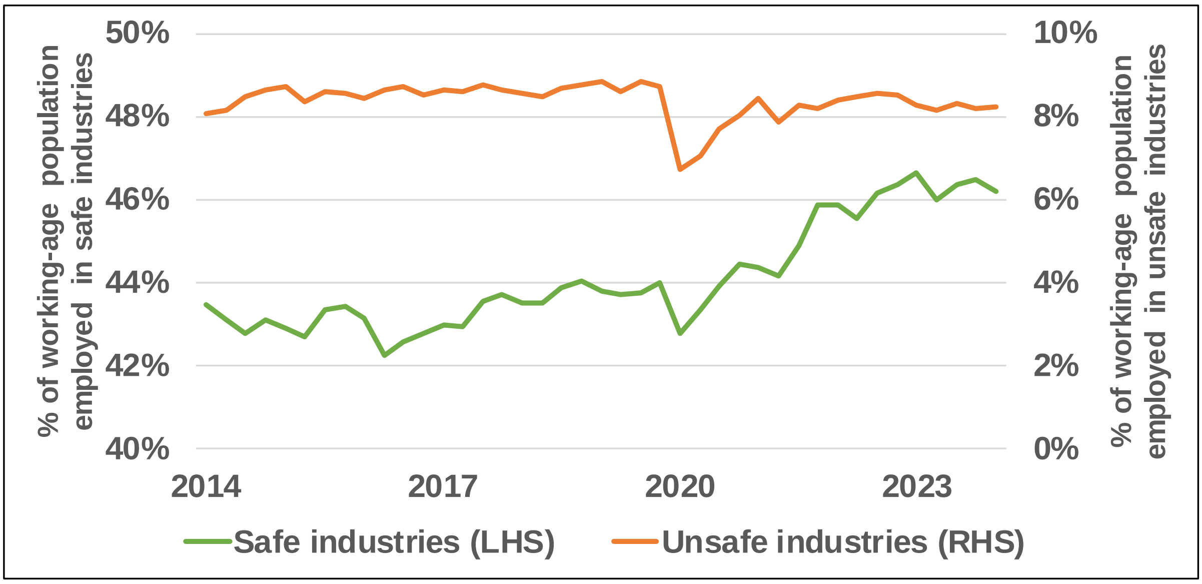


Figure 2. *Employment in the Safe and Unsafe industries*

Note: The unsafe industry ANZSIC codes are 11, 39, 40, 44, 45, 49, 52, 55, 72, 82, 90, 91, 92 and 95.

A year later, employment in the unsafe industries had partially recovered to over 8 per cent of the working-age population. However, employment has languished at that level ever since. For example, from the latest data at the time of writing, the unsafe industries employed 8.2 per cent of the working-age population in May 2024, down from the pre-COVID level in 2019 of 8.8 per cent. So, employment in the unsafe industries has still not fully recovered to its pre-COVID level. This may indicate that the unsafe industries remain scarred from their experiences of social distancing during COVID.

In contrast, employment in the safe industries has grown strongly. Following the initial decline in employment in the June quarter 2020, it was restored to its pre-COVID level of nearly 44 per cent of the working-age population only six months later, in the December quarter 2020. After that, it continued to rise strongly to level out at over 46 per cent of the working-age population from the December quarter 2022 (Figure 2). From the latest data, the safe industries employed 46.2 per cent of the working-age population in May 2024, up from the pre-COVID level in 2019 of 43.8 per cent.

In the overall employment market, this very strong performance of employment in the safe industries has easily offset the lacklustre employment performance in the unsafe industries.

Unemployment fell from a pre-COVID rate of about 5.2 per cent, to level out at about 3½ per cent during the 2022-23 financial year. This turned a positive unemployment gap into a negative unemployment gap. This in turn contributed to a positive inflation gap, with inflation peaking at about 5 per cent points above its target rate of 2½ per cent.

Since then, those unemployment and inflation gaps have shrunk, but have not disappeared. Using the latest data at the time of writing, in July 2024, the unemployment gap was –0.5 percentage points and in the March quarter 2024 the inflation gap, based on the price deflator for household consumption, was 2.2 percentage points. To close the unemployment gap, it is likely that employment in the safe industries would need to moderate to 45 to 45½ per cent of the working-age population. That would restore balance in the labour market, thus enabling inflation to stabilise around its target rate of 2½ per cent.

In short, the over-prolonged fiscal and monetary stimulus led to over-heating of the labour market in the "safe" industries, contributing to post-COVID macro-economic instability. Much of this macro-economic stability may have been avoided if we had been able to follow the macro policy principles for a pandemic set out by Guerrieri et al. (2022). The fiscal stimulus would have been limited to compensating for COVID income losses. The policy interest rate would have begun to normalise from early 2021, when it was clear that employment in the safe industries had already recovered to above pre-COVID levels. This will be demonstrated when alternative policy scenarios are modelled in detail in sections 6.

RBA Analysis

While the RBA did not forecast the post-COVID outbreak of inflation, with the benefit of hindsight it has offered its own analysis of the factors that led to the inflation outbreak in Beckers, Hambur and Williams (2023). In this analysis, they estimate the contribution of both demand factors and supply factors to peak inflation. Because macro policy is a demand factor, we focus on their estimates of the contribution of demand factors to inflation.

They use three alternative methods to quantify the contribution from demand factors. The three methods are based on the components of the CPI, an inflation forecasting equation and a macro model. We discuss the results from these three methods in turn below.

One complication in using the results from Beckers et al. (2023) is that in this study we focus on the contribution of macro policy to peak inflation, which was recorded from the December quarter 2021 to the December quarter 2022. However, Beckers et al. (2023) reports their main results for three months later, when inflation was beginning to decline. However, we can use Graphs 3-5 of Beckers et al. (2023) to extract their estimates for the factors driving peak inflation during 2022 with reasonable accuracy. In the case of Graph 3, which is of particular interest, we asked the authors for the original data, which they kindly provided[11].

[11] I thank Ben Beckers of the RBA for kindly providing the data for Graph 3 of the Beckers et al. (2023) paper.

Their first approach uses the components of the CPI and was originally developed by Shapiro (2022). It classifies the price change for each component in each quarter as either supply driven or demand driven. It is demand driven or supply driven depending on whether the price change is accompanied by a quantity change in the same direction or the opposite direction. If these changes don't exceed a minimum threshold, the cause of the price change is regarded as ambiguous. Beckers et al. (2022) apply this approach to 15 components of the Australian CPI, whereas Shapiro (2022) was able to perform a more detailed analysis, distinguishing 124 components of the US PCE index.

Applying this CPI approach, the contributions to the peak CPI inflation rate of 7.83 per cent during 2022 are estimated as 4.13 percentage points from supply factors, 2.73 percentage points from demand factors and 0.98 percentage points where the cause is ambiguous. To interpret these results, we need a reference point.

In his work for the USA, Shapiro (2022) uses a 10-year average of values in the pre-COVID period as his reference point. Here, we use a 9-year average, from 2011 to 2019, because the Beckers et al. (2023, Graph 3) data extends back to 2011. Over that 9-year period, the average contribution of the demand factor to inflation was 0.46 per cent. Thus, at the time of peak inflation, the demand factor was contributing an additional (2.73-0.46=) 2.3 percentage points compared to the reference period.

While the Shapiro approach turns out to be the most useful of the three approaches used by Beckers et al. (2023), it does have limitations, as they pointed out. In reality, demand and supply factors as categories are both broad and interlinked. Demand shocks are a broad category, including not only changes to fiscal and monetary policy, but also factors with more long-lived effects such as changes to consumers' rate of time preference or changes to the equity risk premium. There is an important link between supply and demand factors in a pandemic, as Woodford (2022) explains. Closure of an industry due to a pandemic is a supply shock, but if the resulting loss of income to workers and business owners in that industry leads to lower consumer demand, it gives rise to a demand shock. These limitations cloud the interpretation of the results.

Despite these limitations, the CPI method is readily understood and is useful as a cross-check on other methods. The result of a contribution of demand factors to peak inflation of 2.3 per cent seems broadly consistent with other estimates. Earlier, we used the results from the Jordà and Nechio (2023) paper to estimate that fiscal over-compensation in Australia, combined with an accommodating monetary policy, added 2.1 percentage points to inflation. In the second part of this paper, we use our Australian macroeconomic model to estimate an identical contribution to peak inflation from that policy overreach. Further, we find that the effects of fiscal policy on inflation in our Australian model are comparable with the effects in leading models of the USA and EU.

The second approach used by Beckers et al. (2023) uses an inflation forecasting equation for the trimmed mean CPI. Using the June quarter 2021 as a base, this reduced form inflation equation was used dynamically to generate a forecast for inflation through to the March quarter 2023. The equation forecast is for trimmed mean CPI inflation of 2.8 per cent during 2022, compared to the actual outcome of 6.8 per cent, a forecasting error of 4.0 percentage points. Thus, this inflation equation, like the RBA itself, was unable to forecast the inflation outbreak.

Beckers et al. (2022) suggest that their inflation equation may have missed the inflation outbreak because of unmodelled supply factors. However, the price equations in our own macroeconomic model were reasonably successful in forecasting the inflation outbreak (Murphy, 2021b), with excess demand for goods and services driven by macro policy playing an important role. The price inflation equation used by Beckers et al. (2023) misses this because its inflation drivers include excess demand for labour, but not excess demand for goods and services.

In their third approach Beckers et al. (2023) use the RBA's DSGE model of the Australian economy (Gibbs, Hambur and Nodari, 2018). Like our macroeconomic model, this is a structural model of the macroeconomy specifically designed to investigate how economic shocks are transmitted through the economy. In principle, this makes it the best of the three approaches for rigorously attributing peak inflation to different kinds of shocks, as Beckers et al. (2023) note.

Unfortunately, in practice, the RBA DSGE model is not suitable for analysing the effects of fiscal policy on inflation. It assumes Ricardian Equivalence (Gibbs, Hambur and Nodari, 2018, p. 11), which unrealistically implies that no consumers increase their spending in response to the large fiscal benefits many received during COVID, because all consumers take into account that they will have to pay for those benefits later through higher taxes and all consumers are assumed to have access to finance. In effect, the RBA DSGE model *assumes* that most of the fiscal policy response had no effect on economic activity or inflation, making the model unsuitable for estimating the size of those fiscal policy effects.

DSGE models can be usefully used to model the effects of fiscal policy provided the default assumption of Ricardian equivalence is modified. Several DSGE models that have been modified in this way are used to simulate fiscal policies in Coenen et al. (2012) and we cite results from that in section 6. With similar modifications, the RBA DSGE model could be used in the same way.

As we shall see in Table 7, our Australian model provides a more detailed and robust breakdown of the factors contributing to peak inflation in 2022.

3.3 Main findings from the first part of our evaluation

Overall, our evaluation of the macro policy response to COVID against the principles of macro policy in a pandemic finds that the fiscal and monetary policy expansions were too prolonged. Some fiscal policies were appropriately tied to income losses from pandemic restrictions, although the alignment could have been better. However, other fiscal policies stimulated aggregate demand and continued for too long. Monetary policy remained highly expansionary for at least a year too long.

In a future pandemic, fiscal policy should concentrate on paying full compensation for income losses resulting from pandemic restrictions, while avoiding measures to stimulate aggregate demand. Monetary policy would focus on inflation in the industries not subject to restrictions.

This completes the first part of our evaluation of the macro policy response to COVID.

4 Modelling Approach

In the second part of this paper, we evaluate the Australian macro policy response to COVID using multiple policy scenarios generated using an Australian macro-econometric model. These scenarios include a *baseline* scenario that uses the actual policy response, and a *shorter stimulus* scenario that uses the macro policy principles for a pandemic that were described in the first part of this paper. We assess how well unemployment and inflation are controlled in each scenario. Our broader purpose is to quantify the potential public benefit from using a better approach to macro policy in future pandemics.

This section provides an overview of our macroeconomic model and section 5 explains the different macro policy regimes and scenarios. Following that modelling background, section 6 updates Murphy's (2023a) scenarios and also simulates the *shorter stimulus* scenario based on the pandemic macro policy principles.

Blanchard (2018) makes the case that different types of macroeconomic models are needed for different purposes. Indeed, he identifies five types of models for five different purposes. The same is true here. The theoretical models of Woodford (2022) and Guerrieri et al (2022) that we relied on in the first part of our evaluation are designed for the purpose of determining the optimal macro policy response to a pandemic. To quantify the effects of using a different policy response, we need a different type of model, namely a model designed for macro policy simulation. For that purpose, we use the same macro-econometric model as Murphy (2023a).

Our macro-econometric model takes into account how the severity of pandemic restrictions varied up and down during 2020 and 2021. It simulates how different macro policy approaches affect inflation and unemployment outcomes on a quarter-by-quarter basis. None of that is possible using the theoretical models of Woodford (2022) and Guerrieri et al (2022), partly because in those models a pandemic occurs with constant severity in a single unit of time.

The main limitation of our macro-econometric model for the purposes of this paper is that, like most macro-econometric models, it has one representative consumer. Thus, while the theoretical models distinguish between consumers from the safe and unsafe industries, our macro-econometric model does not. That distinction was useful in the first part of our paper in two ways. First, it was used to assess horizontal equity between participants in the safe and unsafe industries. Second, it was used to take into account that government payments targeted at consumers from the unsafe industries who lose income due to COVID restrictions are more likely to be spent promptly than government payments that are general or untargeted in nature.

In the second and third parts of this paper we aim to take those points into account in the way we interpret our modelling results. We informally consider how different macro policy scenarios would affect horizontal equity. Similarly, we discuss how the results may vary depending on whether government payments are targeted or untargeted.

This section provides an overview of our model and discusses its suitability for generating the various scenarios. It begins with a general description of the model and then focuses on the industry detail, fiscal detail and the modelling of COVID, which all play important roles.

4.1 General description of model

The Australian macro-econometric model used to generate the various scenarios is described in Murphy (2020). While our model was developed from scratch, it can be considered as the latest model in a series of models that includes the AMPS model (Murphy et al., 1986), MM (Murphy, 1988) and MM2 (Powell and Murphy, 1997).

These Murphy models are New Keynesian, having the three important features of a Keynesian short run, neoclassical long run and forward-looking behaviour in financial markets. New Keynesian DSGE models began emerging later, beginning with Rotemberg and Woodford (1997), and possess these same three features, although with some differences in the detail.

For the purposes of this paper, the most significant difference between the macro-econometric model used here and New Keynesian DSGE models is in the modelling of aggregate household consumption. The model used here includes the National Asset Target (NAT) consumption equation introduced and described in Murphy (2020), whereas DSGE models assume that households base their consumption decisions on intertemporal optimisation. Both approaches imply that Ricardian equivalence holds in the long run.

Regarding the short run, the NAT consumption equation includes a link from current income to consumption, which is important in this study in modelling the stimulus to household consumption from the government payments to households and businesses made under COVID. This link can also be present in DSGE models when their pure intertemporal optimisation approach to modelling consumption is modified in certain ways, for example, by assuming that some households do not have access to finance or live “hand-to-mouth”.

The macro-econometric model uses error correction models (ECMs) to introduce dynamics flexibly equation-by-equation around equilibrium relationships that are based on economic theory. Several dynamic parameters may appear in an individual equation, depending on the results of econometric testing. This contrasts with theory-driven DSGE models, where optimisation problems of economic agents are solved to obtain equations that incorporate both equilibrium relationships and dynamics. This typically leads to fewer dynamic parameters than would be obtained under the ECM approach. At the other end of the spectrum, data-driven VAR models include system-wide dynamics, allowing for flexible dynamics both within and across equations.

These differing approaches to dynamics illustrate a more general difference in approach between the three types of macro models. Macro-econometric models, such as the model used here, aim to balance principles from macroeconomic theory with econometric analysis of historical data. DSGE models generally place more weight on the theory while VAR models usually place more weight on the data. In the spirit of Blanchard (2018), we consider that all three types of models have their place, depending on the purpose.

This study involves both forecasting a baseline scenario and simulating other scenarios based on alternative policy assumptions. The balance that macro-econometric models offer between the data consistency that is important for forecasting and the theory consistency that is important for policy analysis, is useful in this situation.

There has been a revival in macro-econometric modelling in Australia. There are two other broadly comparable Australian macro-econometric models that have been developed recently, EMMA at the Treasury (Bullen et al., 2021) and MARTIN at the Reserve Bank of Australia (Ballantyne et al., 2020). The recent development of these three models suggests that macro-econometric models continue to play a useful role.

Indeed, the RBA has recently adopted MARTIN as its core macroeconomic model. Ballantyne et al. (2020) state that their experience from working with DSGE models over the years shows that "while DSGE models are useful tools for addressing some specific policy questions, they have too many drawbacks to serve as the RBA's core macroeconomic model".

For the purposes of this paper of analysing the COVID recession and the macro policy response to it, our model has three clear advantages.

Compared to the other two models, our macro model has finer industry and fiscal detail and it models the macroeconomic effects of social distancing under COVID. As we shall see, the modelling of COVID is important for capturing the nature of the macroeconomic shock that macro policy needed to respond to, the finer industry detail helps capture the uneven impacts of that shock across the economy, and the fiscal detail helps differentiates the economic effects of the various programs included in the fiscal policy response.

Without those three advantages, other forecasters were generally unable to foresee in 2021 the outbreak of inflation that occurred in 2022. In June 2021, the average forecast from a panel of 21 economists was for inflation in 2022 of 2.1 per cent (Martin, 2021). In November 2021, the Reserve Bank's inflation forecast for 2022 was 2.25 per cent (Reserve Bank of

Australia, 2021). Finally, in December 2021, the Treasury's inflation forecast (Australian Government, 2021b) was 2.75 per cent for 2021-22 and 2.5 per cent for 2022-23.

In contrast, in late 2021 an outbreak in inflation was forecast using the modelling approach of this paper. In October 2021 in a seminar paper, Murphy (2021b) forecast that inflation would reach a peak of 6.2 per cent in 2022, more than double the rate forecast by others at the same time. The outcome for consumer price inflation in 2022 was even higher at over 7 per cent.

In fact, using the same model, Murphy (2021a) raised the inflation alarm even earlier, in June 2021. He correctly forecast that "over-stimulation of the economy leads to inflation, higher interest rates and swings in unemployment from 2022 to 2024".

In the latest 2024 version of the macro model, there are 60 estimated equations. The estimation method most used is OLS. The estimation period generally starts in the September quarter 1985, but more recent start dates are used in cases where structural change is considered to be an issue. The estimation period usually ends in the most recent quarter for which there is a full set of data, which was the March quarter 2024 at the time of finalising the modelling for this study in July 2024.

The main features of the 2019 version of the macro model have already been described in more detail in Murphy (2020) and so, in general, are not discussed further here. The main exception to this is the industry detail, which is discussed in section 4.2 because of its importance to this paper.

In model development work in 2020 and 2021, the model's fiscal detail was further developed for modelling the fiscal response to COVID. This finer level of fiscal detail is discussed below in section 4.3.

In further model development work in 2022, the effects of COVID were modelled, primarily using indicators of geographic mobility. This work was also needed so that the model could track reasonably the macroeconomic fluctuations of 2020 and 2021. This modelling of the effects of COVID is discussed in section 4.4.

4.2 Industry Detail in the Model

Industry detail is included in the model only to the extent that it is expected to improve policy analysis and forecasting at the macro level. This led to the model recognising six broad industries (Table 3). For clarity, the Australian Bureau of Statistics (ABS) names for the constituent industry divisions for each broad industry are shown in the final column of the table.

In the first five industries, output is produced using a combination of intermediate inputs, labour, structures capital, machinery and equipment capital and a fixed factor. The fixed factor accounts for a relatively high share of value added in agriculture, where it represents agricultural land, and mining, where it mainly represents mineral resources.

Table 3. *Macro Model Industries*

Model industry	Model Code	ABS industry divisions
Agriculture	*A*	agriculture, forestry and fishing
Mining	*B*	Mining
Manufacturing	*C*	Manufacturing
Government services	*G*	public administration and safety; education and training; health care and social assistance
Other private services	*S*	all industries not included elsewhere
Housing services	*T*	residential property operators

In the remaining industry, housing services, output is produced using a combination of intermediate inputs, housing capital, housing land and capitalised ownership transfer costs, which include stamp duty on conveyances. This last input recognises that households invest in moving house so that their housing characteristics, such as size and location, better match their changing circumstances, thus adding to the value of housing services.

Of the six broad industries, other private services is the largest, accounting for 54 per cent of gross value added in 2019, prior to the COVID-19 pandemic. It is also the industry that was most affected by social distancing under COVID. That is, other private services includes most of the “unsafe” industries. By separately identifying this industry, the model better captures the uneven effects of COVID across the economy. In the other two models, EMMA and MARTIN, other private services are combined with other industries that were less affected by COVID.

4.3 Fiscal Detail of Model

In the macro model, the government budget refers to the budgets of all three levels of government (federal, state and local) consolidated together. Following the development work in 2020 and 2021, there are model levers for changing fiscal policy in all of the areas shown in Table 4. This is greater fiscal detail than in the Reserve Bank model described in Ballantyne et al. (2020) and the Treasury model discussed in Bullen et al. (2021).

The modelling of the COVID fiscal expansion involves adjustments to most of these fiscal levers, as detailed in Table A3. While the model is mainly intended for macro analysis, generally a change to a fiscal lever has the main behavioural effect that would be expected from a public economics perspective.

Table 4. *Fiscal Levers in the Macro Model*

Fiscal Area	Fiscal Detail/Base
General government final demand	consumption, investment
General government transfers	age-related, child-related, disability-related, unemployment-related, other transfers to

	households, transfers to business, transfers to overseas
Company income tax	tax rate, rate of immediate expensing for investment in (a) machinery and equipment and (b) structures
Goods and services tax	tax rate, coverage rate by industry
Stamp duty on conveyances	on ownership transfer costs
Other product taxes	on final demand, on intermediate inputs (allows for differences in effective tax rates between components)
Payroll tax	tax rate (allows for differences in effective tax rates at the industry level)
Land-related taxes (municipal rates, state land tax)	on land rents (allows for differences in effective tax rates at the industry level)
Other production taxes net of subsidies	on gross value added by industry
Mining royalties	on mining industry gross value added

Note: tax and transfer rates are generally effective rates rather than statutory rates.

To model the COVID fiscal expansion in an appropriate way, it was also necessary to re-classify two of the key programs – Boosting Cash Flow for Employers and JobKeeper. The ABS classified these two programs as pure production subsidies whereas behaviourally the former program was a business transfer and the latter program was partly (Murphy, 2023a).

4.4 Modelling COVID

Here we explain how COVID effects have been added to the model and then discuss the estimation results after those effects are incorporated. This updates the previous description of the modelling of COVID effects contained in Murphy (2023a). These COVID effects are removed in the *no COVID* scenario presented in section 6.

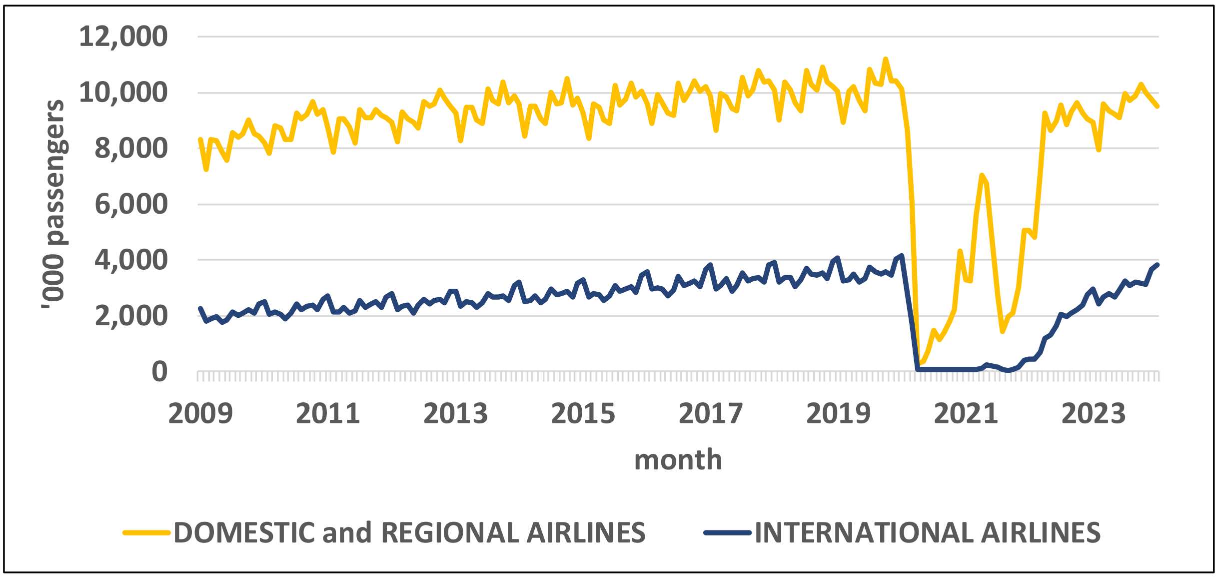
General Approach

As discussed in section 2.1, in the modelling of Eichenbaum et al. (2021), voluntary and mandatory social distancing taken together shift consumer demand, consumer supply and labour supply to the left.

The leftward shifts in both consumer demand and consumer supply mean that the quantity of consumption necessarily falls, but the direction of impact on consumer prices can only be determined with quantitative modelling. As we shall see, there are also other COVID effects to be modelled beyond consumer markets and labour supply, that were not considered in the simpler macroeconomic model of Eichenbaum et al. (2021).

As Brodeur, Gray, Islam and Bhuiyan (2021) point out, the literature on COVID commonly measures social distancing using indicators of geographic mobility. For our macroeconomic model, we need a measure of domestic geographic mobility for modelling domestic effects and a measure of international geographic mobility for modelling international trade in services associated with movements of people. Data on passenger movements at Australian airports conveniently provides both types of indicators.

The indicator used for domestic geographic mobility is based on passenger movements for domestic and regional airlines (Figure 3). During COVID, these domestic passenger movements were negatively affected by fear of contracting COVID, government travel restrictions, state border closures and other government restrictions. The government restrictions on travel and other activities introduced in late March 2020 saw domestic passenger movements fall to close to zero from April 2020 (Figure 3). That was part of a national lockdown that continued from end-March 2020 until mid-May 2020. A series of partial recoveries in domestic air travel were then interrupted by COVID outbreaks that led to a lockdown in Victoria in 2020Q3 and lockdowns in NSW and Victoria in 2021Q3.



Source: Bureau of Infrastructure and Transport Research Economics (2024)

Figure 3. *Australian Airport Passengers*

The indicator used for international geographic mobility is based on passenger movements for international airlines (Figure 3), which during COVID were heavily affected by Australian Government travel restrictions. To limit the spread of COVID to Australia, in March 2020 overseas travel was largely banned, except for Australians returning from overseas, resulting in international passenger movements, like domestic passenger movements, falling to close to zero from April 2020 (Figure 3). These international restrictions began to be eased in November 2021 and were fully lifted in July 2022 (Figure 3).

To construct the pair of geographic mobility measures, passenger movements are assumed to be normal in 2019, the year immediately before COVID. The mobility indices are then calculated as the ratio of actual to normal passenger movements, where normal movements are upscaled for population growth. Finally, these mobility indices are converted from a monthly to quarterly frequency for use in the macro-econometric modelling. The resulting pair of geographic mobility indices, *COVID_DOM* and *COVID_INT*, is shown in Figure 4. These indices take a value ranging from zero to unity, where zero represents complete immobility and unity represents normal mobility.

Figure 4 also shows forecasts for these geographic mobility indicators. At the time of writing, the latest readings, for 2024Q1, were 0.92 for *COVID_DOM* and 0.91 for *COVID_INT*. It is assumed that the geographic mobility indicators continue to recover to their normal values of unity.

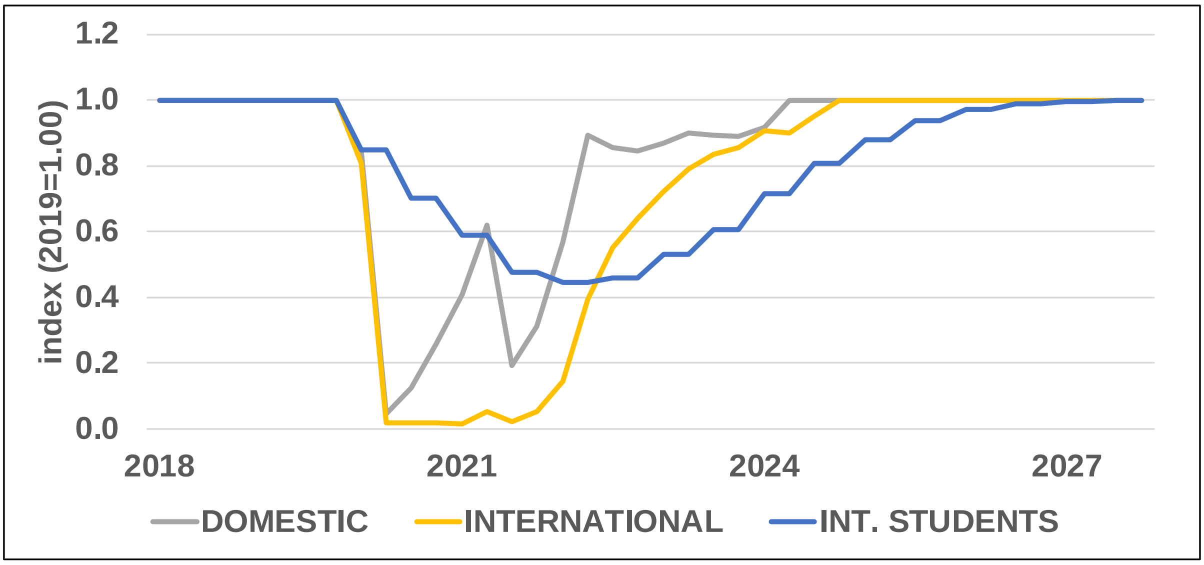


Figure 4. *Geographic Mobility Indices*

During COVID, air travel was often impacted by restrictions, while some other activities were only affected during lockdowns. Thus, to complement the geographic indicators in capturing the impacts on the economy of social distancing, a time dummy variable, *COVID_202*, is used for the national lockdown quarter, and another time dummy variable, *COVID_213*, is used for the lockdown in Victoria and NSW.

Finally, because of timing issues, COVID had more complex effects on the export of education services than are captured by *COVID_INT*. When international students decide not to enrol because of the international border closure, fee income is typically lost not for one quarter, but for one to four years, depending on the length of the course. These more slowly developing but protracted effects are taken into account in constructing *COVID_EDU* (Figure 4), as the fifth and final variable used to capture the economic effects of COVID. This variable is constructed using a highly stylised model of international student enrolments.

Two methods were used to identify which of the 60 estimated equations of the model were affected by COVID and hence needed to be extended to incorporate one or more of the five

COVID effects. The final outcome, in which COVID effects appear in 19 equations, is summarised in Table A1.

The first method was to consider economic theory. As noted above, from the work of Eichenbaum et al. (2021), we would expect negative COVID effects on consumer demand, consumer supply and labour supply, which account for 10 of the estimated equations in the macro-econometric model. Consumer demand is represented by the equation for aggregate consumption, *HCONZ*, and the five equations for its components. COVID-affected consumer supply is represented in the three price equations for domestic sales of services. Finally, labour supply is represented by the labour force participation rate equation.

The second method involved statistical testing. That testing largely confirmed the presence of COVID effects in the 10 equations suggested by economic theory and they also identified a further nine equations with COVID effects.

The second method was to add the main COVID variable, *COVID_DOM*, to all 60 estimated equations and then re-estimate using data that includes the COVID period. A significant coefficient on *COVID_DOM* was possible evidence of a COVID effect of some type.

Having identified the 19 estimated equations that should include COVID effects, the nature of those effects was developed using economic theory and further statistical testing. Table A1 shows which of the five COVID effects are included in each of the 19 equations and the associated t-statistics.

Government shutdowns were an important source of COVID effects. There were government shutdowns of the following providers of consumer services: providers of food and beverage services (on-premise provision), gyms and indoor sports services, cinemas, entertainment venues, casinos, and places of worship. Travel was also limited, with non-essential travel banned and international travel mainly limited to Australians returning from overseas, as noted earlier. All of these shutdowns and restrictions negatively affected different areas of the other private services industry (i=SN). The risk of contracting COVID also deterred the use of some consumer services, including visits to medical centres, which are part of the government-type services industry (i=G).

Thus, the shutdowns applied to a series of narrowly-defined industries, which covered only a proportion of the more broadly-defined industries identified in the model, particularly industry SN and, to a lesser extent, G. Hence, typically only a proportion, *w*, of economic activity in a model industry was suppressed when a shutdown was in operation.

This provides the basis for a suppression equation, which relates the actual level of an activity to its normal level. In particular, the observed level of an activity, *Y*, will equal the normal level of the activity, Y^n, reduced by applying the relevant COVID mobility factor, *U*, to the share *w* of the activity that may be subject to shut down. We treat -*w* as a parameter to be estimated.

Suppression equation

$$Y_t = [w \cdot U_t + (1 - w)] \cdot Y_t^n$$

If there is complete immobility, *U=0*, so actual activity is equal to the proportion *1-w* of normal activity. If there is normal mobility, *U=1*, so actual activity equals its normal level.

In the estimated equations of the macro-econometric model, a first order error correction model (ECM) is typically used to model the adjustment of a variable to its equilibrium value, Y^*. This adjustment process is assumed to refer to the normal value of the variable, Y^n, rather than the suppressed value, *Y*. This is because economic considerations and initial statistical testing suggest that variations in mobility, *U*, have a contemporaneous effect on activity, as shown in the suppression equation, rather than a delayed effect operating via an equilibrium variable.

Underlying ECM equation

$$\Delta\, logY_t^n = b_1 \cdot \Delta\, logY_t^* - b_2 \cdot\ (logY_{t-1}^n - logY_{t-1}^*)$$

or,

$$logY_t^n = b_1 \cdot \Delta\, logY_t^* + b_2 \cdot logY_{t-1}^* + (1 - b_2) \cdot logY_{t-1}^n$$

The next step is to take the natural logarithm of the suppression equation and re-arrange it to make normal activity the subject.

$$logY_t^n = logY_t - log\,[1 - w \cdot (1 - U_t)]$$

We then use the logged suppression equation to eliminate normal activity from the ECM equation so that the estimating equation only involves observed variables.

Non-linear estimating equation

$$logY_t = b_1 \cdot \Delta\, logY_t^* + b_2 \cdot logY_{t-1}^* + log\,[1 - w \cdot (1 - U_t)] + (1 - b_2) \cdot \{logY_{t-1} - log\,[1 - w \cdot (1 - U_{t-1})]\}$$

This equation is non-linear in the suppressed proportion parameter, *w*. If *w* is sufficiently small, we can use the following first order approximation around *w=0*, to obtain a simpler, linearised estimating equation.

Approximation:

$$log\,[1 - w \cdot (1 - U_t)] \approx -w \cdot (1 - U_t)$$

Linearised estimating equation:

$$logY_t = b_1 \cdot \Delta\, logY_t^* + b_2 \cdot logY_{t-1}^* - w \cdot (1 - U_t) + (1 - b_2) \cdot \{logY_{t-1} + w \cdot (1 - U_{t-1})\}$$

In practice, we are able to use the linearised version in most cases, except for the four equations for exports and imports of services (Table A1), where it is necessary to use the non-linear version because the suppressed proportion, *w*, is high. In both the non-linear and linearised equations, -*w* is treated as a parameter to be estimated.

Estimation Results

In discussing the estimation results, we begin with the 10 equations where COVID effects would be expected based on the work of Eichenbaum et al. (2021). We then discuss the remaining nine equations where COVID effects have been identified.

The modelling of consumption demand, both in aggregate and at the industry level, is based on the logic of the linearised estimating equation presented above.

In the aggregate consumption function, both domestic immobility, *1-COVID_DOM*, and the lockdowns, *COVID_202* and *COVID_213*, are highly significant (Table A1). Using the estimation results, the overall immobility effect on aggregate consumption, *CCOVID*, is as follows.

$$CCOVID_t = c_5 \cdot COVID\_202_t + c_3 \cdot COVID\_202_{t-1} + c_{10} \cdot COVID\_213_t + c_7 \cdot (1 - COVID\_DOM_t)$$

In the absence of COVID, *COVID_202=COVID_213=0* and *COVID_DOM=1*, so this immobility effect on consumption disappears.

The consumer demand system allocates total household consumption across the six industries in the model. This involves modelling consumer demand for the products of the first five industries (i=A,B,C,G,T) and then obtaining consumer demand for other private services residually (i=SN).

For consistency, in this consumer demand system, we use the constructed consumption immobility variable, *CCOVID*, to capture COVID effects (Table A1). This ensures that the two COVID variables making up *CCOVID* have the same relative importance in determining consumer demand at the industry level as they do at the aggregate level. The estimation results imply that COVID effects shifted the composition of aggregate consumption away from other private services and towards the other five industries. These shifts towards the other five industries are all highly significant (Table A1). This pattern of results is consistent with the observation above that social distancing mainly impacted on the other private services industry.

The labour force participation rate is negatively affected by the two lockdown variables, *COVID_202* and *COVID_213*. Again, these effects are highly statistically significant (Table A1).

COVID effects on consumer supply operate through the three price equations for domestic sales of services. In each case, the equilibrium price based on marginal cost, *P**, is adjusted upwards for the effect of COVID on domestic immobility to obtain a new equilibrium price, *P***. This new equilibrium price is substituted into the ECM to determine the actual price.

$$logP_t^{**} = logP_t^{*} + d \cdot (1 - COVID\_DOM_t)$$

This equation captures the overall effect of COVID on the market clearing price. On the one hand, suppression of demand leads to lower output and marginal cost, thus reducing *P** and thereby indirectly reducing *P***. On the other hand, suppression of supply directly raises *P*** through the second term in the above equation. The overall effect on price will be determined by the relative magnitude of these demand and supply shifts, as foreshadowed earlier.

In the estimated price ECMs for services, the coefficient on the COVID variable (represented by *d* in the above equation) is statistically significant in one out of three cases. The effect is retained in the two insignificant cases because it is correctly signed and plausible in magnitude.

We now turn to the remaining nine equations in the model in which the COVID effects now appear, beyond the areas identified in the simple model of Eichenbaum et al. (2021).

The international travel ban, reflected in the measures of international geographic mobility (Figure 4), disrupted international travel and international study. This resulted in much lower travel-related international trade during COVID (Figure 5). As noted earlier, the proportion of trade in services that was suppressed under COVID was high, so it was necessary to use the non-linear form of the estimating equation.

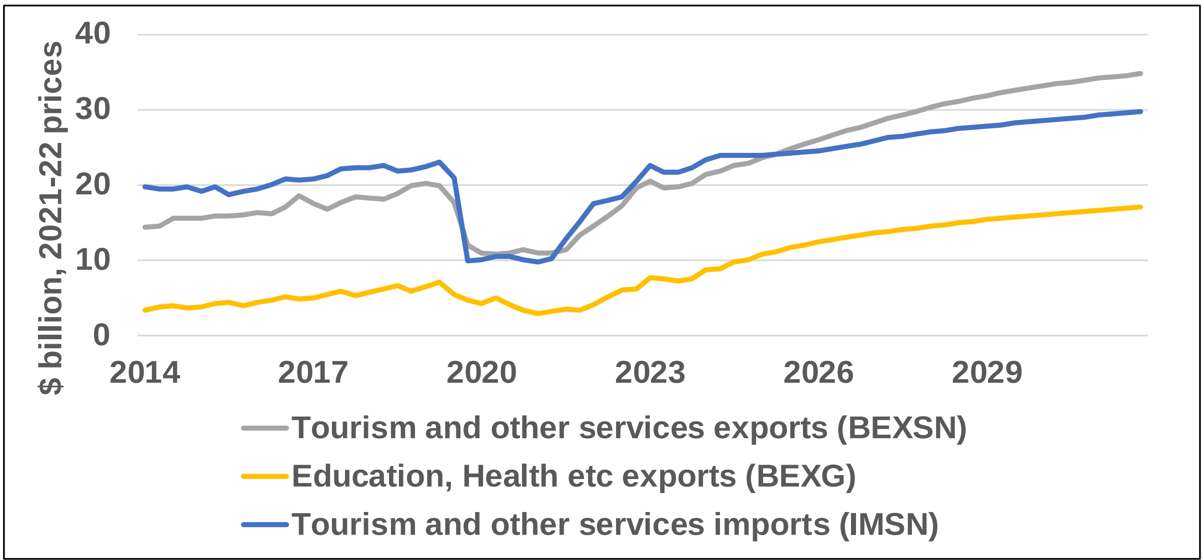


Figure 5. *Travel-related Trade*

The impact of COVID on international tourism is taken into account in the model by the inclusion of the international geographic immobility effect, *1-COVID_INT*, in the four equations for exports and imports of services (Table A1). Foreign expenditure of Australian tourists is included mainly in *IMSN*, while Australian expenditure of foreign tourists is included mainly in *EXSN*. *IMG* is a very small category and so is not included in Figure 5.

The impact of COVID on export income from international students is taken into account in the model by the inclusion of the international student variable, *COVID_EDU*, in the two equations for exports of services. International student fees account for most of *BEXG*, while their living expenses in Australia are included in *EXSN*, alongside the expenditure in Australia of foreign tourists.

All six COVID effects appearing in these four equations for trade in services are highly significant (Table A2).

In the early stages of COVID, viewing of properties was suppressed resulting in fewer transactions and hence lower investment in ownership transfer costs, *CFOTC*. This is modelled through the inclusion of the domestic geographic immobility effect, *1-COVID_DOM*, in that investment equation (Table A1). This COVID effect is highly significant.

Finally, COVID changed some labour market dynamics.

When industries were shut down under COVID restrictions, the falls in output were accompanied by accompanied by similar and almost synchronised percentage falls in employment, as might be expected. This contrasts with the more gradual response of employment to changes in output that characterises traditional business cycles. The more rapid employment response under COVID was taken into account by modelling the speed of adjustment of employment to depend on the domestic geographic immobility effect, *1-COVID_DOM*, in the three industries most affected by COVID restrictions (i=C,G,S). The estimated boosts to these speeds of adjustment under COVID are positive in all three cases and statistically significant in two of them (Table A1).

Wages is the other area where COVID changed labour market dynamics. In the model, the wage variable is average compensation of employees, as reported in the national accounts. Further, in the national lockdown of 2020Q2, the employment losses were disproportionately in lower-wage jobs: part-time employment fell 9 per cent while full-time employment fell 4 per cent, quarter-on-quarter. This had the compositional effect of increasing the average wage per employee, as measured in the national accounts, even if wage rates per hour did not change. This compositional effect is captured in the wage equation by modelling wage movements to depend on the movement in and out of lockdown using the COVID variable, *COVID_202*.

In summary, there are clear economic explanations for the appearance of direct COVID effects in the 19 estimated equations covered by Table A1. There are no direct effects of COVID in the remaining 41 estimated equations. However, there are indirect effects, because the directly affected variables interact with other variables through economic relationships in the model.

5 Macro Policy Regimes and Scenarios

Policy regimes refer to the way policy instruments are used to automatically pursue policy targets. This section describes the alternative macro policy regimes used in this paper and their use in different scenarios.

The first policy regime is the default macro policy regime built into our macro-econometric model. Under this regime, fiscal and monetary policy automatically pursue different policy targets using simple policy rules. This default macro policy regime was used in Murphy (2023a) and is used here in section 6, in this second part of our evaluation of the macro policy response to COVID.

The second policy regime is open-loop optimal control. Under this regime, the policy instruments are used in a co-ordinated way to pursue the policy targets as closely as possible. This optimal control policy regime was used in Murphy (2020) and is used here in sections 7 and 8 in the third part of our evaluation of the macro policy response to COVID.

There is also a hybrid policy regime. It uses the default fiscal policy combined with optimal control of monetary policy. We refer to this hybrid regime as optimal money and it is used in section 9.

Table 5 provides an overview of how policy instruments are used to pursue policy targets in the five key policy scenarios in this paper. The five scenarios are represented in the columns of the table. The default policy regime is used in the first three scenarios, optimal control is used in the fourth scenario and optimal money in the fifth scenario.

Policy instruments are represented in the rows of the table. Thus, a given cell of the table shows how a particular policy instrument is set in a particular scenario.

Table 5. Overview of Macro Policy Regimes and Scenarios

Scenario Instrument	Default Policy	Baseline (actual policy)	Shorter stimulus	Optimal Control (forward-looking)	Optimal Money (forward-looking)
Policy interest rate	Taylor rule responding to inflation and unemployment gaps	Taylor rule adjusted for extension of ELB policy to May 2022	Taylor rule responding to inflation and unemployment gaps	Control of inflation, unemployment and public debt gaps	Control of inflation and unemployment gaps
Average personal income tax rate	Fiscal rule responding to public debt gap from 2025-26	Fiscal rule responding to public debt gap from 2025-26	Fiscal rule responding to public debt gap from 2025-26	Control of inflation, unemployment and public debt gaps	Fiscal rule responding to public debt gap from 2025-26
Other fiscal instruments	No fiscal measures	Fiscal measures shown in Table 1	Fiscal measures shown in Table 6	Fiscal measures shown in Table 6	Fiscal measures shown in Table 1

The policy regimes use the same two policy instruments to pursue the same three policy targets. As seen in the rows of Table 5, the RBA's policy interest rate, the cash rate target, is the monetary policy instrument and the average rate of personal income tax is the fiscal policy instrument. There are also many “other fiscal instruments” in the model, which are represented in the final row of the table. Unlike the first two policy instruments, the other fiscal instruments are adjusted manually rather than automatically.

The first two policy targets are for unemployment and inflation. The target for the unemployment rate is the sustainable unemployment rate or NAIRU. The target for annual inflation is 2½ per cent, consistent with the RBA’s target range of 2 to 3 per cent. The third policy target is a long-term target for public debt, ensuring fiscal sustainability. Under both policy regimes, macro policy aims to reduce the gaps between unemployment, inflation and public debt and their respective target values.

The inflation and public debt targets are essential to the successful operation of the model. Monetary policy needs to actively target inflation so that the inflation rate has a long-term anchor. Fiscal policy needs to actively target public debt (or target a related fiscal variable such as the budget balance) to ensure that fiscal policy operates in a sustainable way, with the government complying with its intertemporal budget constraint.

In contrast, it is not strictly necessary for macro policy to target the unemployment rate. This is because the operation of the labour market, as represented by the wage equation, will ensure that the unemployment rate eventually converges to the NAIRU. However, it is good standard practice to include unemployment as a target of macro policy, with the aim of ensuring that the unemployment rate is less variable than it would otherwise be.

While the policy regimes share the same instruments and targets, there are two general differences between them. The optimal control regime is both more flexible and forward-looking than the default policy regime.

The optimal control regime is more flexible. Under it, fiscal and monetary policy are used in a co-ordinated way to control the inflation, unemployment and public debt gaps as well as possible, as shown in the fourth scenario in Table 5. In contrast, under the default policy regime used in the first three scenarios, there are separate simple rules for fiscal and monetary policy. Under the fiscal rule, the average rate of income tax adjusts gradually to close the public debt gap. Under the Taylor rule for monetary policy, the policy interest rate adjusts in response to the observed inflation and unemployment gaps.

The optimal control regime is forward looking. It uses the structure of the model and its forecasts for the target variables to work out a plan to adjust fiscal and monetary policy to pursue the three targets. In contrast, the default policy regime is backward looking. It is guided by the current outcomes for the three target variables.

Both policy regimes allow for an effective lower bound (ELB) on the policy interest rate, as described in section 5.2. This is important when modelling monetary policy during the COVID pandemic because the ELB was reached.

We use the default macro policy regime in the second part of our evaluation of the macro policy response to COVID in section 6. This compares how well unemployment and inflation were controlled under the actual macro policy response (*baseline* scenario) with how well they are controlled under a macro policy response guided by the macro policy principles for pandemics (*shorter macro stimulus* scenario). We also include a scenario where there is no active fiscal policy response (*default policy* scenario), partly for comparability with Murphy (2023a). The general policy assumptions for these scenarios can be read from their columns in Table 5.

We use the optimal control regime in the third part of our evaluation of the macro policy response to COVID. From the fourth column of Table 5, we see that the *optimal control* scenario uses the macro policy settings from the *shorter stimulus* scenario as its starting point. It then adjusts the paths for the policy interest rate and the average rate of personal income tax until the unemployment, inflation and public debt gaps are optimally controlled. We are interested in whether the *optimal control* scenario produces better policy outcomes than the *shorter stimulus* scenario. The main *optimal control* scenario appears in section 7 and two variants of it appear in section 8.

Like the optimal control regime, the optimal money regime is used in the third part of our evaluation of the macro policy response to COVID. From the final column of Table 5, we seen that the *optimal money* scenario uses the actual macro policy settings from the *baseline* scenario as its starting point. It then adjusts the path for the policy interest rate until the unemployment and inflation gaps are optimally controlled. In section 9 we use the *optimal money* scenario as one of our policy benchmarks for assessing monetary policy under COVID, taking the fiscal policy response as given.

As explained above, the unemployment target in both regimes is the NAIRU, which is estimated in the wage equation. Thus, we begin this section by describing the estimation of the wage equation, as background. We then describe the workings of the default and open-loop optimal control policy regimes in turn.

5.1 Modelling Wages

The wage equation is an inflation-expectations augmented Phillips Curve. The average wage, *W*, inflates at above or below a benchmark rate according to whether the unemployment rate, *URT*, is below or above the *NAIRU*. This wage adjustment gradually brings the labour market to an equilibrium in which *URT* equals *NAIRU* so that the unemployment gap is closed.

The benchmark rate for wage inflation equals underlying labour productivity growth, *LEGR*, plus expected inflation calculated as a weighted average of the Reserve Bank's inflation target, *INFT*, and recent inflation in *PCPIA*. This is consistent with the model's long run equilibrium in which real wages rise at the same rate as labour productivity.

The wage equation allows for two complications in modelling the link from the unemployment rate to wage inflation. These are that the relationship between wage inflation and unemployment is likely to be non-linear and the *NAIRU* changes over time. These two complications are now discussed in turn.

Wage equation

$$\Delta \log(W_t) = LEGR_t + (1 - 0.2) \cdot \log(1 + INFT_t/100) + 0.2 \cdot \Delta^4 \, log(PCPIA_{t-1})/4$$
$$+ 0.0125 \cdot (1/b) \cdot \{(NAIRU_t/URT_{t-1})^b - 1\} + 0.025 \cdot \Delta COVID\_202_t$$
$$+ 0.016 \cdot \Delta COVID\_202_{t-1}$$

where:

$$NAIRU_t = 7.94 \;\; for \; t \leq 124 \; (1997q2)$$

$$NAIRU_t = [7.94 \cdot (132 - t) + 6.41 \cdot (t - 124)]/(132 - 124) \;\; for \; 124 < t \leq 132 \; (1999q2)$$

$$NAIRU_t = [6.41 \cdot (158 - t) + 5.52 \cdot (t - 132)]/(158 - 132) \;\; for \; 132 < t \leq 158 \; (2005q4)$$

$$NAIRU_t = [5.52 \cdot (195 - t) + 4.69 \cdot (t - 158)]/(195 - 158) \;\; for \; 158 < t \leq 195 \; (2015q1)$$

$$NAIRU_t = 4.69 \;\; for \; t > 195 \; (2015q1)$$

$$b = 0.5$$

Estimation period: 1992q1-2024Q1

Given that the unemployment rate cannot be negative, wage inflation is likely to be more sensitive to a given fall in unemployment when the unemployment rate, *URT*, is already low relative to the *NAIRU*. Such a non-linearity was recognised by Phillips (1958) in his original Phillips Curve for the United Kingdom and was recently found to be present in a Phillips Curve for the Euro area by Byrne and Zekaite (2020) and for the United States by Cristini and Ferri (2021).

In our wage equation, this non-linearity is introduced using the parameter *b*. The response of wage inflation to unemployment is linear if *b* equals –1 and becomes increasingly non-linear for higher values of *b*. In the limit as *b* approaches zero, wage inflation depends negatively on the logarithm of the unemployment rate. If *b* equals 1, it depends on the reciprocal of the unemployment rate, as in the Reserve Bank's MARTIN model (Ballantyne et al., 2020).

In the above wage equation, *b* has a freely estimated value of 0.2, but with a high standard error, and has been constrained to 0.5, well within a 90 per cent confidence interval. This value of *b* is midway between the case where unemployment depends negatively on the logarithm of the unemployment rate and the case where it depends on the reciprocal of the unemployment rate. It implies that wage inflation depends on the reciprocal of the square root of the unemployment rate.

It is clear from the historical pattern of unemployment that the *NAIRU* has varied over time. This is taken into account by using piece-wise linear regression to allow the *NAIRU* to vary as a function of time. We allow for four kinks[12]. The level of the *NAIRU* at each kink is estimated as part of the estimation of the wage equation. This results in the time-based estimates for the *NAIRU* shown below the wage equation. As can be seen, the NAIRU is estimated have fallen along three linked linear segments from 7.94 per cent up to the June quarter 1997 to be 4.69 per cent since the March quarter 2015. This estimate for the current NAIRU of 4.69 per cent has a standard error of 0.43 percentage points.

We can compare our estimate for the current NAIRU of 4.69 per cent with the estimates obtained in studies by the Treasury and the RBA.

In a Treasury wage equation study, Ruberl, Ball, Lucas and Williamson (2021, p. 26) obtain "an estimate of the NAIRU within a range of 4½ to 5 per cent over the five-years immediately prior to the COVID-19 recession". That is similar to our estimate that the NAIRU has been 4.69 per cent since the March quarter 2015. Treasury revised its estimate of the NAIRU down from 4¾ per cent to 4¼ per cent in 2022 (Australian Government, 2022, p. 59; Australian Government, 2023b, p. 31).

In a RBA study, Cusbert (2017, p.13) estimated the NAIRU to be "currently around 5 per cent", as of early 2017. Ellis (2019) states that the RBA subsequently revised its estimate of the NAIRU down to 4½ per cent. In a recent study, Ballantyne, Sharma and Taylor (2024) do not specify an updated estimate, but we interpret their Graph 10 to mean that the RBA estimate of the NAIRU remains unchanged at 4½ per cent.

Both the Treasury and RBA studies allow the NAIRU to vary historically by assuming it follows a random walk. Taken literally, the random walk assumption implausibly implies that the *NAIRU* does not have a mean and it can become negative, so we prefer the piece-wise linear regression approach that we have used. However, in practice the two approaches appear to produce broadly similar historical estimates for the NAIRU as can be seen by comparing the *NAIRU* estimates here with those in Graph 2 of Cusbert (2017) and Chart 9 of Ruberl et al. (2021).

Taking this research into account, it seems probable that the NAIRU is currently between 4 and 5 per cent. Thus, our estimate of 4.69 per cent seems reasonable for the purposes of this study.

Our wage equation ensures that the unemployment rate, *URT*, eventually converges to equal the *NAIRU*, so that the unemployment gap is closed. However, this can occur relatively slowly, resulting in unacceptably high variability in unemployment. To reduce variability in unemployment, macro policy also responds to the unemployment gap under the policy regimes that we use. We now describe the workings of the default and open-loop optimal control policy regimes in turn.

[12] The time location of these four kinks is estimated in a preliminary regression of the actual unemployment rate as a piece-wise linear function of time.

5.2 Default Fiscal and Monetary Policy Rules

As noted above, the default policy regime is basic in design. Fiscal policy is assigned to the public debt target and monetary policy is assigned to the inflation and unemployment targets. Further, the default policy regime is backward looking, being guided by current outcomes for the three target variables.

The fiscal policy rule ensures fiscal sustainability by setting a long-run target, *RPUBLIT*, for the ratio of net public debt, *PUBLI*, to smoothed nominal GDP, *SGDPZ*. While in practice the government may achieve its long-run fiscal target through a variety of measures such as tax increases or expenditure cuts, the macro model makes the simplifying assumption that fiscal sustainability is achieved through gradual adjustments in the average rate of personal income tax as it applies to labour income, *POLLAB*.

Besides the debt target, the fiscal rule is extended to include a consistent target for the deficit, *PUBNB*, where the deficit target is calculated by applying the equilibrium rate of growth in nominal GDP, *GRZ*, to the debt target. In model simulations, this extension improves the performance of the tax rate in targeting debt.

See Murphy (2020) for a more complete description of an earlier but broadly similar version of this default fiscal policy rule.

Default Fiscal policy – personal income tax rate

$$\Delta POLLAB_t = (GDPZ_t / WBILL_t)$$

$$\cdot \{0.05 \cdot [PUBNB_{t-1}/SGDPZ_{t-1} - GRZ_t/(1 + GRZ_t) \cdot RPUBLIT_t]$$

$$+ 0.003 \cdot [PUBLI_t/SGDPZ_t - RPUBLIT_t/(1 + GRZ_t)]\}$$

$$+ POLLAB\_A_t + DUMOC_t \cdot POLLABX_t/100$$

The inclusion of this fiscal policy rule in the model makes the personal income tax rate, *POLLAB*, endogenous. However, in the scenarios in section 6, we need to model the fiscal response to COVID, which brought forward the stage 2 personal income tax cuts from 2022-23 to 2020-21, as indicated in Table 1. Further, the stage 3 personal income tax cuts (as revised in January 2024) were introduced in 2024-25. To take these policy changes into account, in section 6 we make *POLLAB exogenous* until 2024-25. We then ensure fiscal sustainability by using the fiscal policy rule from 2025-26 onwards, as indicated in Table 5.

Finally, the fiscal policy rule also allows for the use of optimal control. When the default policy regime is used *DUMOC*=0, and the fiscal policy rule operates in the normal way. However, when optimal control is used *DUMOC=1*, and optimal control alters the personal income tax rate outcome via *POLLABX*.

The monetary policy rule is a type of Taylor rule and hence ensures that inflation converges to a specified target rate. This rule is estimated using historical data from the March quarter 1992 and aims to capture, in broad terms, the RBA's approach to monetary policy since the introduction of its targeting of consumer price inflation. Under this approach, the policy interest rate, *RS*, is determined by the four equations set out below.

Default Monetary policy rule (Taylor rule)

$$log(RST_t^* - RSMIN - RST\_A_t^*)$$
$$= 0.66 \cdot log(RS_{t-1} - RSMIN) + (1 - 0.66) \cdot log(RL_t - RLPREM - RSMIN)$$
$$+ (0.15/(\overline{RS} - RSMIN)) \cdot (100 \cdot \Delta^4 PCPIA_t/PCPIA_{t-4} - INFT_t)$$
$$- 0.033 \cdot (URT_t - NAIRURBA_t) - 0.12 \cdot DUMGFCR_t + 0.04 \cdot DUMGFCR_{t-1} - 0.34$$
$$\cdot COVID\_212\_222_t$$

$$\Delta NAIRURBA_t = 0.22 \cdot (NAIRU_t - NAIRURBA_{t-1})$$

$$RST_t = \begin{cases} 0.1, & RST_t^* < 0.1 \\ RST_t^*, & RST_t^* \geq 0.1 \end{cases}$$

$$\Delta log(RS_t - ELBOC) = \Delta log(RST_t - ELBOC) + DUMOC_t \cdot RSCX_t$$

where:

$$RLPREM = 0.56;\ RSMIN = -1;\ ELBOC = -0.25$$

Estimation period: 1992q1-2024Q1

The first and main equation determines a preliminary value, *RST**, for the policy interest rate, *RS*. *RST** adjusts relative to a neutral interest rate[13] in response to the gap between actual inflation and the inflation target, *INFT*. This inflation target is set at 2.5 per cent, which is the midpoint of the Reserve Bank's historical inflation band of 2 to 3 per cent. The inflation rate is constructed using the Consumer Price Index adjusted for the introduction of GST in the third quarter of 2000, *PCPIA*, consistent with Dungey and Pagan (2009).

The monetary rule also targets the unemployment rate, *URT*, at the sustainable rate perceived by the Reserve Bank, *NAIRURBA*. This perceived sustainable rate, *NAIRURBA*, adjusts quicky to changes in the actual sustainable rate, *NAIRU*, as shown in the second equation below. Thus, in the monetary rule, monetary policy responds to both the inflation gap and the unemployment gap.

[13] The neutral value for *RS* is modelled as the 10-year government bond rate, *RL*, net of a term premium of 0.56 percentage points, which is estimated within the monetary rule.

Monetary policy in the COVID pandemic was exceptional. The Reserve Bank reduced its cash rate target to an assessed Effective Lower Bound (ELB) of 0.1 in November 2020 and held it there until May 2022, despite ongoing variations in inflation and unemployment. This ELB of 0.1 is allowed for under both policy regimes, but in different ways.

In the Taylor rule, the ELB is allowed for by using a Tobit regression model. In the first equation presented above, the inflation and unemployment gaps can lead to a preliminary outcome for the policy interest rate, *RST**, that is below 0.1. In the third equation, that inadmissible interest rate outcome is "censored" and replaced with 0.1 to create *RST*. In contrast, under OLS estimation censoring is not taken into account, resulting in biassed coefficient estimates.

The Taylor rule also takes into account the idea that the RBA makes smaller adjustments in interest rates as it approaches the *ELB* and begins to run out of room for further adjustments. This curvature is included in the Taylor rule by using a lower asymptote, *RSMIN*, of –1. This asymptote is introduced by measuring interest rates relative to *RSMIN* and taking the logarithm.

With the *ELB* included, the rule can account for the cash rate being close to zero in the 2020-21 recession year. However, the cash rate remained close to zero in the 2021-22 financial year, despite unemployment falling and inflation rising to be near their target values. This departure from the rule occurred as part of the monetary policy response to COVID announced by Lowe (2020). It is modelled using a time-based dummy variable, *COVID_212_222*. This dummy variable is highly significant, with a t-statistic of –8.2. This discretionary expansion of monetary policy during the later part of COVID can be simulated or removed by switching this dummy variable on or off. Whether this special COVID monetary stimulus was appropriate is considered in sections 6 and 9.

The monetary rule includes another dummy variable, *DUMGFCR*. This dummy variable takes into account that monetary policy during the global financial crisis was more expansionary than can be explained by the rule alone.

Finally, the fourth and final equation uses *RST* to obtain the final outcome for the policy interest rate, *RS*. When the default policy regime is used, *DUMOC*=0, and *RS* always equals *RST*. However, when optimal control is used *DUMOC=1*, and optimal control alters the interest rate outcome via *RSCX*. The optimal control regime is now explained.

5.3 Open-loop Optimal Control of Fiscal and Monetary Policy

The open-loop optimal control policy resembles the default macro policy described above in that it is based on the same targets for inflation, unemployment and public debt of *INFT*, *NAIRU* and *RPUBLIT* and the same policy instruments of *RS* and *POLLAB*. As a result, it leads to the same outcomes in the long run. It differs from the default macro policy by ensuring that the transition to this long run is achieved with the lowest possible social loss.

This optimal transition is obtained by considering all of the targets together, by explicitly deciding the appropriate relative weight for each target to deal with trade-offs, and by not applying any restrictions on which instrument can be used to pursue which target. See Murphy (2020) for an earlier application of optimal control to an earlier edition of the same model.

Here we use the open loop version of optimal control because it allows us to solve for the optimal macro policy response specific to the COVID economic shock. One potential problem with open loop optimal control is that it can lead to time inconsistency in which policymakers renege on their announced response to a shock. For example, the announcement of an anti-inflationary monetary policy may reduce inflation expectations leading to lower wage demands, and this may make it unnecessary to fully implement the original, announced policy. However, such reneging undermines the policymaker's credibility so that future announcements may not be fully believed.

Here time inconsistency is avoided by assuming that policymakers commit to their original policy plan in response to an economic shock, similar to Brayton, Laubach and Reifschneider (2014). This policy plan is chosen and announced in the June quarter 2020. Although the economy was subject to other shocks after the June quarter 2020, we implicitly assume that policy makers had perfect foresight about those future shocks to avoid the need to update the optimal control plan every quarter. We return to this assumption of perfect foresight in section 7.

The formal optimal control problem, which chooses time paths for the two macro polices to minimise social loss from not exactly achieving the targets during the transition, is set out below.

Choose policy instrument path:

$$RSCX_t, POLLABX_t \; for \; t = 1, \dots 120$$

to minimise social loss SL:

$$\begin{aligned} SL = \sum_{t=1}^{132} (1-\delta)^{t-1} \cdot \{ & \alpha_1 \cdot [100 \cdot \Delta^4 NAPHCON_t / NAPHCON_{t-4} - INFT_t]^2 \\ & + \alpha_2 \cdot [URT_t - NAIRU_t]^2 + \alpha_3 \cdot [\Delta RS_t]^2 + \alpha_4 \cdot [RSELB_t]^2 \\ & + \alpha_5 \cdot [100 \cdot \Delta POLLAB_t]^2 \\ & + \alpha_6 \cdot [(100/4) \cdot (PUBLI_t / SGDPZ_{t-1} - RPUBLIT_t)]^2 \} \end{aligned}$$

where:

$$RSELB_t = \frac{1}{b\_RS} \cdot \left\{ \left(\frac{0.5 \cdot (RL_t - RLPREM) + 0.5 \cdot RLF - ELBOC}{RS_t - ELBOC} \right)^{b\_RS} - 1 \right\}$$

$$b\_RS = 1$$

In this measure of social loss (SL), the consumer price inflation target refers to the price deflator for household final consumption expenditure in the national accounts, *NAPHCON*. The US Federal Reserve targets this measure of consumer price inflation, which in the USA is known as the PCE price index. Instead, the RBA targets the Consumer Price Index or CPI. The PCE price index is broader and follows economic concepts more closely, while the CPI is more familiar to the public. On balance, we prefer the US Federal Reserve approach.

Earlier, we used the CPI as the inflation target in the default Taylor rule for monetary policy because that rule is intended to represent the behaviour of the Reserve Bank. In practice, the choice made between *NAPHCON* and *CPIA* in measuring *SL* is immaterial to our results because the responses of the two inflation measures to the economic changes we consider in the various scenarios are very similar.

Notice that the two policy instruments, *RS* and *POLLAB*, are controlled indirectly via *RSCX* and *POLLABX*. As seen above, these 'X' subscript variables are appended to the default policy rules. This indirect approach allows *RS* and *POLLAB* to be fully controlled over the instrument horizon, which extends for 120 quarters or 30 years. After the 30 years, *RSCX* and *POLLABX* are set to zero and the default policy rules take over.

Social loss (SL) in each quarter has six components. It is assumed to depend on the squared deviations of inflation, unemployment and public debt from their respective target values of *INFT*, *NAIRU* and *RPUBLIT*. In addition, to avoid large, erratic changes to the policy instruments, *RS* and *POLLAB*, which would be implausible and probably undesirable, there is also an assumed social loss from changing the values of the two instruments.

Finally, there is a component designed to ensure that the interest rate, *RS*, does not come too close to a floor, *ELBOC*, which is set to –0.25. This component, *RSELB*, is based on the ratio of the equilibrium interest rate, to the actual interest rate, *RS*, where both interest rates are calculated relative to *ELBOC*. In the steady state *RSELB* equals zero, consistent with the other five components of social loss. Here the equilibrium interest rate is calculated as a simple average of its long run value *RLF*, and its short run value, *RL-RLPREM*.

Under the assumed value for the parameter *b_RS* of 1, this component is highly non-linear in *RS*. As a result, *RSELB* does not make a material contribution to social loss when the interest rate, *RS*, is well away from the floor, *ELBOC*, but its contribution tends to infinity as *RS* approaches *ELBOC*. In this way, the *RSELB* component has the desired effect of preventing *RS* from going very close to *ELBOC*, while otherwise having little effect on the outcome for *RS*.

The overall social loss, *SL*, is assumed to depend on the sum of the time discounted values of the quarterly losses over the target horizon. The target horizon is 132 quarters or 33 years.

The target horizon is set longer than the instrument horizon to avoid myopic instrument changes occurring towards the end of the instrument horizon.

To use this measure of social loss, *SL*, we need values for the weights, α_i, attached to the six components of social loss in each quarter, as well as a time discount rate, δ, to use in combining the quarterly losses into a single measure of loss. Following Brayton et al. (2014), future losses are discounted at a quarterly rate of 1 per cent i.e. an annual rate of 4 per cent. In practice, the optimal control policy has very low sensitivity to the assumed discount rate because the model converges to a steady state in which the social loss is zero.

It is only the *relative* value of the weights that affects the solution for the optimal control policy, so we can normalise the weight for the inflation gap at 1. We follow Brayton et al. (2014) from the US Federal Reserve in also assigning weights of 1 to the unemployment gap and the change in the interest rate. The equal weights on inflation and unemployment are also consistent with RBA Review, which "supports the equal consideration of monetary policy's objectives for price stability and full employment" (de Brouwer, Fry-McKibbin and Wilkins, 2023, p. 93). Notwithstanding those valid justifications for the equal weight assumption, to accommodate a range of views, in section 8 we explore the sensitivity of our results to alternative assumptions about the relative weight assigned to the unemployment target.

Brayton et al. (2014) only need those three weights because they confine themselves to optimal control of monetary policy. We need a further three weights because we also have optimal control of fiscal policy and a floor for the interest rate.

We choose a low weight of 0.125 for the change in *POLLAB*. This low weight allows a high degree of flexibility in fiscal policy. This seems appropriate given the very flexible actual response of fiscal policy to the COVID shock observed in the June quarter 2020. We choose a very low weight of 0.004 for the public debt target. This low weight partly reflects the higher relative magnitude of the public debt ratio compared to the other targets, and partly the idea that public debt gaps can be resolved gradually over a relatively long period.

Finally, we choose a weight of 0.002 for the interest rate floor, *RSELB*. This weight is calibrated to be just high enough to keep *RS* positive in the main optimal control scenario, very close to the ELB of +0.1 and well clear of the floor of –0.25. At the same time, it is small enough for this component to otherwise have little effect on the outcome for *RS*.

This optimal control approach to the *ELB* differs from the Taylor rule approach to the *ELB* presented in section 5.2. In the Taylor rule, the *ELB* is enforced precisely. That is not an option using the EViews add-in for optimal control, *mcontrol.prg*. Thus, we instead enforce the *ELB* to a close approximation by using our *RSELB* variable in the measure of social loss and carefully selecting the values for its weight and the absolute floor, *ELBOC*.

Once weights have been chosen, social loss, *SL*, provides a useful score for how well macro policy controls unemployment and inflation, while also taking into account the four other more minor components of *SL* described above. A lower score indicates better macroeconomic control. While only optimal control works by choosing the macro policy that minimises this score, we report the *SL* score for all scenarios (Table A4).

As seen in the final column of Table 5, our *optimal money* scenario used in section 9 involves optimal control of monetary policy, but not fiscal policy. To confine optimal control to monetary policy, the above optimal control problem is varied in two ways. First, an instrument path is chosen for *RCSX* but not *POLLABX*. Second, we drop the two fiscal policy-related terms from the measure of social loss by using the following setting.

$$\alpha_5 = \alpha_6 = 0$$

As noted above, optimal control is simulated using the EViews *mcontrol.prg* add-in, which was written by Brayton of the US Federal Reserve. We customised the program to allow use of a quasi-Newton solution method. This avoids the need to re-calculate at each iteration the matrix of the numerical derivatives of paths for target variables with respect to paths for instrument variables, so the optimal control solution can be found more quickly.

6 Updated and Shorter Stimulus Scenarios

Having described our macroeconomic model in section 4 and the design of our policy regimes and scenarios in section 5, this second completes the second part of this paper by presenting the outcomes of each macro policy scenario. We focus on how well unemployment and inflation are controlled in each scenario compared to under the actual macro policy of the *baseline* scenario.

First, we simulate a *no COVID* scenario. Then, we simulate three scenarios under COVID with alternative macro policy settings. Those settings were summarised in Table 5 of section 5. Macro policy is least expansionary under the *default policy* scenario and most expansionary under the *baseline* scenario, which uses the actual policy response. Falling in between those two extremes is the *shorter stimulus* scenario, which is based on the macro policy principles for a pandemic.

Murphy (2023a) simulated all of the above scenarios, except for the important *shorter stimulus* scenario, which was developed for this paper. Thus, in this section we update Murphy's (2023a) results and also present the *shorter stimulus* scenario for the first time. This will allow us to draw conclusions for the second part of our evaluation of the macro policy response to COVID.

This section has six parts. First, we highlight the improvements made to the model since Murphy (2023a). Second, we discuss the model inputs used in generating the updated scenarios. Third, we present the results for the updated scenarios. Fourth, we discuss the model inputs and report the results for the *shorter stimulus* scenario. Fifth, we cross-check our main results against comparable results from leading international models. Sixth, we present our findings for this second part of our evaluation of the macro policy response to COVID.

6.1 Updated Model

Murphy's (2023a) COVID modelling used historical data to the June quarter 2022. With the passage of time, the historical data has now been extended seven quarters to the March quarter 2024. This additional post-COVID data allows the effects of COVID and the policy responses to it to be modelled with greater certainty. There have also been refinements to the model.

Previously, the model assumed constant growth rates for underlying labour productivity, with a different rate estimated for each of its five labour-employing industries. These industry-specific productivity growth rates were measured per person employed. Following improvements to the model, we now allow for changes in these industry-specific productivity growth rates from both a downshift in average hours worked as well as a downshift in underlying productivity growth rates on a per hours worked basis.

To estimate the downshift in average hours worked, we use piecewise linear regression with estimated locations for the kinks. We find a steady downshift in average hours worked from 34.2 hours in the September quarter 1995 to 31.5 hours in the September quarter 2020.

We use a similar approach to estimate the decline in productivity growth on an hours worked basis. We find a kink in trend productivity at the September quarter 2005. At that point, there was a drop in trend annual growth in output per hours worked from 1.9 per cent to 1.1 per cent. A similar productivity drop was identified in the most recent InterGenerational Report (Australian Government, 2023a).

These two downshifts are estimated at the aggregate level. They are then taken into account in estimating industry-specific components for productivity growth.

Allowing for the downshift in productivity growth means that the model produces lower and more realistic estimates for growth in potential output. It also improves the estimation of the NAIRU in the wage equation.

Murphy (2023a) used an estimated NAIRU of 4.2 per cent. However, re-estimating the wage equation after allowing for the downshift in productivity growth increases the estimate for the current NAIRU to 4.69 per cent, the value reported in section 5.1. Because estimated productivity growth since 2005 is now lower, it explains less of observed wages growth. This leaves more of wages growth to be explained by labour market tightness, leading to a higher estimate for the current NAIRU.

Since Murphy (2023a), it has become apparent that the period of abnormally low net overseas migration, *NOM*, during COVID is being fully offset by a period of abnormally high *NOM* post-

COVID. Hence, this study differs from Murphy (2023a) in that COVID no longer leads to a permanent loss in population.

6.2 Updated Model Inputs

To simulate the scenarios, we need a set of model inputs to represent the COVID pandemic and another set of model inputs to represent the actual macro policy response to COVID. These two sets of inputs are now discussed in turn.

COVID Inputs

We explained in section 4.4. how we have modelled the effects of COVID using five model inputs for social distancing. We vary these inputs in a straightforward way to distinguish the *no COVID* scenario from the scenarios under COVID. In addition to these direct domestic effects, COVID also affected the Australian economy indirectly by changing the international economic environment. Hence, to fully distinguish the *no COVID* scenario, we also need to undo the effects of COVID on the international environment, which requires some judgement. We now explain in more detail how we have adjusted the model inputs for social distancing and the international environment to obtain a *no COVID* scenario.

Table A2 summarises how model inputs have been adjusted for COVID, arranged in two panel of rows for the two different types of model inputs. The "without COVID" column show the model settings in the *No COVID* scenario, while the "with COVID" column shows the model settings in the subsequent scenarios. The "time period of COVID effect" column identifies the time period over which the two settings differ from each other. Most COVID model inputs eventually converge to the same "normal" values, both with and without COVID, because the time period of COVID effects is limited (Table A2).

The two panels of Table A2 are now discussed in turn, beginning with the social distancing effects.

In section 4.4 five indicators of immobility under COVID were found to cause shifts in 19 out of the model's 60 estimated equations. The five COVID variables are *COVID_DOM*, *COVID_INT*, *COVID_EDU*, *COVID_202* and *COVID_213*. Table A1 shows the equations where each COVID variable appears.

In Table A2, the first three COVID variables measure geographic mobility and are set to their normal values of unity in the *No COVID* scenario. In the other scenarios they are set to their actual and projected values under COVID, which range from 0 (no mobility) to unity (normal mobility), as shown in Figure 4 and discussed in section 4.4. Table A2 identifies the time periods over which each variable departs from its normal value. Lower levels of geographic mobility led to lower levels of economic activity.

The next two social distancing variables are a dummy variable for the national lockdown of 2020q2, *COVID_202*, and a dummy variable for the NSW and Victorian lockdown of 2021q3, *COVID_213*. These dummy variables are set to zero in the *No COVID* scenario and unity in the applicable quarter in the other scenarios (Table A2). The lockdowns led to lower levels of economic activity.

The final model input in the social distancing panel of Table A2 is net overseas migration (*NOM*). The international travel ban disrupted *NOM*. *NOM* became negative (Figure 6) as potential new residents were barred from entering Australia while some Australian residents were allowed to return home. Post-COVID, *NOM* has been unusually high allowing the population to fully recover from its losses during COVID. After the population recovery, *NOM* is projected to return, from 2025-26 onwards, to a normal annual level of 225 thousand persons.

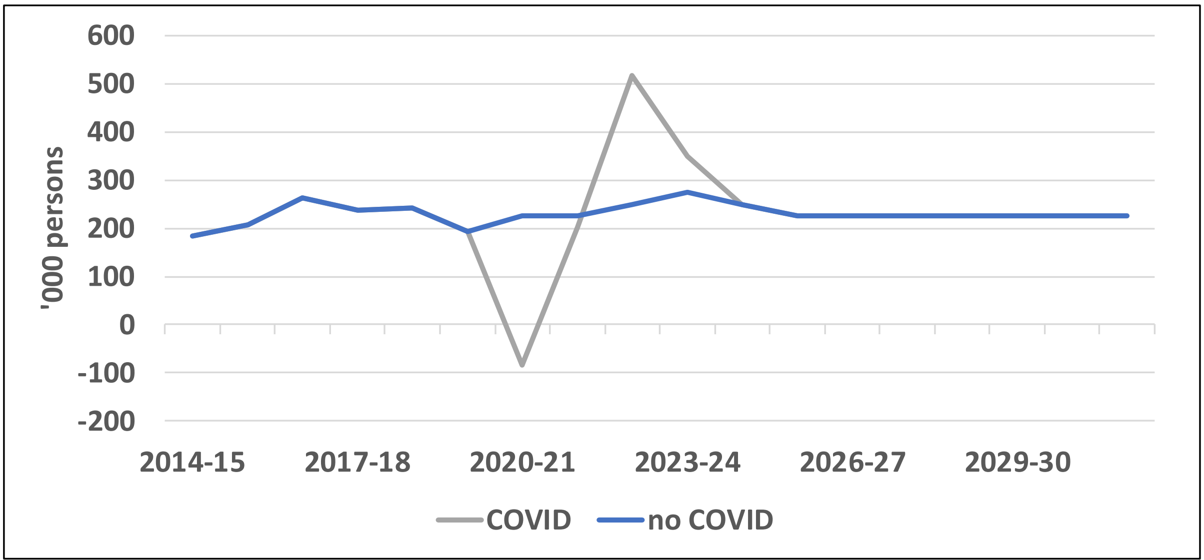


Figure 6. *Net Overseas Migration ('000 persons per year)*

In a hypothetical no COVID situation, it is assumed that *NOM* would have been maintained at around the same normal level throughout (Figure 6). In any case, in both the *COVID* and *no COVID* scenarios, the population is at virtually the same level from 2025-26 onwards. This is different from the earlier modelling in Murphy (2023a). At that time, it was generally believed that there would be no period of migration catchup and hence, in Australia, COVID would leave a legacy of a permanent loss in population.

Turning to the second type of shock, besides affecting the Australian economy directly, COVID affected the Australian economy indirectly through its linkages with a weakened international economy. Globally, the COVID recession in 2020 led to low inflation. However, in 2021 this reversed to high inflation. The reasons suggested for this inflation reversal include highly expansionary fiscal policy fuelling demand and a COVID-related loss of labour supply constricting supply. Consistent with IMF forecasts, world CPI inflation on a quarterly basis is assumed to return to normal from 2025 (Table A2).

In the no COVID situation, it is assumed that world inflation, as measured by the world CPI, would have been normal throughout. It is also assumed that commodity prices, relative to the world CPI, would have been the same as in the COVID situation (Table A2).

This same pattern of low and then high inflation led central banks to reduce policy interest rates in the first half of 2020 before increasing them in 2022 and 2023 until they exceeded neutral rates. In the scenarios under COVID, it is projected that the model's foreign short-term interest rate gradually adjust downwards from the current rate to a neutral rate. In the *no COVID* scenario, foreign interest rates follow a consistent path from their low pre-COVID base towards a neutral rate (Table A2).

Murphy (2023a) assumed that in 2020 and 2021 the residuals of two equations, for household consumption and the labour force participation rate, reflected COVID effects. However, the modelling of COVID effects in these two equations has been improved. Hence, there are no longer any changes made to equation residuals between the *no COVID* scenario and the scenarios under COVID.

Macro Policy Inputs

Here we explain how macro policy under COVID has been translated into model inputs. We have already described fiscal policy under COVID in Table 1 of section 3.1. We have discussed monetary policy under COVID using our Taylor rule set out in section 5.2.

The full details of how the macro policy response to COVID has been fed into the model is provided in Table A3. The first two panels are for government spending and taxation, and cover the fiscal policy measures in Table 1. The third panel is for monetary policy and references the Taylor rule.

The "with policy expansion" column in Table A3 shows the policy settings under the actual fiscal and monetary expansions of the COVID era. Those policy settings are used in the *baseline* scenario. The "without policy expansion" column shows the policy settings in the hypothetical situation in which there was no COVID macro policy response. Those settings are used in the *no COVID* scenario and the *default policy* scenario. The "time period of COVID effect" column identifies the time period over which each element of the policy expansion was in place.

As explained in section 5.2, the monetary policy rule contains a dummy variable, *COVID_212_222*, to take into account that the cash rate remained near zero in the five quarters to the June quarter 2022, when it would normally be higher given prevailing macroeconomic conditions. This was part of the COVID monetary policy response announced by Lowe (2020). This monetary policy response is switched on in the *baseline* scenario by setting *COVID_212_222* to unity instead of zero during the five quarters.

6.3 Updated Scenarios

As noted at the outset of this section, here we present the first three scenarios. They update the macro policy scenarios presented in Murphy (2023a). Beginning from the June quarter 2020, we simulate a hypothetical *no COVID* scenario in which there was no COVID pandemic and hence no macro policy response. The remaining two scenarios introduce the pandemic, but with two alternative macro policy responses, as indicated earlier in Table 5.

- The *default policy* scenario is based on the macro policy rules included in the model. As noted earlier, under those rules there is no fiscal compensation for COVID income losses.
- The *baseline* scenario includes the actual macro policy response to the pandemic, which involved fiscal over-compensation. The baseline scenario is based on actual events to the March quarter 2024 and model forecasts thereafter.

The starting point for constructing the scenarios is the *baseline* scenario. It is simply a central forecast made in mid-2024. As such, it uses historical data to the March quarter 2024, and a model forecast from the June quarter 2024 onwards.

The other two scenarios are counter-factual scenarios constructed by hypothetically varying certain assumptions from the June quarter 2020 onwards. In the case of the *default policy* scenario, the COVID macro policy response is removed. In the case of the *no COVID* scenario, both the COVID pandemic itself and the COVID macro policy response are removed.

In this section, we are interested in comparing differences in macroeconomic outcomes between these scenarios, principally over the historical period from the June quarter 2020 to the March quarter 2024. Rather, this is primarily an exercise in showing how changes to certain model inputs lead to changes in certain model outputs. The results from this depend largely on the structure of the model. None of these scenarios rely on policy makers having any foresight.

Because this paper contains as many as nine scenarios, in presenting the results we concentrate on the four key variables shown in Figures 7-10. Those figures cover the stances of fiscal and monetary policy and the outcomes for unemployment and inflation. The policy assumptions and main results for each scenario are summarised in Table A4, which provides a handy reference for comparing the nine scenarios in this paper.

Figure 7 shows the stance of fiscal policy, as measured by public net borrowing as a percentage of GDP[14]. Figure 8 shows the stance of monetary policy, as measured by the cash

[14] This measure shows a higher level of borrowing than the more familiar measure from the Federal Budget because it is broader, including state and local governments as well as public trading enterprises. Actual borrowing is not a pure measure of fiscal stimulus because it reflects not only discretionary changes in fiscal policy, but also the operation of automatic stabilisers across the economic cycle. We separate out the fiscal stimulus in section 6.5.

rate target[15] set by the RBA. We refer to this target as the policy interest rate. Figure 9 shows the unemployment rate, measured at the middle month of each quarter.

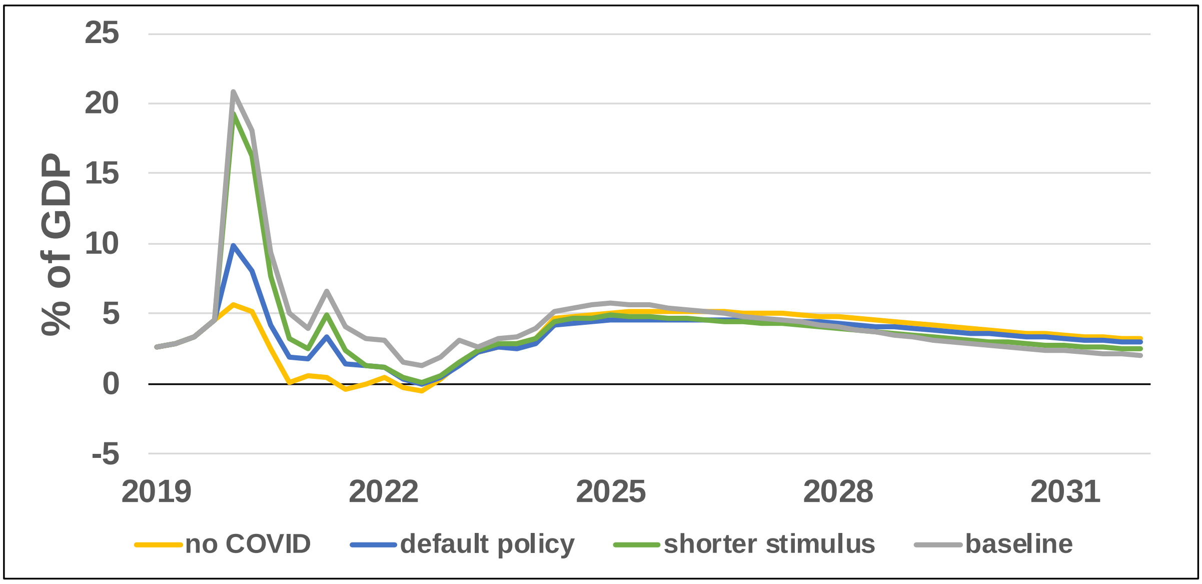


Figure 7. *Public Net Borrowing*

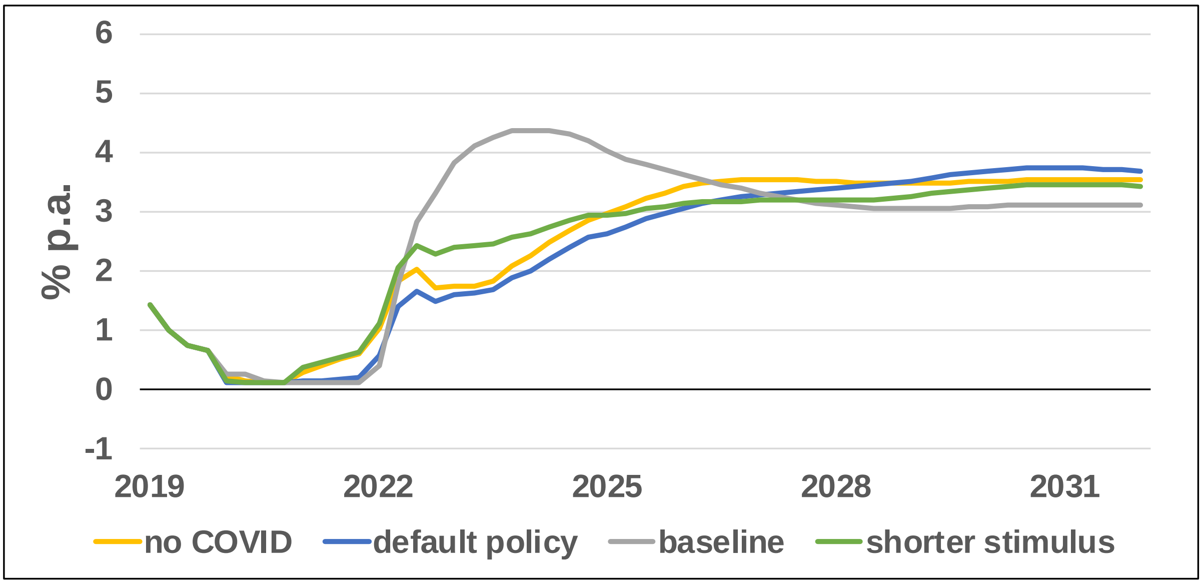


Figure 8. *Policy Interest Rate*

[15] The quarterly values for the cash rate target as averages of the daily values for the quarter.

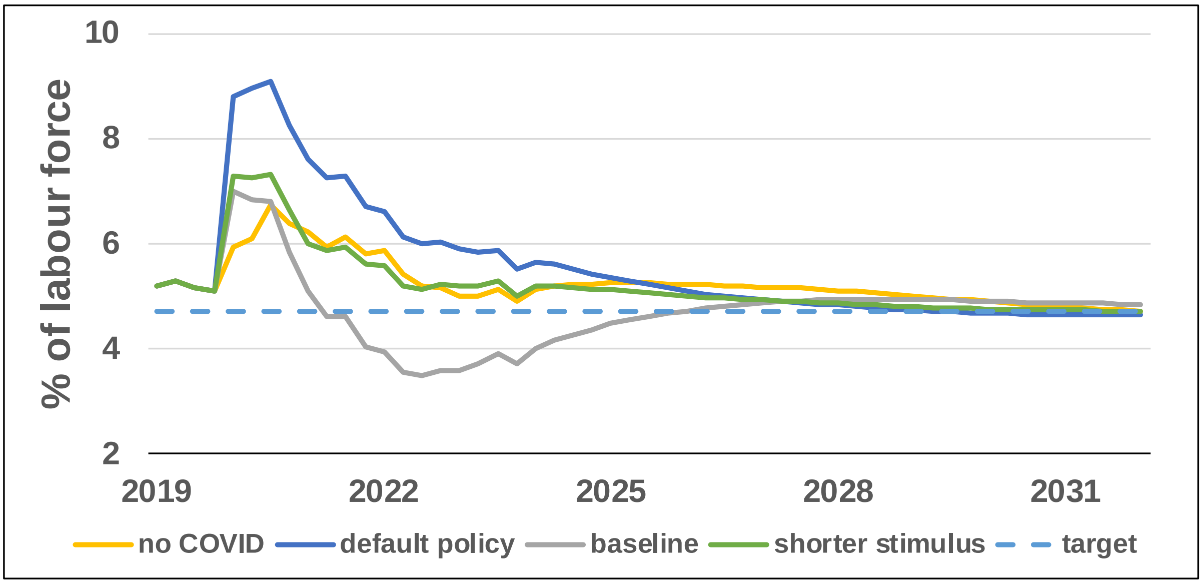


Figure 9. *Unemployment Rate*

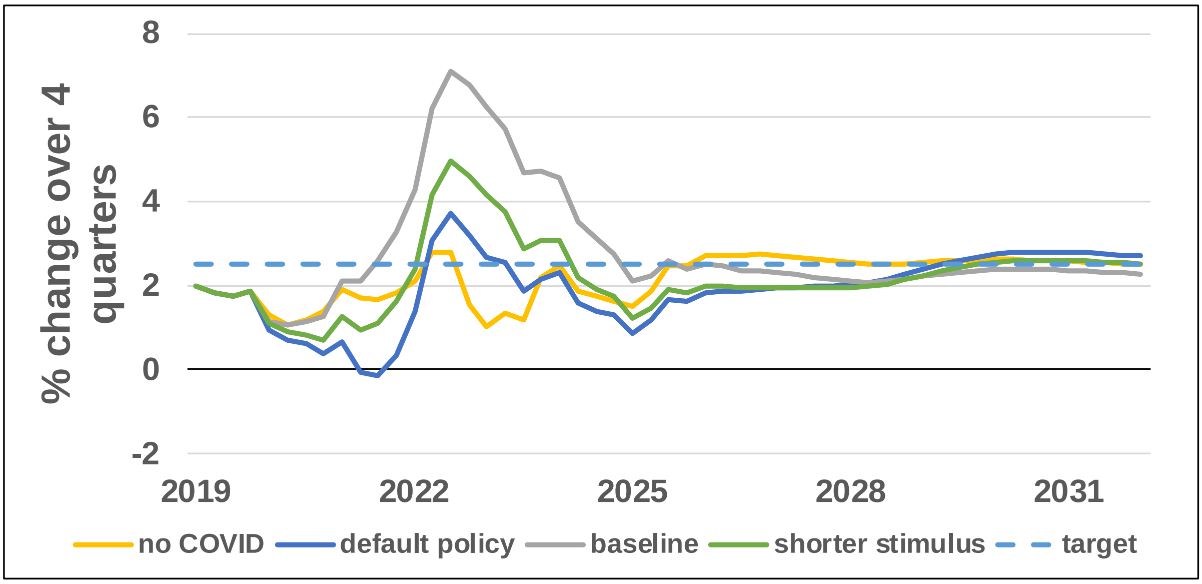


Figure 10. *Consumer Price Inflation Rate*

Figure 10 shows consumer price inflation, as measured by the price deflator for household final consumption expenditure in the national accounts. The US Federal Reserve targets this measure of consumer price inflation, which in the USA is known as the PCE price index. The RBA targets the Consumer Price Index or CPI. The PCE price index is broader and follows economic concepts more closely, while the CPI is more familiar to the public. On balance, we prefer the US Federal Reserve approach to measuring consumer price inflation.

No COVID Scenario

In the hypothetical *no COVID* scenario, the economy follows a relatively stable path. This path is not completely stable because of two significant developments apart from COVID.

First, in 2019, before COVID, aggregate demand was deficient, with unemployment above target (Figure 9) and inflation below target (Figure 10). The RBA responded to this at the time by lowering the policy interest rate (Figure 8) to stimulate aggregate demand, consistent with the Taylor rule for monetary policy. This continues to play out in the hypothetical *no COVID* scenario, with the policy interest rate held below 1 per cent in 2020 and 2021 (Figure 8). This macro stimulus assists in unemployment being fairly close to the NAIRU from 2023 onwards (Figure 9). Similarly, inflation is close to its target from 2024 onwards (Figure 10).

Second, from 2021, an uplift in world commodity prices provides a boost to national income. In the *no COVID* scenario, the resulting boost to budget revenues brings the government budget into approximate balance in 2021 and 2022 (Figure 7).

While these two developments are unrelated to COVID, they affect the capacity of monetary and fiscal policy to provide stimulus when COVID strikes in 2020 and 2021. The low level of the policy interest rate combined with its effective lower bound (ELB) mean that monetary policy has a relatively low capacity to respond. In contrast, the strong government budget position, combined with the low level of public debt, means fiscal policy has a relatively high capacity to respond.

Default Policy scenario

Under the *default policy* scenario, there is no fiscal policy response when COVID strikes. Social distancing under COVID temporarily restricts consumer spending in certain service industries including restaurants, bars, cinemas, gyms and air travel. The most severe restrictions were in the national lockdown that occurred in the June quarter 2020. Under those restrictions, real household consumption is 15 per cent lower in the *default policy* scenario than in the *no COVID* scenario and this flows through to a 7 per cent loss in real GDP. The employment loss is 10 per cent, the effects of which are divided between a lower labour force participation rate, in a typical discouraged worker effect, and a higher unemployment rate. In mid-2020 (the average of the June and September quarters), unemployment peaks at 8.9 per cent in the *default policy* scenario, nearly 3 percentage points above its level in the *no COVID* scenario of 6.0 per cent (Figure 9).

Compared to the previous recessions in the early 1980s and early 1990s, this downturn is unusually deep and short-lived, even under this *default policy* response. By the June quarter 2021, a year after the downturn began, its effects shrink from –15 to –2 per cent for household consumption, from –7 to –2 per cent for GDP, and from +2.8 to +1.4 percentage points for the unemployment rate (Figure 9). Unlike the shallower recessions of the early 1980s and early 1990s that were driven mainly by prolonged weakness in investment, the COVID recession is primarily a consumption recession driven by relatively short-lived social distancing restrictions.

With the economy in recession, the automatic stabilisers in the government budget kick in. As a result, net public borrowing rises to average 7 per cent of GDP from the June to December

2020 quarter compared to 4 per cent of GDP in the *no COVID* scenario (Figure 7). This elevation in net public borrowing of 3 percentage points of GDP fades as the economy rapidly recovers (Figure 7).

Up until 2025, unemployment is higher in the *default policy* scenario than in the *no COVID*, making inflation generally lower. However, there is an exception to this inflation outcome during the exit from COVID. The easing of COVID restrictions leads to a surge in consumer demand, temporarily pushing up consumer price inflation (Figure 10).

Under the Taylor rule for monetary policy used in the model, it is usually the case that a substantial gap of the unemployment rate above the NAIRU automatically leads to a lower policy interest rate to stimulate employment. However, up until the June quarter 2021, the policy interest rate is already close to the *ELB* in the *no COVID* scenario, leaving only limited room for further lowering the policy interest rate in the *default policy* scenario (Figure 8). Thereafter, the policy interest rate has the room to follow a significantly lower trajectory under the *default policy* scenario and does so, even though the unemployment gap has shrunk somewhat. Thus, the *ELB* significantly constrains the response of monetary policy until mid-2021.

baseline scenario

The *baseline* scenario modifies the *default policy* scenario by allowing for the discretionary expansions of fiscal and monetary policy that were implemented in response to COVID. Those macro policy expansions are set out in section 3 and section 6.2.

The discretionary expansion of fiscal policy is massive, as was seen in Table 1. From the June quarter to the December quarter 2020, it raises average net public borrowing from 7 per cent of GDP in the *default policy* scenario to 16 per cent of GDP in the *baseline* scenario (Figure 7). Thus, in responding to COVID, the actual policy response adds 9 percentage points of GDP to public borrowing on top of the 3 percentage points from the operation of the automatic stabilisers in the *default policy* scenario.

In Figure 7 the initial massive fiscal response to COVID gradually shrinks, but it takes several years to almost disappear: borrowing in the *baseline* scenario remains significantly above that in the *default policy* scenario until the middle of the decade. This is because some of the fiscal policy measures announced in the COVID era of 2020 and 2021 had significant budget costs in the post-COVID era, as seen in Table 1. In fact, Table 1 shows that about one-half of the Budget cost, and the associated macro stimulus, occurred from 2021-22 onwards, when the worst of the COVID recession was over.

The problem from some of the stimulus being delivered too late is compounded by further delays before some stimulus measures, such as changes to direct taxes and transfers, have their full effects on economic activity. Thus, while the budget cost of the measures declines over the three financial years from 2020-21 to 2022-23, the stimulus to economic activity is relatively evenly spread. Over the three years, the unemployment rate is an average of 2.5

percentage points lower in the *baseline* scenario than in the *default policy* scenario, and the effect in each year is close to this[16] (Figure 9).

This steady stimulus over three years to the jobs market is not well designed to neutralise the effects of COVID on unemployment, which are large initially but then steadily shrink. During the initial stage, the policy response is successful in reducing the peak unemployment rate in mid-2020 from 8.9 per cent under the *default policy* scenario to 6.9 per cent under the *baseline* scenario, a saving of 2.0 percentage points in peak unemployment. As noted earlier, under the modelling method used, this simulated initial saving in the unemployment rate of 2.0 percentage points does not include stood down workers receiving the JobKeeper payment, and hence is likely to be lower than estimates that count those workers as employed.

As the effects of COVID fade, the stimulus to the jobs market from the continued expansionary macro policy push the unemployment rate down to be around 3.5 percentage points during the 2022-23 financial year, taking it well below the NAIRU (Figure 9).

This tight labour market contributes to high inflation. Consumer price inflation is above 3 per cent from the March quarter 2022 to the December quarter 2024 in the *baseline* scenario. Inflation peaks at 7.1 per cent in the December quarter 2022, compared to 3.7 per cent under the *default policy* scenario. Thus, the macro policy response to COVID added a simulated 3.4 percentage points to peak inflation (Figure 10), compared to the *default policy* scenario.

Up until the March quarter 2021, high unemployment and low inflation justify keeping the policy interest rate at the *ELB* of 0.1 per cent under the Taylor rule. However, by the June quarter 2021, the massive macro stimulus of the *baseline scenario* has restored unemployment and inflation to close to their target values. Hence, under the usual Taylor rule used in the model, the policy interest would have begun to climb towards a neutral rate from the June quarter 2021. Instead, the policy interest rate remained at the *ELB* until the June quarter 2022 in a clear departure from the Taylor rule (Figure 8).

In the modelling, this departure from the Taylor rule is interpreted as a discretionary expansion of monetary policy in response to COVID, lasting from the June quarter 2021 to the June quarter 2022[17]. This discretionary expansion of monetary policy is included in the *baseline* scenario alongside the discretionary expansion of fiscal policy. However, this discretionary expansion of monetary policy is excluded in the other scenarios.

From the September quarter 2022 onwards, monetary policy reverted to broadly conforming with the Taylor rule. By then, the large discretionary expansion of fiscal and monetary policy had resulted in unsustainably low unemployment (Figure 9) and inflation well above its target

[16] This average unemployment rate effect of –2.5 per cent reflects effects of –2.3, –2.7 and –2.5 in the three years from 2020-21 to 2022-23.

[17] This 5-quarter episode is captured in the model's Taylor rule using a dummy variable, which is highly significant with a t-ratio of 8.2, as was seen in section 5.2.

of 2.5 per cent (Figure 10). Consistent with the Taylor rule, monetary policy tightened. This resulted in the policy interest rate being 1 to 2½ percentage points higher for three years, from the December quarter 2022 to the September quarter 2025 in the *baseline* scenario than in the *default policy* scenario (Figure 8). Thereafter, the policy interest rate stabilises at a similar level in all scenarios.

In summary, the large, protracted macro policy stimulus under the *baseline* scenario provided a saving in peak unemployment in mid-2020 of 2.0 percentage points, but at the cost later of adding 3.4 percentage points to peak inflation at end-2022. To weigh up this better control of unemployment against this worse control of inflation, we use the measure of social loss (SL) explained in section 5.3. The SL score under the *default policy* of 164 falls to 135 under the actual policy of the *baseline* scenario (Table A4), indicating that the actual policy improved macroeconomic control.

This fall in social loss under the *baseline* scenario may seem odd, because the addition to peak inflation is larger than the saving in peak unemployment, and inflation and unemployment are assigned equal weights in measuring SL. The explanation is that the unemployment effect is more persistent than the inflation effect, as is usually the case (Blanchflower et al., 2014).

Comparison with previous results

We now compare these updated results for the effects of the actual macro policy response to COVID with the original results of Murphy (2023a). The main difference is in how the results are presented. Here, separate results are presented for each scenario, whereas Murphy(2023a) expresses the results as deviations from the *no COVID* scenario.

In the original results, the actual policy response, compared to the default policy response, resulted in a saving of 1.9 percentage points in peak unemployment in mid-2020. This saving rises marginally to 2.0 percentage points in these updated results. In the original results, the actual policy response added 3.1 percentage points to peak inflation during 2022. This estimate rises a little to 3.4 percentage points in the updated results. This slight increase in the simulated inflation effect can be traced to the higher estimate for the NAIRU combined with the non-linear effect of labour market imbalance on wage inflation.

6.4 Shorter Stimulus Scenario

We now present the *shorter stimulus* scenario. The *shorter stimulus* scenario varies the *baseline* scenario to better comply with the principles for macro policy in a pandemic. As explained below, the fiscal policy response is shortened to better align the fiscal stimulus with the duration of COVID restrictions and the monetary stimulus complies with the backward-looking Taylor rule. We now discuss the settings for monetary and fiscal policy in turn.

In the *shorter stimulus* scenario, monetary policy follows a standard Taylor rule, responding to observed inflation and unemployment gaps in the normal way. This is achieved by switching off the dummy variable in the Taylor rule that models how monetary policy departed from the Taylor rule from the June quarter 2021 to the June quarter 2022 by being more expansionary. Because this Taylor rule uses observed inflation and unemployment gaps, it does not require any policymaker foresight.

While actual COVID monetary policy departed from the Taylor rule by being more expansionary, the pandemic monetary policy principle likely involves monetary policy departing from the Taylor rule in the opposite direction, by being less expansionary. This principle requires that the monetary authorities look passed lower employment in the unsafe industries, because it has been deliberately created for the benefit of public health and target employment/inflation in the safe industries. Unfortunately, our macro-econometric model does not delineate the unsafe industries sharply enough to support a rule based on economic conditions in the safe industries. Hence, our modelling likely understates the extent to which monetary policy was too expansionary during COVID.

To shorten the fiscal policy stimulus, we apply in a broad way the principle of full compensation for losses in a pandemic such as COVID. Fortunately, applying this principle does not require that policy makers can forecast the progress of a pandemic, which would be highly challenging. Rather, the full compensation principle requires that compensation is paid as and when income losses from pandemic restrictions occur. In 2021, the COVID disaster payment and business support programs operated broadly in this way. Thus, applying the full compensation principle in a future pandemic requires policymaker preparedness, but not policymaker foresight.

To apply the full compensation principle, we have taken the actual policy measures shown in Table 1 and removed or reduced certain measures in two types of adjustments to obtain Table 6. Areas where adjustments have been made from Table 1 are highlighted in red in Table 6. The overall effect is to approximately halve the total fiscal stimulus from $428 billion (Table 1) to $219 billion (Table 6). These adjustments mean that the remaining fiscal stimulus better aligns with the duration of the COVID restrictions.

Table 6. Budget Cost of COVID-era Fiscal Policy Measures under shorter stimulus ($billion)

Policy Measure	19-20	20-21	21-22	22-23	23-24	24-25	total
JobKeeper	21	68	0	0	0	0	89
COVID disaster payment & business support	0	0	21	0	0	0	21
JobSeeker supplements	6	15	2	2	2	2	29
boosting cash flow for employers	15	21	0	0	0	0	36
accelerated depreciation	0	0	0	0	0	0	0
bring forward of stage 2 income tax cuts	0	0	0	0	0	0	0
payments to support households	0	0	0	0	0	0	0
other policy measures	12	25	8	0	0	0	45
	53	130	30	2	2	2	219

Sources: Australian Government (2020, 2021a, 2021b)

The first type of adjustment is to remove the economic support payments that aimed to stimulate aggregate demand. We do this because untargeted stimulus is not consistent with the macro principles for countering a pandemic-induced recession. The measures for accelerated depreciation for business investment, personal income tax cuts and additional transfers to social security recipients (‘payments to support households’) are deleted (Table 6).

The second type of adjustment is to reduce the other policy measures category from $167 billion to $45 billion (Table 6). This could have been achieved by removing some of the smaller pandemic programs included under this heading and funding most of the non-pandemic measures from the budget. These adjustments are concentrated in the budget outyears to help achieve the desired effect of better aligning the remaining fiscal stimulus with the duration of the COVID restrictions.

We also check from the simulation results that the fiscal measures contained in Table 6 are consistent with the principle of full compensation for COVID income losses. We do this by comparing across the scenarios the total level of real private disposable income over the years to 2024-25.

Under the *default policy* scenario, real private disposable income at 2021-22 prices is $177 billion *lower* than in the *no COVID* scenario. This is the loss in real income that can be attributed to COVID. There is no fiscal compensation for this COVID income loss.

In contrast, under the actual policy response of the *baseline* scenario, real income is $165 billion *higher* than in the *no COVID* scenario, despite COVID. That is, the actual policy response to COVID turned a $177 billion income loss into a $165 billion income gain. This implies approximately $2 of compensation for every $1 of lost income, as noted by Murphy (2023a).

Under the *shorter stimulus* scenario, real income is only $10 billion lower than under the *no COVID* scenario, largely erasing the loss of $177 billion under the *default policy* scenario. Thus, in the *shorter stimulus* scenario, fiscal policy fully compensates for COVID income losses to a close approximation. That is, there is approximately $1 of compensation for every $1 of lost income, as intended.

Under the macro policy principles for a pandemic, we would expect the *shorter stimulus* scenario to find the compensation sweet spot of $1 compensation for $1 of lost income. This should provide superior control over unemployment and inflation compared to the *default policy* and *baseline* scenarios that respectively provide $0 and $2 of compensation for every $1 of lost income. We now examine the simulation results to see whether this is the case.

Under this shortened macro policy stimulus, the initial expansion of macro policy remains very large. This is true for both fiscal and monetary policy.

Under the actual policy response of the *baseline* scenario, public net borrowing soared to average 16 per cent of GDP from the June to December quarters 2020. During the same period, net public borrowing is almost as high at 14 per cent of GDP under the *shorter stimulus* scenario. This is well above the level of 7 per cent of GDP under the passive fiscal policy of the *default policy* scenario (Figure 7).

In the first year of COVID, monetary policy is very expansionary under the *shorter stimulus* scenario, similar to under the actual policy of the *baseline* scenario. In both scenarios, the policy interest rate is reduced to the ELB and remains there until the March quarter 2021 (Figure 8).

In 2021 and 2022 the situation changes, with macro policy following a markedly less expansionary path under the *shorter stimulus* scenario than under the *baseline* scenario. Again, this is true for both fiscal and monetary policy.

Under the *baseline* scenario, fiscal policy remained quite expansionary in 2021 and 2022, although less so than in 2020. Net public borrowing averaged 4 per cent of GDP. This declines to a mildly expansionary 2 per cent of GDP under the *shorter stimulus* scenario, just above the level of 1 per cent of GDP under the passive fiscal policy of the *default policy* scenario (Figure 7).

Under the backward-looking Taylor rule of the *shorter stimulus* scenario, the policy interest rate begins rising from the ELB in the June quarter 2021, one year earlier than under the actual policy of the *baseline* scenario. As a result, the policy interest rate is between ¼ and ¾ of a percentage point higher in the *shorter stimulus* scenario than in the *baseline* scenario from the June quarter 2021 to the September quarter 2022.

Under its very large initial expansion of macro policy, the *shorter stimulus* scenario reduces the unemployment rate in mid-2020 to 7.3 per cent, a saving of 1.6 percentage points compared to the rate of 8.9 per cent under the *default policy* scenario (Figure 9). However, this is a little less than the saving of 2.0 percentage points under the even larger initial expansion of fiscal policy in the *baseline* scenario.

At the same time, the shorter stimulus to macro policy under the *shorter stimulus* scenario results in the unemployment rate falling more gradually towards the NAIRU, avoiding the overshoot into an overheated labour market seen in the *baseline* scenario (Figure 9). More balanced labour and goods markets lead to a lower peak in inflation.

Inflation reaches a peak of 5.0 per cent at end-2022 in the *shorter stimulus* scenario, down from 7.1 per cent in the *baseline* scenario (Figure 10). This implies that, compared to the *default policy* scenario, the *shorter stimulus* adds 1.2 percentage points (calculated from unrounded data) to peak inflation, much less than the 3.4 percentage points added under the actual policy.

Putting this another way, the *shorter stimulus* scenario reduces peak inflation by 2.1 percentage points compared to the *baseline* scenario (Figure 10). Nevertheless, even under the shorter stimulus, the inflation rate at end-2022 of 5.0 per cent implies an inflation gap that is still quite high at 2.5 per cent. The *no COVID* and *default policy* scenarios help explain the reasons for this.

Under the *no COVID* scenario, the inflation gap at end-2022 is only 0.3 percentage points. The exit from COVID restrictions released pent up consumer demand, making it inevitable that inflation would become elevated relative to a *no COVID* scenario, which is the reverse of what occurred when restrictions were imposed in 2020 (Figure 10). Thus, in the *default policy* scenario, the inflation gap at end-2022 widens to 1.2 percentage points under the exit from COVID restrictions. It widens further to 2.5 per cent under the expansionary fiscal policy of the *shorter stimulus* scenario. However, the *shorter stimulus* scenario succeeds in substantially reducing peak unemployment, compared to the *default policy* scenario (Figure 9).

Overall, the *shorter stimulus* results in an inflation outcome that is greatly superior to that under the actual policy, but an unemployment outcome that is slightly inferior. Weighing up those outcomes, the social loss score under the actual policy of the *baseline* scenario of 135 falls to 80 under the *shorter stimulus* scenario (Table A4), indicating that the shorter stimulus considerably improves macroeconomic control compared to the actual policy.

More broadly, our results support the macro policy principles for a pandemic under which the *shorter stimulus* scenario should find the compensation sweet spot. With its $1 of compensation for every $1 of income lost to COVID, social loss from unemployment and inflation gaps is held to 80. Under the $2 compensation rate of the *baseline* scenario, social loss rises to 135. Similarly, under the $0 compensation rate of the *default policy* scenario, social loss rises to 164.

Besides providing better control over unemployment and inflation, full compensation also preserves horizontal equity, as emphasised in the first part of our evaluation. However, as noted at the outset of this second part of our evaluation, our macro-econometric model has a single representative consumer and therefore does not provide results for horizontal equity.

6.5 Cross-check Against Leading International Models

The most notable finding in this section is that peak inflation is 2.1 percentage points higher under the actual policy of the *baseline* scenario than under our preferred *shorter stimulus* scenario. How confident can we be in this estimate that over-prolonged macro policy stimulus added 2.1 percentage points to peak inflation in 2022? Among Australian macro-econometric models, our model is best placed to provide such an estimate for the reasons noted in section 4. It forecast an outbreak of inflation in 2022. Further, this was associated with advantages it has in modelling macro policy under COVID including finer industry and fiscal detail and modelling of the economic effects of social distancing under COVID.

That said, we now perform a cross-check of our results against comparable results from leading international models. This cross-check is performed using fiscal multipliers for output and inflation.

The main recent international study on the effects of fiscal stimulus in structural models was a collaboration across modelling groups by Coenen et al. (2012). They compare the effects of seven different types of fiscal stimulus across nine well-known models falling into two groups. The first group of models were developed at the US Federal Reserve Board, the European Central Bank, the IMF, the European Commission, the OECD and the Bank of Canada. Coenen et al. (2012) note that “these models have been tested extensively over the years and have been frequently applied to policy questions”. The second group of models are the widely-referenced estimated DSGE models of Christiano, Eichenbaum, and Evans (2005) and Smets and Wouters (2007).

The Coen et al. (2012) study calibrates the size of each fiscal stimulus so that it has a direct budget cost equivalent to one per cent of GDP, *before* allowing for indirect budget gains. Typically, a fiscal stimulus will lead to higher incomes that will lift budget revenues, so the final budget cost after allowing for these indirect budget gains will be less than the direct budget cost. Hence, to compare our results with those reported by Coenen et al. (2012), we need to measure fiscal stimulus in the same way, as the direct budget cost.

In Figure 7 we showed net public borrowing, expressed as a percentage of GDP, for both the *baseline* and *shorter stimulus* scenarios. The *difference* in net public borrowing between the two scenarios is shown as the grey line in Figure 11. As such, it reflects the effect on government borrowing of the extra fiscal measures that are included in the *baseline* scenario but not in the *shorter stimulus* scenario. To measure the fiscal stimulus in the same way as Coenen et al. (2012), we have extracted the direct budget cost of these extra fiscal measures, which is shown in Figure 11 as the blue line.

This extra fiscal stimulus in the *baseline* scenario, compared to the *shorter stimulus* scenario, is the amount of fiscal stimulus that was applied over and above what was needed to compensate for COVID income losses. It was mainly applied over 13 quarters, from the June quarter 2020 to the June quarter 2023 (Figure 11). Over that period, the average extra stimulus was the equivalent of 2.6 per cent of GDP (Figure 11), implying a total extra stimulus of about $200 billion. This is broadly consistent with the difference between the cost of budget measures reported in Table 1 for the *baseline* scenario and Table 6 for the *shorter stimulus* scenario.

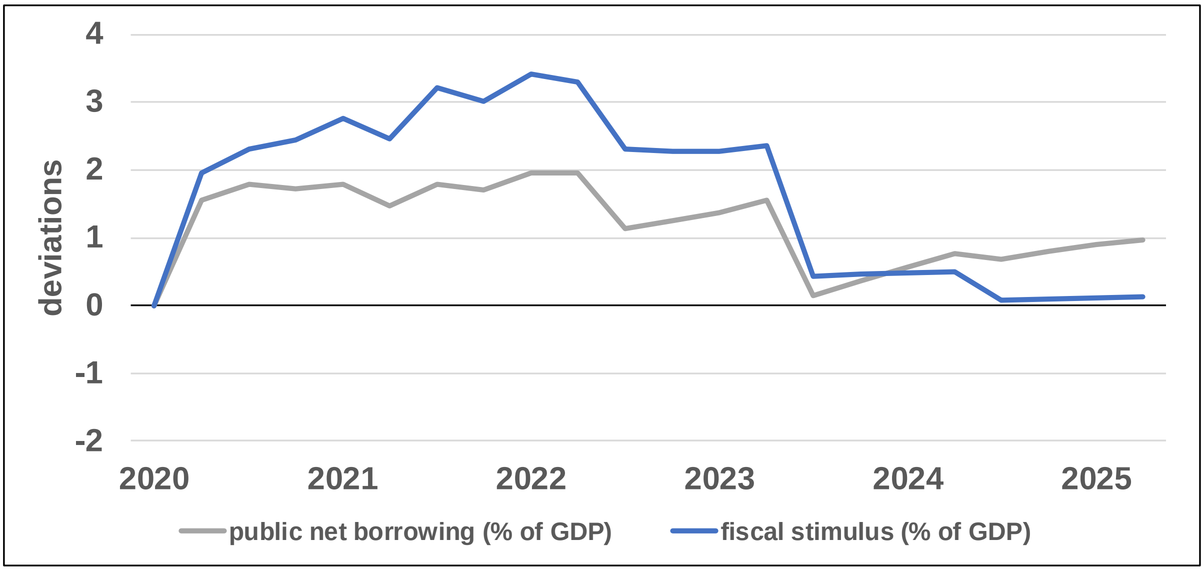


Figure 11. *Extra Public Net Borrowing and Extra Fiscal Stimulus*

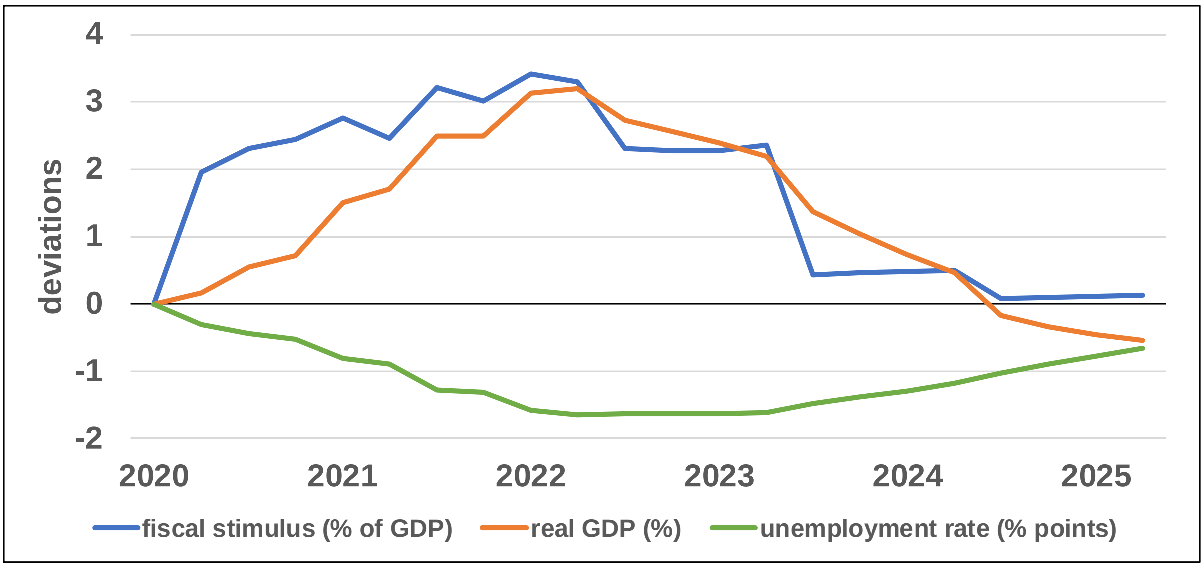


Figure 12. *Extra Fiscal Stimulus and Economic Activity*

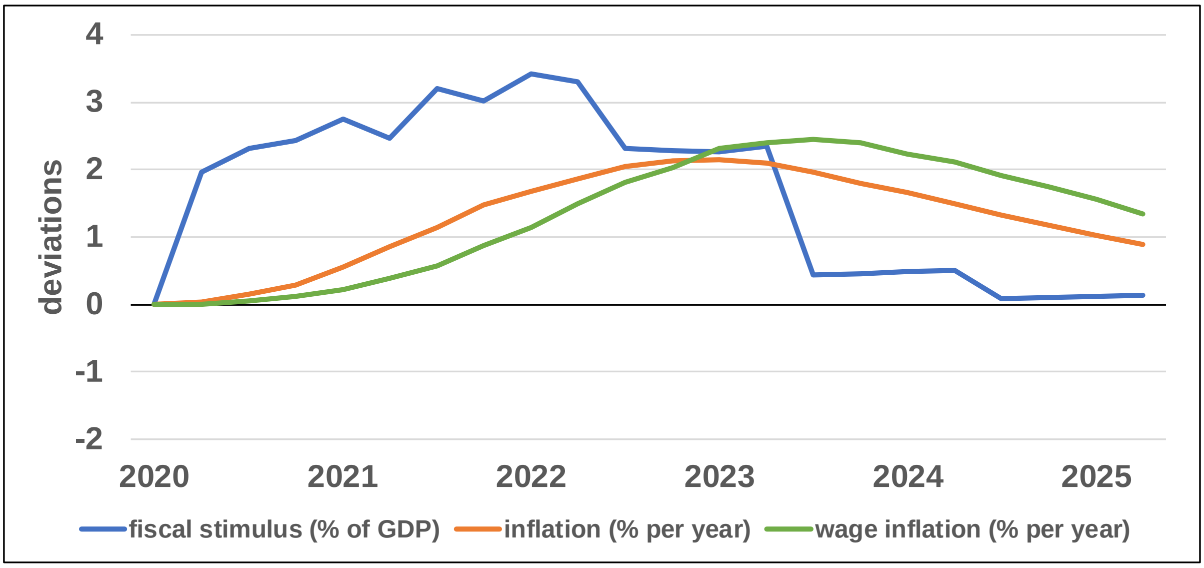


Figure 13. *Extra Fiscal Stimulus and Inflation*

In the modelling, this extra stimulus generates indirect budget gains averaging 1.0 per cent of GDP over the same period. This reduces the final average increase in public borrowing from 2.6 to 1.6 per cent of GDP (Figure 11).

Figures 12 and 13 show the effects of this extra fiscal stimulus on economic activity and inflation. These effects are shown for five years, to facilitate direct comparisons with the figures in Coenen et al. (2012).

Figure 12 shows the effects of the extra fiscal stimulus on real GDP and unemployment. Over the same 13 quarters as before, the gain in real GDP averages 2.0 per cent (and peaks at 3.2 per cent) (Figure 12). Dividing this by the average fiscal stimulus of 2.6 per cent of GDP implies a fiscal output multiplier of 0.8. We now cross-check this value for the output multiplier with the Coenen et al. (2012) study. As Coenen et al. (2012) emphasise, fiscal output multipliers depend on both the associated assumption about monetary policy and the nature of the fiscal stimulus.

A fiscal stimulus has implications for monetary policy. It will generally lead to lower unemployment and higher inflation, which will induce a higher policy interest rate under a standard Taylor rule. The exception is when the monetary authority decides to "accommodate" the fiscal stimulus by not raising the policy interest rate. This action boosts the fiscal output multiplier, compared to a situation where the policy interest rate increases.

The RBA did accommodate the extra fiscal stimulus in Australia. Because of the departure from the Taylor rule discussed earlier, the policy interest rate in the *baseline* scenario does not move clearly above its path in the *shorter stimulus* scenario until the December quarter 2022, notwithstanding the more expansionary fiscal policy in the *baseline* scenario (Figure 8). Thus, the extra fiscal stimulus in the *baseline* scenario was accommodated by the RBA for between two and three years.

Coenen et al. (2012, Table 3) present real GDP multipliers for seven types of fiscal stimulus for both the USA and the EU. These multipliers assume two years of monetary accommodation, similar to what occurred in Australia. Each multiplier is an average calculated from several well-known models. The multipliers vary depending on the type of fiscal stimulus. Weighting these multipliers together using the combination of types of measures included in the extra fiscal stimulus in Australia[18], gives a weighted multiplier of 0.9 for the USA and the same for the EU.

This is very similar to our fiscal output multiplier of 0.8 that was constructed above. Thus, our simulated GDP effects from the extra fiscal stimulus (Figure 12) are in line with the fiscal output multipliers generated by well-known models for a comparable mix of fiscal measures.

In our modelling of the extra fiscal stimulus, the average addition to real GDP of 2.0 per cent is accommodated by an average subtraction from the unemployment rate of 1.2 percentage points (Figure 12). The implied Okun's coefficient of -0.6 is close to Okun's original value of -0.5.

Next, we use the Coenen et al. (2012) study to cross-check our simulated inflation effects from the extra fiscal stimulus. In our modelling, a peak fiscal stimulus of 3.4 per cent of GDP in the March quarter 2022 leads to a peak annual inflation effect of 2.2 percentage points in the March quarter 2023, implying a fiscal inflation multiplier of 0.6.

We use Figures 4 and 5 of Coenen et al. (2012) to calculate fiscal inflation multipliers in the same way for their various models. For the USA, the median fiscal inflation multiplier from seven models is 0.7, and the multiplier lies in a narrow range from 0.6 and 0.8 for five of the models, the other two models being low and high outliers. For the EU, the fiscal inflation multipliers are lower, averaging 0.4 across the four models. In explaining this difference, Coenen et al. (2012) point to evidence that prices are less flexible in Europe than in the USA. In any case, as best we can judge, our Australian fiscal inflation multiplier of 0.6 seems consistent with these average fiscal inflation multipliers from well-known models of 0.7 for the USA and 0.4 for Europe.

This comparison of fiscal inflation multipliers is not as straightforward as for the fiscal output multipliers for two reasons. On the one hand, Coenen et al. (2012) only provide inflation effects for one type of fiscal stimulus, an increase in government consumption, which may have a higher peak inflation effect than if our mix of extra fiscal measures was used. On the other hand, Coenen et al. (2012) consider a fiscal stimulus that lasts for only two years, and this would have a lower peak inflation effect than under our fiscal stimulus, which lasts for over three years. As these qualifications operate in opposite directions, we are still left with the conclusion that our implied inflation multiplier for Australia of 0.6 seems to be consistent with inflation multipliers from well-known models.

[18] The weights are 42% for government consumption, 8% for government investment, 5% for general transfers, 27% for corporate income tax, 15% for labour income taxes and 3% for indirect taxes.

A final point of interest from Figure 13 is that the inflation impact of the extra fiscal stimulus in our macro-econometric model is led by consumer price inflation, as measured by the national accounts price deflator for household consumption, rather than by wage inflation, as measured by average compensation of employees in the national accounts. One reason that government forecasters in Australia did not foresee the inflation outbreak in 2022 is that they focussed mainly on developments in wage inflation, especially as measured by the wage price index. Figure 13 illustrates the limitations of this forecasting approach.

6.6 Main findings from the second part of our evaluation

There are two major findings from this second part of our evaluation of the macro policy response to COVID.

First, we find that the actual policy response, based on a large, protracted macroeconomic policy stimulus, results in an overall improvement in macroeconomic outcomes in our *baseline* scenario, compared to a *default policy* scenario with a more passive policy response. Superior control over unemployment outweighs inferior control over inflation. The measure of social loss from variations in inflation and unemployment from their respective target values was reduced from 164 to 135 (Table A4).

Second, we find that a *shorter stimulus* policy response, based on the macro policy principles for a pandemic, would have resulted in a further and larger improvement in macroeconomic outcomes. Compared to the *baseline* scenario, the inflation outcome is greatly superior and the unemployment outcome is only slightly inferior. The measure of social loss from variations in inflation and unemployment from their respective target values is reduced much further, from 135 to 80 (Table A4).

More broadly, the *shorter stimulus* scenario finds the compensation sweet spot. Its $1 of compensation for every $1 of income lost to COVID holds the social loss from unemployment and inflation gaps to 80, compared to social losses of 135 and 164 under the $2 and $0 compensation rates of the *baseline* and *default policy* scenarios respectively. Further, it preserves horizontal equity.

Optimal Control Policy Response

This third part of our evaluation of the macro policy response to COVID uses optimal control to further analyse the macro policy response to a pandemic.

In the second part of our evaluation of the Australian macro policy response to COVID, we found that the *shorter stimulus* scenario, which is based on the principles for macro policy in a pandemic, resulted in the best overall control of unemployment and inflation. It produces a lower social loss from unemployment and inflation than the actual policy response incorporated in the *baseline* scenario, which in turn produces a lower social loss than the more passive approach of the *default policy*.

That leaves open the question of whether there exists a policy scenario that provides significantly better macroeconomic control than the *shorter stimulus* scenario. Open-loop optimal control is designed to find the macro policy that provides the best control. In this section we apply optimal control to the *shorter stimulus* scenario to obtain an *optimal control* scenario. We then evaluate the relative merits of the two scenarios while also taking into other considerations, including horizontal equity.

In section 8, we check how sensitive the optimal control policy response is to what we feed in about how much we care about unemployment control compared to inflation control. We want to understand whether macro policy recommendations for a pandemic should depend in an important way on preferences for unemployment control compared to inflation control.

In section 9, we use optimal control as part of a more in-depth analysis of monetary policy under COVID. The analysis takes the actual fiscal policy response to COVID as given. It then evaluates the actual monetary policy response against two benchmark policy responses, a backward-looking response based on our Taylor rule and a forward-looking response based on open-loop optimal control.

We now apply optimal control to the *shorter stimulus* scenario to obtain the *optimal control* scenario. The optimal control method finds the macro policy that results in the lowest social loss from gaps between inflation and unemployment and their respective target values. As explained in section 5.3, the *optimal control* scenario automatically adjusts monetary policy, via the policy interest rate, and fiscal policy, via the average personal income tax rate to minimise social loss.

There are three main reasons that the *optimal control* scenario designed using our macro-econometric model can produce a different macro policy to the *shorter stimulus* scenario designed using the macro policy principles for a pandemic. First, the scenarios are based on different policy objectives. While the design of both scenarios is concerned with macro stability (although in different ways), only the design of the *shorter stimulus* scenario is concerned with horizontal equity. Second, the designs of the two scenarios are based on different models, one recognising different types of consumers and the other recognising the complexities of macro dynamics. Third, the *optimal control* scenario will adjust macro policy not only for the economic shocks from COVID but also for non-COVID shocks.

We compare the outcomes between the scenarios in Figures 14-17, which cover the same four macro variables as we did in Figures 7-10. Besides the *shorter stimulus* and *optimal control* scenarios, we also show the *baseline* scenario for a more complete perspective.

The automatic adjustments to monetary and fiscal policy in the *optimal control* scenario lead to a modest fall in social loss to 58, down from 80 in the *shorter stimulus* scenario (Table A4). This fall is modest because unemployment and inflation follow broadly similar paths in the two scenarios, particularly when compared to the *baseline* scenario (Figures 16 and 17).

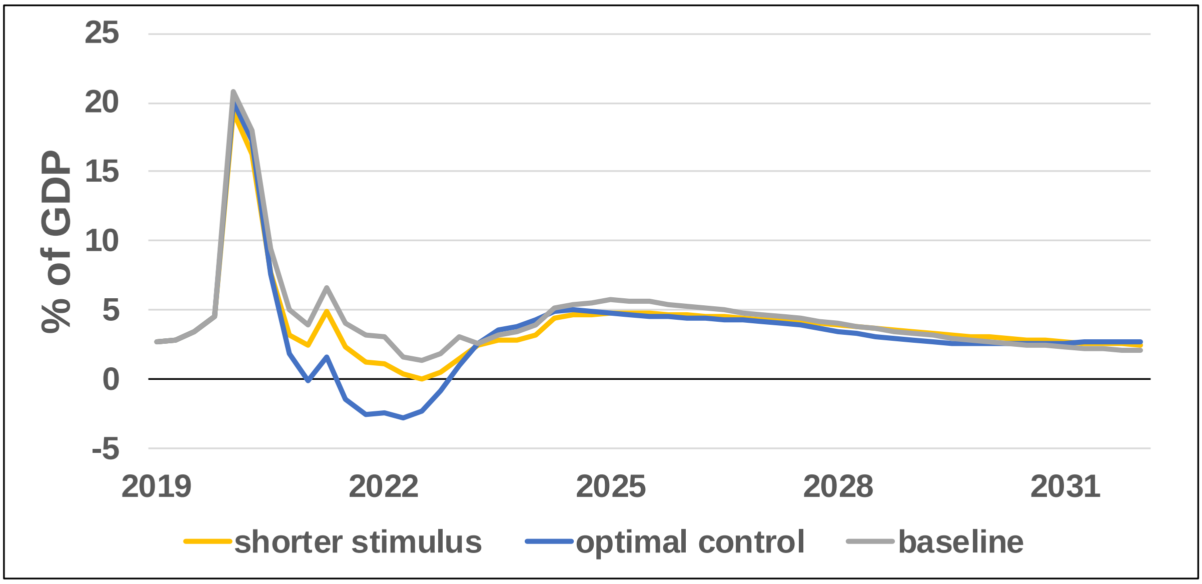


Figure 14. *Public Net Borrowing*

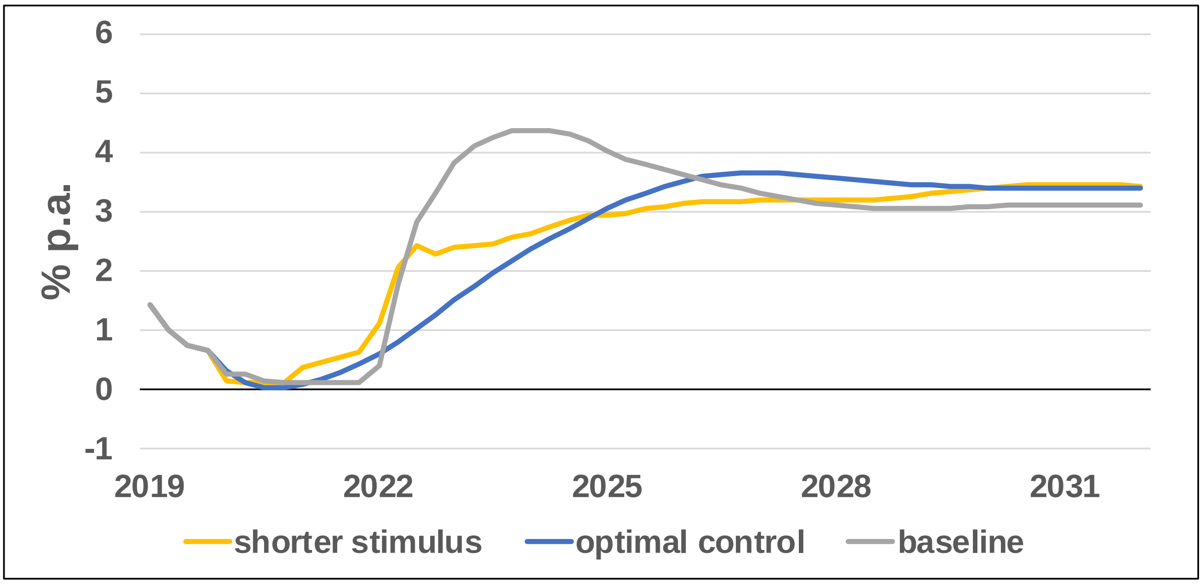


Figure 15. *Policy Interest Rate*

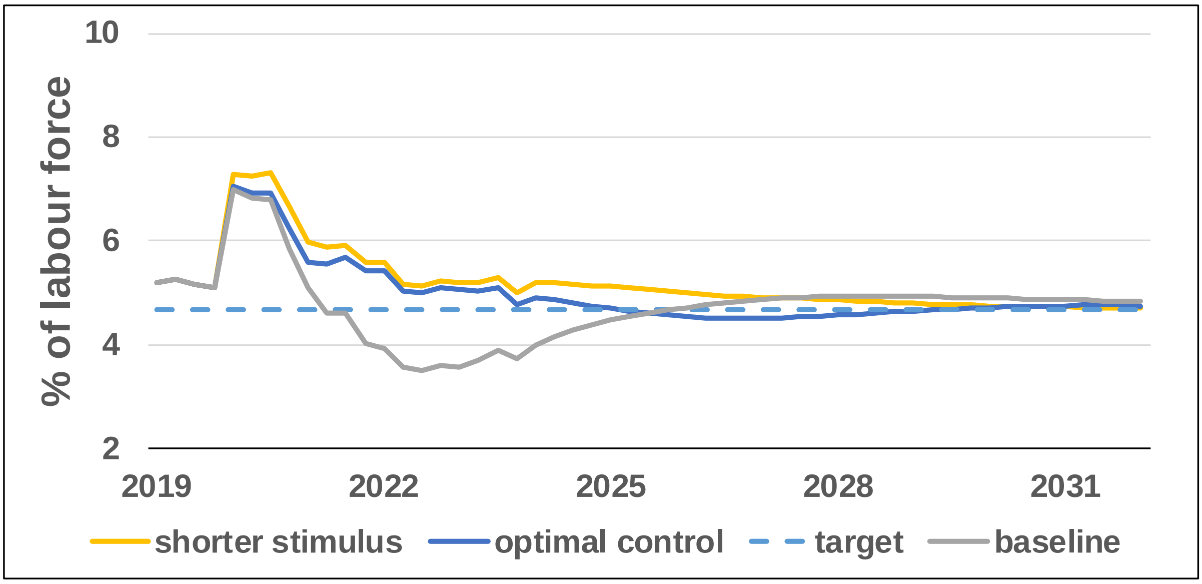


Figure 16. *Unemployment Rate*

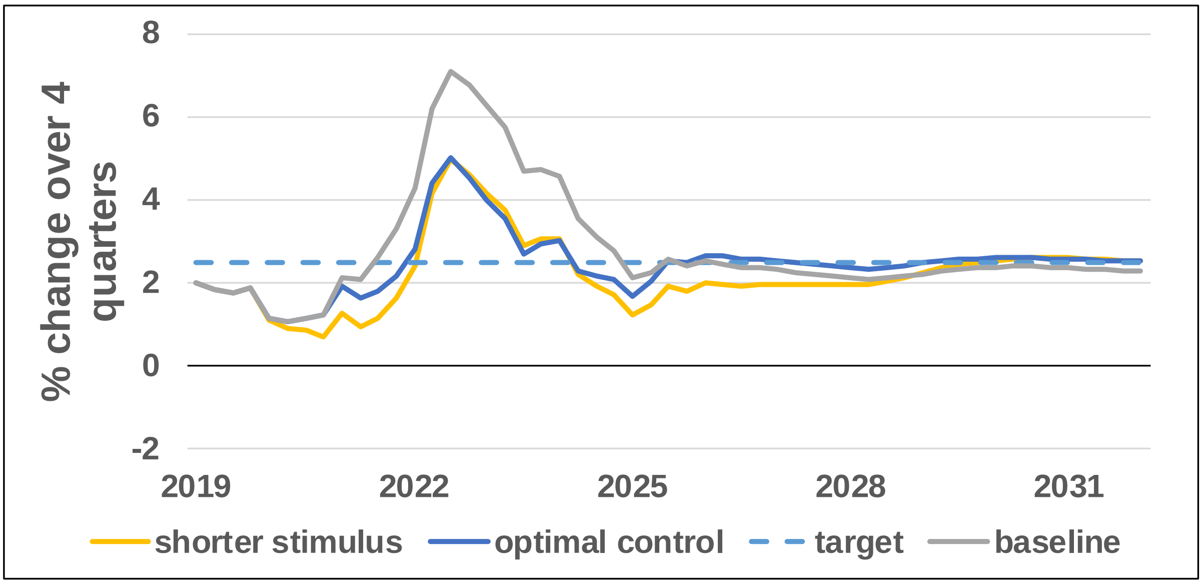


Figure 17. *Consumer Price Inflation Rate*

These broadly similar paths for unemployment and inflation suggest that the overall stance of macro policy is also similar between the two scenarios. This is not surprising because, as noted above, the design of both scenarios is concerned with macro stability, although in different ways.

The main difference between the two scenarios is that, from 2021 to 2023, they use a somewhat different mix of fiscal and monetary policy to achieve a similar overall macro policy stance. During this period, fiscal policy is tighter (Figure 14) and monetary policy is looser

(Figure 15) in the *optimal control* scenario than in the *shorter stimulus* scenario. Equally, in 2020 and from 2024 onwards, the policy mixes are similar.

We can be more specific about the differences in policy mix. Fiscal policy is noticeably tighter in the *optimal control* scenario compared to the *shorter stimulus* scenario from the March quarter 2021 to the March quarter 2023 (Figure 14). Over this period, net public borrowing is 2.8 percentage points of GDP lower, on average. Conversely, monetary policy is noticeably looser in the *optimal control* scenario compared to the *shorter stimulus* scenario from the June quarter 2021 to the June quarter 2024 (Figure 15). The policy interest rate is 0.6 percentage points lower, on average.

The raises the question of whether we prefer the policy mix in the *optimal control* scenario or the policy mix in the *shorter stimulus* scenario. On the one hand, the policy mix in the *optimal control* scenario leads to an apparent small improvement in control over unemployment and inflation.

On the other hand, the tighter fiscal policy of the *optimal control* scenario would mean that there is substantial under-compensation for the income losses in the unsafe industries from COVID restrictions. Such under-compensation would result in horizontal inequities between consumers in the unsafe and safe industries that are not present in the *shorter stimulus* scenario. Further, the more expansionary monetary policy in the *optimal control* scenario would do little to address those horizontal inequities.

On balance, we prefer the *shorter stimulus* scenario over the *optimal control* scenario because it is clearly superior for horizontal equity, while only slightly inferior for macro stability. This superior performance for horizontal equity is unsurprising because horizontal equity was a policy objective in designing the *shorter stimulus* scenario, but not in designing the *optimal control* scenario.

It may also be the case that the small improvement in macro stability seen in the *optimal control* scenario would not be fully borne out in reality. As noted previously, the macro-econometric model does not take into account that compensation paid to consumers in the unsafe industries, whose incomes have been disrupted by COVID, is likely to be more effective in supporting macro stability than untargeted government payments. Also, the macro policy response in the open-loop *optimal control* scenario is based on the rather demanding assumption that policy makers have perfect foresight.

Despite these differences, the most striking result when comparing the *shorter stimulus* scenario and *optimal control* scenario is their similar paths for unemployment and inflation. This answers the question posed at the start of this section of whether there exists a policy scenario that provides *significantly* better macroeconomic control than the *shorter stimulus* scenario. The *optimal control* scenario shows that there does not. Furthermore, macroeconomic control is much better in both scenarios than in either the *baseline* scenario or the *default policy* scenario.

Another striking aspect of the results is that the initial macro policy response to COVID is similar in all three scenarios, including under the actual macro policy of the *baseline* scenario. This is true for both fiscal policy and monetary policy.

There is a very large initial expansion in fiscal policy in 2020 under all three scenarios. Under the actual policy response of the *baseline* scenario, public net borrowing soars to average 16 per cent of GDP from the June to December quarters 2020. Borrowing is similarly high at 14 per cent of GDP under the *shorter stimulus* scenario and this rises to 15 per cent after the automatic adjustments of the *optimal control* scenario (Figure 14). All three scenarios show similarly large increases in public borrowing compared to the *default policy* scenario, in which public borrowing reaches only 7 per cent of GDP under a passive fiscal policy (Figure 7).

In the first year of COVID, monetary policy is also very similar in all three scenarios. The policy interest rate is reduced to the ELB and remains there up until at least the March quarter 2021 (Figure 15). The fact that the presence of the ELB constrains the expansion in monetary policy plays a significant role in the modelling. First, it means that, in the first year of COVID, monetary policy is more similar in the three scenarios than might otherwise be the case. Second, with monetary policy constrained, fiscal policy plays a greater role in responding to the COVID recession.

The reason that it is optimal to have a very large initial expansion in fiscal policy is to limit the rise in unemployment from COVID restrictions. Under the *default policy* scenario, unemployment reached a peak of 8.9 per cent in mid-2020 (Figure 9). Under the very large initial fiscal expansions of the *baseline*, *shorter stimulus* and *optimal control* scenarios (Figure 16), this peak moderates by around 2 percentage points to about 7 per cent. More precisely, the savings in peak unemployment, compared to the *default policy* scenario, are 2.0, 1.6 and 1.9 percentage points respectively.

In short, these results demonstrate that a very large fiscal stimulus was justified in 2020 to help reduce the large unemployment gap caused by social distancing under COVID. Similarly, it was appropriate to reduce the policy interest rate to the ELB, at least until the March quarter 2021. This finding that it was appropriate for macro policy to be very expansionary in 2020 is robust to the different policy objectives and different models used to design macro policy in the *shorter stimulus* scenario versus the *optimal control* scenario.

While appropriate in 2020, the actual macro policy stimulus continued for too long. This was shown clearly in section 6, when the *baseline* scenario was compared to the *shorter stimulus* scenario.

As noted above, on balance we prefer the policy response of the *shorter stimulus* scenario over that of the *optimal control* scenario because it is superior for horizontal equity. However, one advantage of the *optimal control* scenario is that it is explicit about the subjective relative weight that is placed on controlling unemployment compared to controlling inflation. We use that advantage in the next section by examining whether the *optimal control* policy differs much between policy hawks, who only care about inflation, and policy doves who care mainly about unemployment.

7 Hawks and Doves

In section 7 we found that the initial very large macro policy response to COVID in 2020 was close to optimal, serving to reduce peak unemployment in mid-2020 by about 2 percentage points. This initial response includes a very large initial expansion in fiscal policy and the reduction in the policy interest rate to the assessed ELB.

That said, macro policy stimulus was applied for too long, beyond the end of COVID restrictions, adding a simulated 2.1 percentage points to peak inflation during 2022. This excess inflation effect is the same irrespective of whether we used the *shorter stimulus* scenario or the *optimal control* scenario as the reference scenario.

Here we examine the sensitivity of these findings to the weight placed on controlling unemployment relative to the weight placed on controlling inflation. Our *optimal control* scenario was developed by attaching equal weights to controlling unemployment and inflation. We now use the broader range of perspectives represented by an archetypal policy dove and an archetypal policy hawk.

7.1 Hawks and Doves

In the *optimal control* scenario, we followed Brayton et al. (2014) of the US Federal Reserve by attaching equal weight to targeting inflation and unemployment. They explain their choice as follows.

> The objectives of policy are to stabilize inflation around 2 percent and the unemployment rate around u*[19]. For the baseline case, we assume equal weights on both arguments. This formulation may be seen as consistent with the Federal Reserve's mandate to promote maximum employment and price stability.

The equal weight assumption also seems consistent with RBA Review, which "supports the equal consideration of monetary policy's objectives for price stability and full employment" (de Brouwer, Fry-McKibbin and Wilkins, 2023, p. 93).

Following the RBA Review, a Bill has been introduced under which a new Monetary Policy Board of the RBA would be given a very similar mandate to the US Federal Reserve, based on price stability and employment. Specifically, the proposed new paragraph 9B(1)(a) of the Reserve Bank Act sets the objectives of monetary policy as: "(i) price stability in Australia; and (ii) the maintenance of full employment in Australia". Hence, the equal weight assumption can be justified by reference to both the US Federal Reserve and the RBA Review.

[19] Here u* refers to the NAIRU.

On the other hand, just because the two objectives are listed in the proposed amendments to the RBA Act, does not necessarily mean they should be assigned the same weight. The proposed amendments also include that "the ***overarching objective***[20] of the Bank is to promote the economic prosperity and welfare of the people of Australia both now and into the future". This overarching objective could be interpreted as meaning that the weights can be chosen based on the relative importance of the inflation and unemployment objectives in promoting economic welfare.

Di Tella, MacCulloch and Oswald (2001) examined this issue by analysing how the subjective well-being of individuals, as measured in surveys, was systematically influenced by levels of unemployment and inflation. Using time series data for 12 European countries, they estimate that the marginal effect of unemployment on well-being is 1.66 times the marginal effect of inflation on well-being. This estimate of the marginal rate of substitution between inflation and unemployment takes into account both a "fear of unemployment" effect from national unemployment as well as the "personal effect" for those who become unemployment.

Subsequent studies using similar survey methods have produced a range of estimates for the marginal rate of substitution between inflation and unemployment. Both Wolfers (2003) and Blanchflower, Bell, Montagnoli and Moro (2014) estimate a much higher marginal rate of substitution of around 5. However, Blanchflower et al. (2014) point out that such estimates need to be adjusted before being used as an unemployment weight in a measure of time discounted social loss, so as to avoid double counting the welfare loss from unemployment being typically more persistent than inflation. Under our assumed annual discount rate of 4 per cent, this adjustment reduces the Blanchflower et al. (2014) unemployment weight considerably, from 5.6 to 1.8.

A recent study by Hofstetter and Rosas (2021) estimates a marginal rate of substitution for Europe of 1.6, similar to the original estimate of Di Tella et al. (2001) of 1.66. Welsch (2011) obtains a lower estimate of 1.0, similar to the value used by the US Federal Reserve.

Taking into account the proposed mandate of the Monetary Policy Board, the practices of the US Federal Reserve and the empirical evidence from studies of how well-being is affected by inflation and unemployment, an unemployment weight of somewhere between 1 and 2 seems reasonable to the author. However, to accommodate most views, we use a very wide range of weights. At one extreme, we use an unemployment weight of 4, which we interpret as the weight used by an archetypal policy dove. At the other extreme, we use an unemployment rate of 0 for an archetypal policy hawk[21]. It is technically possible for the hawk not to place any weight on unemployment because the operation of the wage equation will

[20] This emphasis is in the text of the Bill.

[21] To be precise, we use a negligible unemployment weight for the hawk of 0.001 rather than a weight of exactly zero. Using a weight of exactly zero would have required substantial re-programming work with only a trivial effect on the modelling results.

automatically close the unemployment gap, albeit slowly. However, some weight must be placed on inflation because otherwise there is nothing to anchor the inflation rate.

7.2 Optimal Responses of Hawks and Doves

In section 7 we compared actual macroeconomic outcomes under COVID to simulated outcomes under a single *optimal macro policy* scenario that was based on an unemployment weight of 1. We now compare the actual macroeconomic outcomes to the simulated outcomes under the optimal control policy of the dove, based on an unemployment weight of 4, and the optimal control policy of the hawk, with an unemployment weight of zero. We are interested in comparing the scenarios to determine whether the actual macro policy and associated outcome is justified from someone's perspective, either the hawk or the dove.

We compare outcomes for unemployment and inflation between the three scenarios in Figures 18-19. These outcomes reflect the overall stance of macroeconomic policy in each scenario. We do not report on the policy mix between fiscal and monetary policy because of our observation in section 7 that the policy mix under optimal control does not take horizontal equity into account.

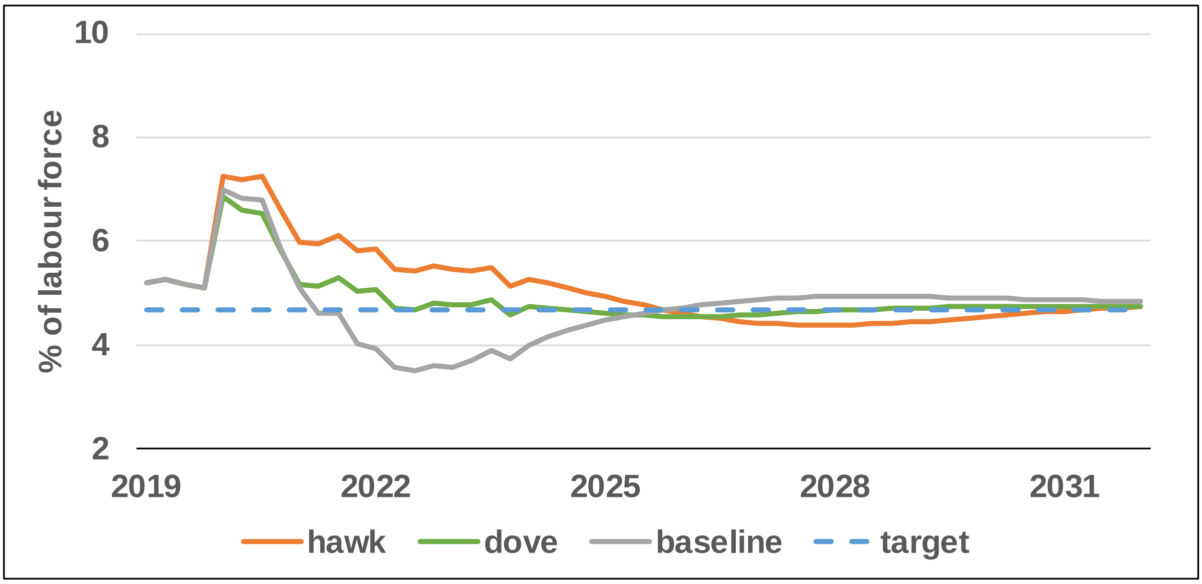


Figure 18. *Unemployment Rate*

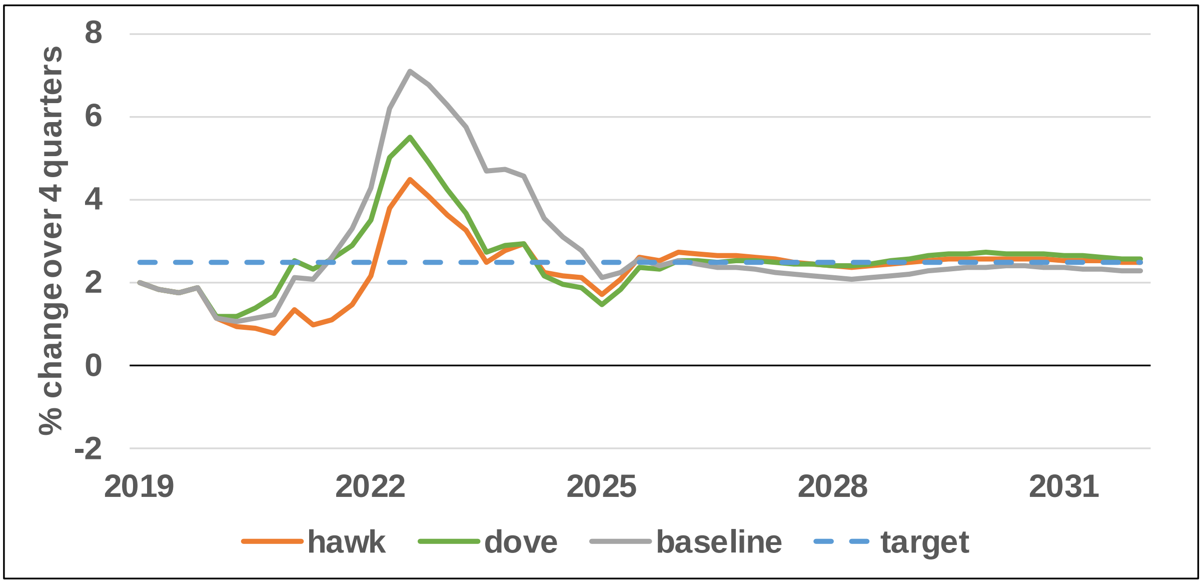


Figure 19. *Consumer Price Inflation Rate*

Both the hawk and the dove broadly mimic the actual very large expansion in macro policy that occurred in 2020, even though they have different motives. The hawk is concerned about the negative inflation gap at the time, while the dove is more concerned about the positive unemployment gap. In any case, peak unemployment in mid-2020 falls from 8.9 per cent under the *default policy* scenario to 7.2 per cent under the *hawk* scenario and 6.7 per cent under the *dove* scenario (Figure 18). It falls to 6.9 per cent until the actual policy response of the *baseline* scenario (Figure 18), midway between the falls under the hawk and dove. This confirms our conclusion from sections 6 and 7 that the initial very large expansion of macro policy in response to COVID was appropriate.

Beyond 2020, this picture changes. As noted in section 6, in the *baseline* scenario, over-prolonged macro policy stimulus led to a negative unemployment gap from 2022 to 2024. Over these three years, the unemployment rate tracks closer to the NAIRU under both the hawk and the dove because in both cases the macro stimulus is shorter. The unemployment gap is a little lower under the dove than under the hawk (Figure 18). This reflects the dove's higher weight on targeting unemployment, which leads to a more expansionary macro policy.

These smaller unemployment gaps under the hawk and dove lead to smaller inflation gaps. While inflation peaks in the December quarter 2022 at 7.1 per cent under the *baseline* scenario, it has substantially lower peaks of 4.5 per cent under the hawk and 5.5 per cent under the dove (Figure 19). Both the hawk and the dove outperform the actual inflation outcome by reining in macro stimulus sooner.

At the same time, the different preferences and associated macro policies between the hawk and the dove are reflected in the peak gaps for unemployment and inflation. In mid-2020, the *dove* achieves an unemployment gap of 2.0 per cent, better than the 2.5 per cent gap under the *hawk*. On the other hand, at end-2022 the *hawk* achieves an inflation gap of 2.0

per cent, better than the 3.0 per cent gap under the *dove*. Thus, the dove is prepared to accept an additional 1.0 percentage points of peak inflation in exchange for a reduction of 0.5 percentage points in peak unemployment. These results are consistent with the *dove* placing a high weight on targeting unemployment and the *hawk* placing all of its weight on targeting inflation.

In summary, the hawk and dove scenarios show that our general policy conclusions in sections 6 and 7 do not depend on how much weight you place on controlling unemployment compared to inflation. Irrespective of whether you are a hawk or a dove, the initial very large expansion of macro policy in 2020 was appropriate. Similarly, according to both the hawk and dove, the macro policy stimulus then continued for too long, adding unnecessarily to the peak in inflation during 2022.

8 Alternative Monetary Policy Responses

In this section we complete the third part of our evaluation of the macro policy response to COVID by investigating the monetary policy response in more depth. To focus on monetary policy, we take the excessively long fiscal policy response to COVID as given and consider how monetary policy might have responded. Monetary policy was faced with two major economic shocks, the shock from COVID itself, and the shock from the excessively long fiscal response to COVID.

We evaluate the actual response of monetary policy in the *baseline* scenario against two alternative benchmarks. These alternative benchmarks are used in an *optimal money* scenario and a *Taylor rule* scenario.

The key difference between the two benchmarks is that they make polar assumptions about the forecasting ability of the RBA. The *optimal money* scenario assumes perfect foresight by the RBA, whereas monetary policy is backward looking under the *Taylor rule* scenario. In the real world, the RBA has some forecasting ability to help guide monetary policy, so a reasonable policy benchmark would lie somewhere between the *Taylor rule* scenario and the *optimal money* scenario.

The results from all three scenarios are presented in Figures 20-22, which cover the policy interest rate, the unemployment rate and consumer price inflation. Net public borrowing has already been shown in Figure 7 in the case of the *baseline* scenario. It follows a similar path in the other two scenarios because fiscal policy is the same.

We now evaluate the actual monetary policy of the *baseline* scenario against the *optimal money* scenario. We then evaluate it against the *Taylor rule* scenario. Finally, we use the results to provide a decomposition of the different factors contributing to peak unemployment in mid-2020 and peak inflation in 2022.

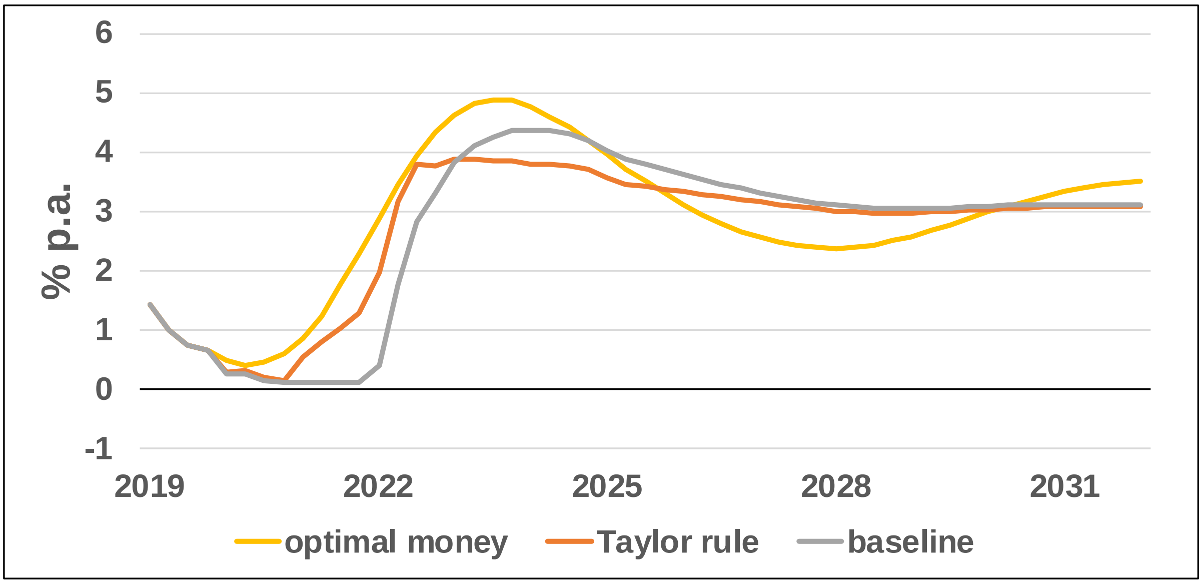


Figure 20. *Policy Interest Rate*

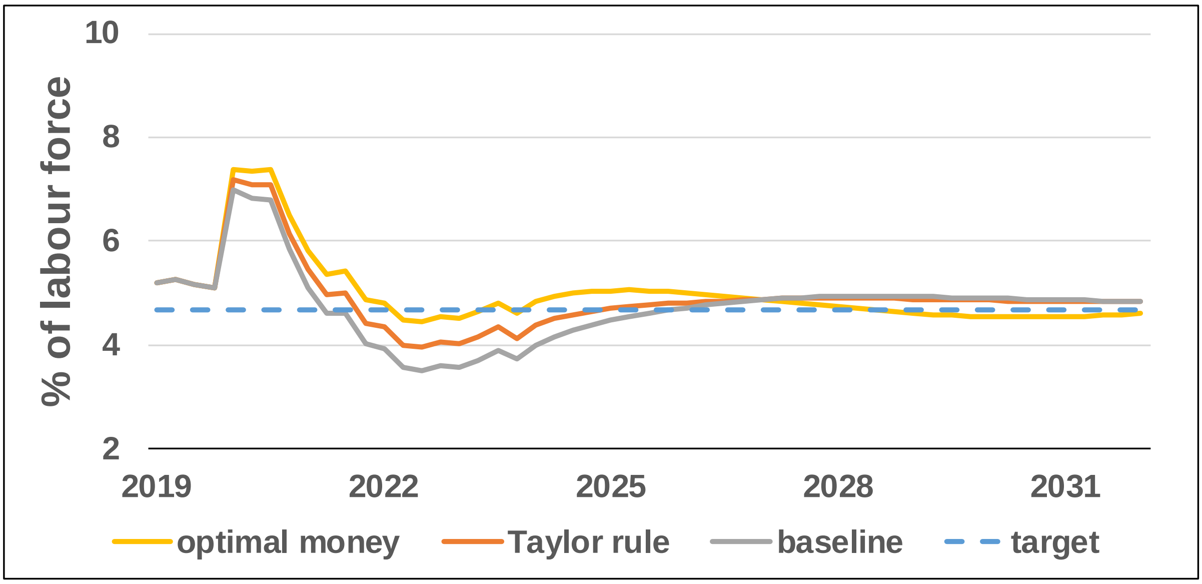


Figure 21. *Unemployment Rate*

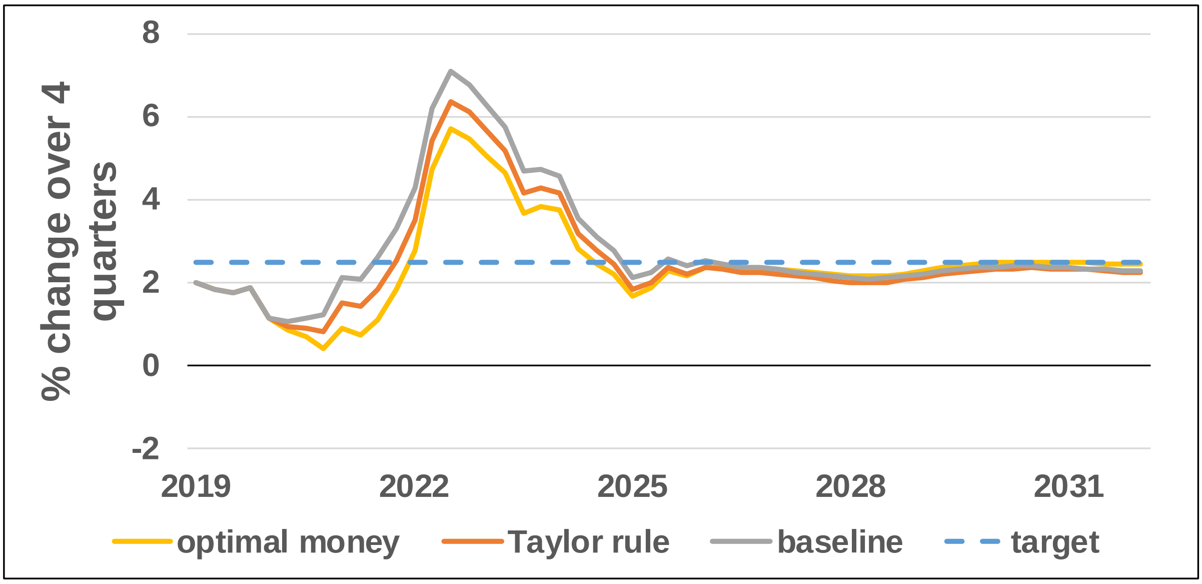


Figure 22. *Consumer Price Inflation Rate*

8.1 Optimal Money Scenario

In the first benchmark scenario, we apply optimal control to adjust monetary policy alone, taking the actual fiscal policy response to COVID as given. We refer to this as the *optimal money* scenario. It differs from the *optimal control* scenarios that were presented in sections 7 and 8, because in those scenarios fiscal and monetary were adjusted together. The full details of the design of the *optimal money* scenario were set out in section 5.

Under open-loop optimal control, in the June quarter 2020 the monetary authorities make a plan for the path of the policy interest rate, *RS*, that minimises social loss. This plan for *RS* is based on perfect foresight and is not revised during the scenario.

In the macro-econometric model, financial markets have model-consistent expectations (see section 4). Consequently, in the June quarter 2020, they adjust the exchange rate and bond rate using their expectations for *RS*. To the extent that the plan for *RS* in the *optimal money* scenario differs from its path in the *baseline* scenario, the exchange rate and the bond rate will respond immediately, from the June quarter 2020.

In the *optimal money* scenario, monetary policy is pulled in two different directions during COVID, being influenced by both the COVID recession and the excessively long fiscal stimulus.

In the *optimal money* scenario the COVID recession calls for an initial expansion of monetary policy. The policy interest rate is reduced to 0.4 per cent by the September quarter 2020. However, in the *optimal money* scenario the RBA also understands that the fiscal stimulus will continue for too long, which will have the potential to lead to inflation later. To counter this development, the policy interest rate is gradually raised pre-emptively, starting from the December quarter 2020.

By the March quarter 2022, the policy interest rate has reached 2.3 per cent in the *optimal money* scenario. This is in contrast to the *baseline* scenario, where the policy interest rate still remains at the *ELB* of 0.1 per cent (Figure 20). This tighter monetary policy compared to the *baseline* scenario is reflected in forward-looking financial markets.

In the June quarter 2020, the prospect of tighter monetary policy lifts the exchange 6 per cent above its level in the *baseline* scenario. Similarly, it lifts the 10-year bond rate by 0.5 percentage points. This expectations-driven combination of a higher exchange rate and bond rate, compared to the *baseline* scenario, leads to higher unemployment and lower inflation, even before there have been significant increases in the policy interest rate.

The unemployment peak in mid-2020 is 7.4 per cent in the *optimal money* scenario, up from 6.9 per cent under the *baseline* scenario (Figure 21). On the other hand, the inflation peak during 2022 is down from 7.1 per cent to 5.7 per cent (Figure 22).

While this represents a sizeable reduction in the peak rate of inflation, it still leaves it above the peak of 5.0 per cent in the *shorter stimulus* scenario, in which fiscal policy is more appropriate. This illustrates the limits of trying to use monetary policy to counteract the effects on macro stability of an inappropriate fiscal policy.

The *optimal money* scenario is a rather demanding benchmark for monetary policy. It assumes that, in the June quarter 2020, the Reserve Bank had perfect foresight of both the COVID economic shock and the fiscal policy response to it, so that it could plan monetary policy accordingly. Yet at that time, the nature of the COVID economic shock was still being learned and some of the fiscal response to COVID was still to be announced. More generally, identifying the optimal monetary policy at the outset of COVID depends on highly forward-looking behaviour by the RBA.

8.2 Taylor rule scenario

In contrast, our second benchmark for monetary policy is undemanding. It is the Taylor rule for monetary policy that was set out in section 5.2. A Taylor rule can be specified to be either backward-looking or forward-looking, but the version used here is backward-looking. It is a simple rule that adjusts the policy interest rate based only on the observed sizes of the inflation gap and the unemployment gap. Generally, we would expect a central bank to outperform this backward-looking Taylor rule in pursuing macroeconomic stability. This is because a central bank will have access to additional data and analysis beyond observing the two gaps, enabling it to take a more forward-looking approach. The Taylor rule is used in the *Taylor rule* scenario.

In the *Taylor rule* scenario, a backward-looking RBA does not respond to the fiscal stimulus itself. Rather, the RBA reacts once the economy overheats and a negative unemployment gap and a positive inflation gap emerge, delaying the rise in interest rates compared to the *optimal money* scenario. However, by the March quarter 2022, those gaps have emerged and so the policy interest rate has begun to rise. It has reached 1.3 per cent, placing it between the rate in the *baseline* scenario of 0.1 per cent and the rate in the *optimal money* scenario of 2.3 per cent.

This intermediate path for monetary policy in the *Taylor rule* scenario is reflected in the outcomes for unemployment and inflation. The unemployment peak in mid-2020 is 7.1 per cent in the *Taylor rule* scenario, up from 6.9 per cent under the *baseline* scenario but down from 7.4 per cent under the *optimal money* scenario (Figure 21). Similarly, the inflation peak during 2022 is 6.4 per cent, down from 7.1 per cent under the *baseline* scenario but up from 5.7 per cent under the *optimal money* scenario (Figure 22).

The design of the *baseline* scenario differs from that of the *Taylor rule* scenario in only one way. The *baseline* scenario takes into account that actual monetary policy was more expansionary than called for by the Taylor rule from the June quarter 2021 to the June quarter 2022. As explained in section 5.2, this involves using a time dummy variable *COVID_212_222*. This keeps the policy interest rate at the ELB of 0.1 per cent until the March quarter 2022.

As noted earlier, under the pandemic monetary policy principle, it is likely the policy interest rate would have begun rising even earlier, because the RBA would have focussed on economic conditions in industries not subject to COVID containment policies. However, we have not been able to model this. Instead, we have used our Taylor rule, which refers to economy-wide unemployment and inflation.

We can compare the overall performance of each scenario in controlling both the unemployment gap and the inflation gap using the measure of social loss, SL. SL falls from 135 in the *baseline* scenario to 112 under the *Taylor rule* scenario. This indicates that it would have been better if the RBA had followed the backward-looking Taylor rule during COVID, rather than departed from it by pursuing a more expansionary policy from the June quarter 2021 to the June quarter 2022.

These results help extend the historical evaluation of monetary policy by Gross and Leigh (2022). They find that in the 2001 slowdown the RBA outperformed a backward-looking benchmark for monetary policy by being more expansionary, resulting in better control over unemployment and inflation. They find that this occurred again in the Global Financial Crisis of 2008-09. However, they find that the RBA underperformed a backward-looking benchmark during the pre-pandemic period of low inflation by being less expansionary. This paper adds the result that the RBA again under-performed a backward-looking benchmark in 2021-22, this time by being more expansionary, thereby adding to post-COVID inflation.

While SL falls from 135 under the *baseline* scenario to 112 under the *Taylor rule* scenario, it falls a little further to 103 under the *optimal money* scenario. This indicates that there would have been a further, but smaller, gain if the RBA had perfect foresight. Perfect foresight is unobtainable. However, what we can take from the results is that there would be some benefit if the RBA were able to better forecast the inflation effects of fiscal stimulus.

Overall, these results support our main finding in section 7 that the *shorter stimulus* scenario is our preferred scenario, but here we add a caveat for monetary policy. The *shorter stimulus* scenario combines the Taylor rule with a shorter fiscal stimulus and achieves a relatively low SL of 80. Further, it does not require foresight. Rather, the fiscal authorities compensate for pandemic income losses for as long as pandemic restrictions are in place, while the RBA follows the backward-looking Taylor rule. The caveat is that slightly better macroeconomic control can be achieved if the RBA is better able to forecast the inflation effects of fiscal stimulus.

8.3 Factors Contributing to Inflation and Unemployment Peaks and Social Loss

We can use the scenarios from sections 6 and 9 to analyse the contribution of macro policy factors to the peak inflation rate of 7.1 per cent experienced during 2022. The decomposition is shown in Table 7, alongside a similar decomposition for peak unemployment of 6.9 per cent in mid-2020 and the social loss of 135.

We begin with the scenarios from section 6. From the *no COVID* scenario, in the absence of COVID, inflation during 2022 is simulated at 2.8 per cent, made up of the inflation target of 2.5 per cent and non-COVID factors of 0.3 per cent (Table 7). From the *default policy* scenario, the release of pent-up demand on the exit from COVID added 0.9 percentage points (Table 7), taking inflation to 3.7 per cent. From the *shorter stimulus* scenario, adding a relatively short fiscal stimulus to reduce peak unemployment by 1.6 percentage points adds a further 1.2 percentage points to inflation (Table 7), taking the inflation rate to 5.0 per cent. This reduces the social loss from COVID by 83 index points (Table 7), down from 164 to 80. Of the scenarios used in the table, social loss is lowest in this *shorter stimulus* scenario.

We now use the scenarios from this section to show how macro policy factors added to peak inflation and associated social losses. The excessive length of the fiscal stimulus added 0.7 percentage points to peak inflation (Table 7) taking it to 5.7 per cent (*optimal money* scenario vs *shorter stimulus* scenario). The partly understandable absence of perfect foresight from the RBA in responding to the excessive nature of the fiscal stimulus added a further 0.7 percentage points to peak inflation (Table 7) taking it to 6.4 per cent (*Taylor rule* scenario vs *optimal money* scenario). Finally, departing from the Taylor rule by applying monetary stimulus for too long added another 0.7 percentage points to peak inflation (Table 7), taking it to the actual outcome of 7.1 per cent (*baseline* scenario vs *Taylor rule* scenario). Taking together, these macro policy factors added 55 index points to social loss from unemployment and inflation gaps, taking it from 80 to 135.

Table 7. Factors contributing to Unemployment, Inflation and Social Loss Outcomes

	unemployment rate mid-2020	inflation rate end-2022	social loss
	%	% per year	index
sustainable unemployment rate / inflation target	4.7	2.5	0
non-COVID factors	1.3	0.3	54
COVID under default policy response	2.8	0.9	110
adding shorter stimulus	-1.6	1.2	-83
fiscal stimulus too long (with optimal control monetary policy)	0.1	0.7	23
fiscal stimulus too long (additional effect under Taylor rule)	-0.2	0.7	9
monetary stimulus too long	-0.2	0.7	23
Outcome	6.9	7.1	135

Fiscal and monetary policy share the responsibility for the contribution to inflation of 0.7 percentage points from the absence of perfect foresight from the RBA in responding to the excessively long fiscal stimulus. This contribution would not have arisen without an excessively long fiscal stimulus, so fiscal policy bears the main responsibility. On that basis, we can say that monetary policy added 0.7 percentage points to the peak in inflation and fiscal policy added 1.4 percentage points. The overall effect of this was that inflation peaked at 7.1 per cent under the actual macro policy rather than 5.0 per cent under the shorter stimulus policy.

At the same time, the contribution from the component that involves both fiscal and monetary policy highlights the benefits available if monetary policy makers are better able to anticipate the effects on the inflation outlook of fiscal policy. The linkages from fiscal policy to inflation could be improved in both of the RBA's macroeconomic models, the DSGE model and the MARTIN model.

This completes the third part of our evaluation of the macro policy response to COVID.

8.4 Main findings from the third part of our evaluation

There are four major findings from this third part of our evaluation of the macro policy response to COVID.

First, when we use optimal control, we are unable to improve on the macro policy response of the *shorter stimulus* scenario. The improvement in control over unemployment and inflation is small and is at the cost a significant reduction in horizontal equity because consumers in unsafe industries are clearly under-compensated for COVID income losses. This confirms our choice of the *shorter stimulus* scenario as our preferred macro policy response to COVID.

Second, our macro policy recommendations for future pandemics are not dependent on whether you are a macro policy hawk or dove. Both the dove and the hawk agree that the macro policy stimulus was continued for too long, leading to the inflation peak of 7.1 per cent, compared to 4.5 per cent under the hawk and 5.5 per cent under the dove.

Third, the RBA under-performed a backward-looking benchmark for monetary policy in 2021-22 by using a more expansionary policy. This excessively expansionary monetary policy added 0.7 percentage points to the peak inflation rate. However, the over-compensating nature of the fiscal policy response added 1.4 percentage points and therefore was the major contributor to peak inflation being 2.1 percentage points higher than under our preferred *shorter stimulus* scenario.

Fourth, even with perfect forecasting, including of the effects of fiscal policy on inflation, the RBA would have been able to use monetary policy to neutralise only 0.7 percentage points of the contribution to peak inflation of 1.4 percentage points from fiscal policy.

9 Macro Policy in Future Pandemics

In this section we draw lessons for how macro policy can be better conducted in future pandemics. We do this by bringing together the findings from the three parts of our evaluation of the Australian macro policy response to COVID, which are based on macro policy principles for a pandemic, scenario analysis and optimal control.

Macro policy principles for a pandemic

In future pandemics, better economic outcomes will be obtained if we follow the three principles for economic policy in a pandemic developed by Guerrieri et al. (2022).

1) Choose levels of restrictions on the unsafe industries that optimally balance the health costs from consumption of their goods against the economic benefits.
2) With fiscal policy, fully compensate participants in the unsafe industries for their income losses from those restrictions. This is particularly important for participants who do not have access to finance.
3) Set the policy interest rate to target employment/inflation in the safe industries.

This paper does not evaluate the government's pandemic containment policies. Therefore, we do not reach any conclusions on whether those containment policies were consistent with the first principle. Instead, we take those containment policies as given and evaluate the government's macro policy response to the pandemic against the second and third principles.

If economic policy follows the second principle in future pandemics, the fiscal policy response followed under COVID will be changed in the following ways.

The all-in-one JobKeeper program will be replaced with a pair of programs, one for wage compensation and another for profit compensation. JobKeeper compensated for lost wages in a simplistic way and for lost profits in a perverse way. Separate programs will allow more accurate compensation for COVID income losses, which will be better for horizontal equity and macro stability and help avoid disincentive effects.

Indeed, in 2021 JobKeeper was replaced with two separate programs. These were the COVID disaster payment for wage compensation and COVID business support for profit compensation. This pair of programs also made the further improvement that the duration of payments was tied to the duration of COVID restrictions instead of being pre-set.

As discussed in OECD (2021) and the ILO study of Eichhorst, Marx, Rinne and Brunner (2022), during COVID many countries used a short-term work (STW) program for wage compensation, a superior option to the Australian COVID disaster payment. Indeed, Borland (2023) advocates that Australia use a STW program in future pandemics. A STW program, like a wage subsidy program, is designed to support job retention so as to help limit the risks of labour and capital becoming scarred or stranded. The Independent Evaluation of the JobKeeper Payment (Treasury, 2023a, p. 75) considered the idea of a STW program too briefly, neglecting its advantages. A well-prepared Australian STW program could better calibrate payments to individual workers to their wages lost to pandemic restrictions, as was the case under the UK's CJRS compared to Australia's JobKeeper.

The Boosting Cash Flow for Employers program is not used in the next pandemic. Under that program, payments were made irrespective of whether businesses experienced COVID income losses.

Programs to stimulate aggregate demand are appropriate for combatting a recession that is caused by a deficiency in aggregate demand but are ill-designed for pandemics. Such programs stimulate the economy broadly, whereas in a pandemic we need to neutralise a loss of income that, in the first instance, is confined to the specific industries that are subject to pandemic containment policies. During COVID, the income losses were mainly concentrated in only one-sixth of the economy. The programs to stimulate aggregate demand included accelerated depreciation for business investment, personal income tax cuts and one-off transfers to social security recipients. Such programs are not repeated in future pandemics.

During 2020 and 2021, the Federal Government announced fiscal measures costing an extraordinary $428 billion over the forward estimates. In future pandemics, there will be clear policies for funding both pandemic and non-pandemic policy measures.

As part of their ideal fiscal responses to a pandemic, both Woodford (2022) and Guerrieri et al. (2022) stipulate how and when their pandemic compensation payments are funded from higher taxes. Similarly, in a future pandemic, the government will specify how and when its compensation payments will be funded through the tax system, both to better discipline the size of its fiscal response and to support fiscal sustainability and an efficient tax system.

In a future pandemic, normal fiscal practice will be followed under which non-pandemic policy measures are funded from the budget to avoid an unwarranted stimulus to aggregate demand.

If economic policy follows the third principle in future pandemics, the monetary policy response followed under COVID will be changed in the following ways.

Monetary policy will target employment and inflation in the safe industries. This is likely to result in a pandemic monetary policy that is *less* expansionary than under a standard, backward-looking Taylor rule. During 2021-22, the RBA pursued a monetary policy that was *more* expansionary than under a standard Taylor rule.

Further, the RBA will be better equipped to anticipate the implications of fiscal stimulus for inflation. This will require upgrading the linkages from fiscal policy to inflation in the RBA's MARTIN and DSGE models.

Macro policy scenarios

If the macro policy principles for pandemics are followed in a future pandemic, we can expect better control over unemployment and inflation. We quantified that improvement using policy scenarios from an Australian macro-econometric model. Three scenarios were used.

The actual policy response, under which there was $2 of fiscal compensation for every $1 of private income lost to COVID restrictions, is incorporated in the *baseline* scenario. At the other extreme, there is $0 of compensation for every $1 of lost income in the *default policy* scenario. Falling in between is the *shorter stimulus* scenario that is based on the macro policy principles for pandemics and under which compensation is paid at the rate of $1 for $1. We began by comparing the *baseline* scenario to its polar opposite, the *default policy* scenario.

Compared to the *default policy* scenario, the actual highly expansionary policy of the *baseline* scenario was a near-term success in controlling unemployment, but a medium-term failure in controlling inflation. It reduced peak unemployment in mid-2020 by 2.0 percentage points, but it added 3.4 percentage points to peak inflation at end-2022. Weighing up those outcomes, the actual policy reduced our measure of social loss (SL) from 164 to 135, indicating that it improved macroeconomic control. The *shorter stimulus* scenario does better.

On the one hand, the *shorter stimulus* scenario provides a saving in the peak unemployment rate in mid-2020 that is 0.4 percentage points less than under the *baseline* scenario, so its control of unemployment is slightly inferior. More specifically, the peak unemployment rates are 8.9, 6.9 and 7.3 per cent under the *default policy*, *baseline* and *shorter stimulus* scenarios respectively.

On the other hand, the *shorter stimulus* scenario reduces the peak inflation rate during 2022 by 2.1 percentage points, compared to the *baseline* scenario, so its control of inflation is greatly superior. Peak inflation rates are 3.7, 7.1 and 5.0 per cent under the *default policy*, *baseline* and *shorter stimulus* scenarios respectively.

Weighing up those outcomes, the SL score under the actual policy of 135 falls to 80 under the *shorter stimulus* scenario, indicating that the shorter stimulus substantially improves macroeconomic control compared to the actual policy. There are three reasons for the superior control of inflation under the *shorter stimulus* scenario compared to the *baseline* scenario.

First, the shorter stimulus better aligns the duration of the macro policy stimulus with the duration of COVID restrictions. Second, it avoids over-stimulating the economy by reducing the level of fiscal compensation for every $1 of private income lost to COVID restrictions from $2 to $1. Third, the shorter stimulus only maintains the policy interest rate at the ELB for as long as prescribed by the Taylor rule, whereas it was actually held at the ELB for a year longer.

As an aside, under the pandemic monetary policy principle, the policy interest rate would have begun rising even earlier than under the Taylor rule. This is because monetary policy would have focussed on economic conditions in industries not subject to COVID containment policies. However, we have not modelled this.

Our estimate that over-prolonged macro policy stimulus added 2.1 percentage points to peak inflation in 2022 is a key result of this paper. Among Australian macro-econometric models, our model is best placed to provide such an estimate because it forecast an outbreak of inflation in 2022 due to the three structural advantages it has in modelling COVID and macro policy. Those advantages are that it has finer industry detail allowing it to better captures how COVID impacted unevenly across the economy, it contains more fiscal detail to better differentiate the economic effects of the programs included in the fiscal policy response, and it captures the macro effects of COVID social distancing using indicators of geographic immobility.

We also check this inflation effect estimate using three other methods, besides Australian macro modelling. We used results from leading macro models for other countries, an international study of fiscal policy and inflation under COVID, and detailed analysis of the Australian CPI. These three other methods all produce results that are consistent with our finding that the excessively long nature of the macro policy stimulus in Australia added 2.1 percentage points to our peak inflation rate.

More broadly, in our modelling the *shorter stimulus* scenario finds the fiscal compensation sweet spot, as would be expected under the macro policy principles for a pandemic. Its $1 of compensation for every $1 of income lost to COVID maintains horizontal equity. Further, it holds the social loss from unemployment and inflation gaps to 80, compared to social losses of 135 and 164 under the $2 and $0 compensation rates of the *baseline* and *default policy* scenarios respectively. Finally, the total cost to the government budget over the forward estimates of the fiscal stimulus is approximately halved, from $428 billion to $219 billion.

Optimal control of macro policy

While the *shorter stimulus* scenario provides better macroeconomic control than either the actual policy of the *baseline* scenario or the more passive policy of the *default policy* scenario, that leaves open the question of whether there exists a policy scenario that provides even better macroeconomic control. Optimal control is designed to find the scenario that provides the best control. We applied optimal control to the *shorter stimulus* scenario.

Social loss falls from 135 under the *baseline* scenario to 80 under the *shorter stimulus* scenario to 58 under the *optimal control* scenario. Thus, compared to the *shorter stimulus* scenario, the *optimal control* scenario achieves a relatively small improvement in control over unemployment and inflation. However, this involves using a different macro policy mix from 2021 to 2023, with looser monetary policy and tighter fiscal policy. That tighter fiscal policy clearly under-compensates consumers in unsafe industries for COVID income losses, and thereby reduces horizontal equity.

This highlights a shortcoming of the *optimal control* scenario that, while it targets control of unemployment and inflation, it disregards horizontal equity. This is necessarily the case because our macro-econometric model does not distinguish between consumers in the safe and unsafe industries, as noted in section 4. Once we recognise horizontal equity as a policy objective, it is judged that the *shorter stimulus* scenario achieves the better outcome for national economic welfare, as expected under the macro policy principles for a pandemic.

Importantly, our macro policy recommendations for future pandemics are not dependent on whether you are a macro policy hawk or dove. Under the policy hawk, who is only concerned about inflation, the inflation peak during 2022 would have been 4.5 per cent. Under the policy dove, who is four times more concerned about unemployment than inflation, the inflation peak would have been higher at 5.5 per cent. However, both the dove and the hawk agree that the macro policy stimulus was continued for too long, leading to the much higher actual inflation peak of 7.1 per cent. Under our preferred *shorter stimulus* scenario, the inflation peak is 5.0 per cent, midway between the peaks under the hawk and dove.

Finally, we evaluate monetary policy under COVID against two alternative policy benchmarks, one backward-looking and one forward-looking. Under a backward-looking Taylor rule, monetary policy responds to observed gaps between inflation and unemployment and their respective target rates. We begin by considering the backward-looking benchmark for monetary policy, in a similar vein to Gross and Leigh (2022).

Gross and Leigh (2022) find that the RBA outperformed a backward-looking benchmark for monetary policy in the 2001 slowdown and in the Global Financial Crisis, in both cases by using a more expansionary monetary policy. However, they find that it under-performed that same benchmark during the pre-pandemic period of low inflation from 2016 to 2019, this time by using a less expansionary policy. This paper extends those results by finding that the RBA also under-performed a backward-looking benchmark for monetary policy in 2021-22, this time by using a more expansionary policy.

This excessively expansionary monetary policy added 0.7 percentage points to the peak inflation rate. The over-compensating nature of the fiscal policy response added a further 1.4 percentage points. Thus, as found in the second part of our evaluation, the actual macro policy added a total of 2.1 percentage points to peak inflation during 2022, compared to our preferred *shorter stimulus* scenario.

Under our forward-looking benchmark for monetary policy, the massive fiscal response to COVID is taken as given, and optimal control is used to formulate a plan for monetary policy from the June quarter 2020 under perfect foresight. Under that plan, the RBA would have neutralised 0.7 percentage points of the contribution to peak inflation of 1.4 percentage points from fiscal policy. Of course, perfect foresight about factors such as the future course of the pandemic is unobtainable, so this forward-looking benchmark for monetary policy is unreasonably demanding. However, the results illustrate the point that better forecasting of the effects on fiscal policy on inflation can lead to better macroeconomic control.

Three perspectives

In summary, we have evaluated the Australian macro policy response to COVID from the three different perspectives of macro policy principles for a pandemic, macro policy scenarios and optimal control of macro policy, and they provide consistent lessons for how macro policy can be conducted better in future pandemics. We find that a shorter macro policy stimulus under which the fiscal policy is calibrated to the income losses and duration of the pandemic, and monetary policy focusses on conditions in industries not subject to containment policies, will result in much better control of inflation and greater horizontal equity, at around only one half of the cost to the government budget. The gains will be greater depending on the forecasting capabilities of policy makers.

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APPENDIX

Table A1. **Modelling COVID: t-statistics for immobility effects (estimation to 2024Q1)**

	COVID variable	domestic immobility	national lockdown	state lockdowns	consumption immobility effect	international immobility	int. students immobility
	Code	1-COVID_DOM	COVID_202	COVID_213	CCOVID	1-COVID_INT	1-COVID_EDU
Model Equation(s)	*Code*						
Households:							
household consumption	HCONZ	-5.90	-9.37, -4.83 (-1)	-5.09			
household demand (non-housing)	HCONZi (i=A,B,C,G)				-17.43, -6.05, -11.27, -4.13		
household demand (housing services)	PHCONT				-12.17		
labour force participation	lNSU		-9.40, -2.24 (-1)	-4.41			
average wage (compositional effect)	W		4.11, 2.62 (-1)				
investment in ownership transfer costs	CFOTC	-2.08					
Producers:							
employment in services (adjustment speed)	Ni (i=C,G,S)	1.79, 4.32, 6.67					
prices for domestic sales of services	PDOMi (i=G,SM,SN)	2.30, 1.46, 0.73					
Travel-related International Trade:							
exports of services	BEXi (i=G,SN)					-2.64, -13.05	-6.37, -3.16
imports of services	IMi (i=G,SN)					-6.34, -17.23	

Table A2. *Model Inputs in COVID and No COVID settings*

Variables		Time period of COVID effect	Settings for Time Period of COVID effect	
Description	Code		Without COVID	With COVID
Social Distancing:				
domestic mobility	*COVID_DOM*	2020q2-2024q1	normal (1.00)	actual and projected (see Figure 3)
international mobility	*COVID_INT*	2020q2-2024q3	normal (1.00)	actual and projected (see Figure 3)
international students	*COVID_EDU*	2020q2-2027q2	normal (1.00)	actual and projected (see Figure 3)
national lockdown	*COVID_202*	2020q2-2020q2	normal (0)	1
state lockdowns	*COVID_213*	2021q3-2021q3	normal (0)	1
net overseas migration (via demographic model)	*NOM*	2020/21-2023/24	normal (225k per year)	actual and projected (see Figure 5)
international economy:				
world CPI	*PWCPIF*	2020q2-2024q4	normal (annualised quarterly inflation rate of 2.5%)	actual and projected (convergences to normal rate from above by 2025q1)
world prices for manufactured imports	*PIMFC*	2020q2-onwards	normal (annualised quarterly inflation rate of 2.5%)	actual and projected (convergences to pre-COVID real price by 2027q4)
world prices for rural commodities	*PIMFA, PEXFRUR*	2020q2 onwards	each price level relative to PWCPIF same as under COVID case	actual and projected (normal rate from 2024q3)
world prices for mining commodities	*PIMFB, PEXFMIN*	2020q2 onwards	each price level relative to PWCPIF same as under COVID case	actual and projected (convergences to normal rate from below by 2027q4)
world prices for services	*PIMFG, PIMFSN*	2020q2 onwards	each price level relative to PWCPIF same as under COVID case	actual and projected (convergences to pre-COVID real price by 2027q4)
foreign short-term interest rate	*RSF*	2020q2 onwards	normal (adjusts to equlibrium rate of 3.75% p.a. by 8% per quarter)	actual and projected (actual to 2024q2, then adjusts to equilibrium rate)

Table A3. **Model Inputs without and with Macro Policy Expansion**

Variables		Time period of	Settings for Time Period of Policy Expansion	
Description	Code	Policy Expansion Timing	Without Policy Expansion	With Policy Expansion
spending:				
business subsidies (i=A,B,C,G,S)	*RTPNOi*	2020q2-2021q4	2019 effective rates	includes 20% of JobKeeper, COVID business support
business transfers	*POLBUS*	2020q2-2021q1	zero	includes boosting cash flow & 80% of JobKeeper
general government consumption	*GCON*	2020q2 onwards	remove elevation of 7.5% to 2022q2, 6% to 2023q2, 4% to 2024q2, 2% thereafter	actual (includes other policy measures), then grows with potential output
general government gross fixed capital formation	*CFGG*	2021q2 onwards	remove elevation of 7.5% to 2022q2, 6% to 2023q2, 4% to 2024q2, 2% thereafter	actual (includes other policy measures), then grows with potential output
gap between benefit and survey unemployment	*RLMR*	2020q2-2024q1	2019 gap (1.1%)	actual (includes relaxed eligibility test)
unemployment benefit rate (relative to wage)	*POLUNEMP*	2020q2 onwards	remove elevation of 97% to 2020q3, 44% in 2020q4, 27% in 2021q1 and 9% thereafter	actual (includes COVID supplement), then unchanged
other household transfer rates (relative to wage)	*POL(CHILD, AGED, DISAB, OTHER)*	2020q2-2021q1	lower by 12.6% in 2020q2, 8.4% in 2020q3, 3% in both 2020q4 and 2021q1	actual (includes COVID support payments), then unchanged
taxes:				
effective average personal income tax rate	*POLLAB*	2020q3-2022q2	higher by 0.014	actual (includes bring forward of stage 2 personal income tax cuts)
immediate expensing of machinery and equipment	*POLIO*	2020q2-2023q2	zero	actual (expensing 28% eligible investment for 2020q2-2020q3, 67% for 2020q4-2023q2)
average payroll tax rate	*POLPAY*	2020q2-2021q4	2019 effective rates	actual (includes COVID payroll tax concessions)
monetary policy:				
Taylor rule dummy for looser money: 2021q2 to 2022q2	*COVID_212_222*	2021q2-2022q2	dummy set to zero	dummy set to one

Table A4. Summary of Scenario Policy Settings and Outcomes

scenario		COVID	macro policy settings		inflation and unemployment gaps		sources of social loss (under default weights)			
number	name		fiscal policy	monetary policy	unemployment rate gap mid-2020	inflation rate gap end-2022	unemployment	inflation	other	total
1	no COVID	no COVID	passive	Taylor rule	1.3	0.3	24	17	12	54
2	default policy	COVID	passive	Taylor rule	4.2	1.2	107	49	7	164
3	baseline	COVID	see Table A	actual	2.2	4.6	26	97	13	135
4	shorter stimulus	COVID	see Table B	Taylor rule	2.6	2.5	33	40	7	80
5	optimal control (OC)	COVID	shorter stimulus with OC		2.3	2.5	22	26	10	58
6	hawk	COVID	OC: unemployment weight of 0		2.5	2.0	35	26	6	67
7	dove	COVID	OC: unemployment weight of 4		2.0	3.0	14	32	21	67
8	optimal money	COVID	see Table A	OC	2.7	3.2	28	57	18	103
9	Taylor rule	COVID	see Table A	Taylor rule	2.4	3.9	24	73	15	112

Notes:

1. The baseline scenario is based on actual macro policy. Thus, it reflects historical outcomes to the March quarter 2024, and model projections thereafter. All other scenarios are counter-factual scenarios that begin with the macro policy response to COVID in the June quarter 2020.
2. The contribution to social welfare loss from a given source, such as inflation, is calculated from the squared gaps between the actual and target values. The squared gaps from different quarters are then combined together using time discounting, and the chosen weight for the given source is then applied. Finally, the total social welfare loss is calculated by adding together the contributions from all sources.
3. For comparability across scenarios, the results for the sources of social loss are calculated using the default weights for each target, including equal weights of 1 for the inflation and unemployment targets. At the same time, the hawk and dove scenarios are actually generated using alternative weights for the unemployment target of zero and 4 respectively.
4. OC = optimal control