An Initial Assessment of the Reserve Bank's Bond Purchase Program

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Photo: Bunhill – Getty Images

Abstract

This article provides an initial assessment of the effect of the Reserve Bank's bond purchase program on government bond yields. Overall, we estimate that the program has reduced longer-term Australian Government Security (AGS) yields by around 30 basis points and lowered the spread of state and territory bond yields to AGS yields by 5 to 10 basis points, relative to where they would otherwise have been. This reduction in yields occurred partly in anticipation of the program and partly at its announcement. Bond yields have risen noticeably since the program was announced, but this does not imply that the impact of the program was transitory: many factors contribute to changes in bond yields, and our assessment is that bond purchases serve to hold yields lower than they would otherwise have been over an extended period. The bond purchase program has not had any substantial negative impact on the functioning of government bond markets.

Introduction

At the November 2020 Board meeting, the Reserve Bank announced that it would undertake a $100 billion bond purchase program, purchasing $80 billion of Australian Government Securities (AGS) and $20 billion of bonds issued by the state and territory borrowing authorities (semi-government bonds, or semis) over the following 6 months. In February this year, the Board extended the program by announcing the purchase of an additional $100 billion of AGS and semis after the completion of the initial purchases in mid April; market participants widely expected additional purchases but were uncertain about the amount.[1]

The intention of the bond purchase program was to lower government bond yields. Government bonds are the benchmark fixed-income securities in

Australia, and their risk-free yields underpin the pricing of other bonds and term lending rates, and influence the exchange rate. As such, lower government bond yields put downward pressure on funding costs throughout the economy and help to lower the exchange rate, contributing to easier financial conditions and thereby supporting economic activity and inflation. This article assesses how far purchases reduced government bond yields. While bond yields have risen substantially since November 2020, this does not imply that the effect of the program was transitory: many other factors also influence bond yields, and the evidence suggests that bond purchases serve to hold yields lower than they would have otherwise been over an extended period; this is also the evidence from studies of quantitative easing (QE) programs in other countries.[2]

Given that participants in the Australian government bond market are forward-looking, most of the impact of a bond purchase program should occur as market prices adjust in anticipation of the program and/or when it is announced.[3] Reflecting this, our key results come from an event study covering the period leading up to the announcement of the bond purchase program. In particular, from September 2020 financial markets were increasingly pricing-in the possibility that the Reserve Bank would conduct a bond purchase program, with these expectations confirmed at the Board announcement on 3 November. To quantify the impact of this, we identify key events that led financial markets to reassess the likelihood that the Bank would conduct a bond purchase program, and measure the change in government bond yields around these dates. These events include public announcements by the Bank, newspaper articles and market economist reports.

An alternative approach is to construct a counterfactual scenario of what bond yields might have been in the absence of a bond purchase program. Here we consider 2 approaches. The first assumes that AGS yields would have moved in line with those of US Treasury bonds. The second approach constructs a counterfactual based on the historical relationship between AGS yields and a range of financial market factors, both domestic and international. These 2 approaches suggest that the bond purchase program reduced yields by somewhere between 20 and 30 basis points, broadly in line with the results from our event study.

We also assess the effect of the weekly flow of purchases on bond yields over and above the announcement effect (and find that it is small and transient), and discuss the results of a model that seeks to decompose observed bond yields into expectations of future short-term interest rates plus term premia (and find that the former have risen while the latter are low relative to recent history). Finally, we briefly assess whether the bond purchase program has adversely affected government bond market functioning.

International evidence on bond purchases

Bond purchases can lower bond yields via a number of channels. These include:

- portfolio rebalancing – buying bonds bids up their price and removes interest rate risk from the market, reducing term premia and inducing investors to buy other assets, including to replace the bonds that they sold;
- reducing liquidity premia – steady central bank buying reduces the risk of investors being unable to sell bonds at a reasonable price; and
- signalling – bond purchases underline the commitment of the central bank to hold policy rates lower for longer (including because policy rates are unlikely to be raised while bond purchases are ongoing) and so reinforce expectations for a low policy rate.

The empirical literature on bond purchases, based on experience in other countries, suggests that an initial purchase program announcement equivalent to 1 per cent of GDP reduces yields by around 5–7 basis points on average, although the range of estimates is wide.[4] Initial bond purchase programs also tend to have larger apparent impacts than subsequent programs. This is because additional rounds of bond purchases are often expected by markets and so are already priced-in, and it is difficult to disentangle these pre-existing expectations from the new information in an announcement of a program extension. Also, many

Table 1: Key Event Study Days

Date	Event
14 September	Newspaper article ('RBA and markets out of tune')
22 September	Speech by Deputy Governor Debelle
23 September	Market economist report calling for further policy easing
28 September	Market economist report calling for further policy easing
6 October	October Board announcement
7 October	Newspaper article ('odds shortened on more easing')
15 October	Speech by Governor Lowe
26 October	Newspaper article ('RBA to buy bonds')
3 November	November Board announcement

early bond purchase programs were initiated during a period of market stress, when the liquidity premia channel of bond purchases is relatively important, whereas subsequent programs were often implemented in more settled markets when liquidity premia were low (of note, government bond markets were stable and functioning well in November 2020 when the Reserve Bank commenced its bond purchase program).

Applying the international experience to Australia, the bond purchase program announced on 3 November 2020 could have been expected to reduce longer-term yields by around 30 basis points. Further, most of the effect would be expected to come via lower term premia: liquidity premia were already low and, while bond purchases would have had some signalling effect, forward guidance and the 3-year yield target were already providing a powerful signal regarding the direction of future policy.

Estimates of the announcement (or stock) effect

Event study

As noted above, the literature tends to find that most of the impact of bond purchase programs on yields occurs when expectations are formed, rather than when purchases are made. This implies that an event study – where key dates relating to the outcome of interest are identified and the yield change that occurs on those dates is assessed – is a reasonable way to measure the impact. For this event study we identified 9 events in the 2 months preceding the initial announcement of the Bank's bond purchase program. We then summed the cumulative change over those dates in: AGS yields; the spread of AGS yields to overnight indexed swap (OIS) rates; and the spread of semis yields to AGS yields.

To identify events, we examined end-of-day market summary reports written by bond traders and market economists over September and October 2020, and selected those days where a piece of news was widely cited as relevant to the potential for a Reserve Bank bond purchase program. In total we identified 9 such events, which included speeches by Reserve Bank Governor Lowe and Deputy Governor Debelle, the October and November 2020 Reserve Bank Board announcements, 3 newspaper articles, and 2 market economist reports (Table 1). We used a one-day time interval to measure the change in yield following an event – either 'open-to-close' for events that occurred during trading hours, or 'previous close-to-close' for events that occurred before the market opened – but as a robustness check we also considered a two-day event window (results were similar).

AGS yields declined across the curve in response to the identified events, with the cumulative change in yield largest at the 10-year point at around 30 basis points (Graph 1). To the extent that we have correctly identified the key dates when market

participants reassessed the likelihood of the Reserve Bank conducting a bond purchase program, and no other major news occurred on those dates to move yields for other reasons, this suggests that the bond purchase program led to a fall in the 10-year AGS yield of around 30 basis points.

The fall in yields measured above will incorporate all of the channels discussed earlier – the signalling channel, the portfolio rebalancing channel, the liquidity premia channel. However, any signalling effect of bond purchases will also be evident in OIS rates, which provide a measure of market expectations for the evolution of the cash rate.[5] As such, examining how the spread of AGS yields relative to OIS rates changes – that is, using OIS rates as a control variable – allows us to isolate the combined effect of the portfolio rebalancing and liquidity channels of bond purchases. Measuring AGS yields relative to OIS rates also helps to control for any other macroeconomic or financial market news that might have occurred on the event days that was unrelated to bond purchases but affected cash rate expectations. The results of this analysis are presented in Graph 2, and suggest that for shorter-dated maturities out to around 5 years, most of the observed fall in yields was due to lower cash rate expectations, rather than other factors.[6] For bonds with residual maturity of around 10 years, however, the fall in the spread of AGS yields to OIS rates is very similar to the fall in actual AGS yields, at around 30 basis points. This suggests that the fall in 10-year AGS yields was for the most part driven by falls in term and liquidity premia, and most likely the former (because outside of periods of market dysfunction, liquidity premia are typically low in the AGS market).[7]

Finally, the bond purchase program led to a *larger* fall in semis yields than in AGS yields, with the spread of semis yields to AGS yields at the relevant maturities narrowing by around 5 basis points when measured over a one-day event window (Graph 3), and by around 10 basis points when measured over a two-day window.[8] AGS yields act as the benchmark yield curve in Australia, with other fixed-income securities typically priced at a spread to either AGS yields or to swap rates. If the Reserve Bank had elected to purchase only AGS as part of its bond purchase program, it is likely that semis yields would have fallen by roughly the same extent as AGS yields, leaving the spread between semis and AGS little changed. The inclusion of semis in the program put additional downward pressure on semis yields, resulting in a narrowing in spreads.

A counterfactual approach

An alternative approach to measuring the effect of the Reserve Bank's bond purchase program is to construct a counterfactual scenario for how AGS yields might have moved in its absence, and take the difference between the observed yield change and this counterfactual as measuring the impact of the program.

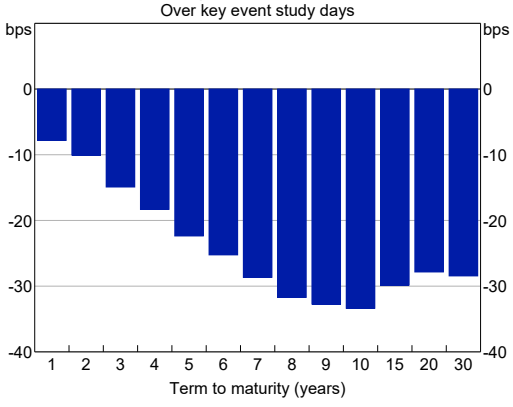
US Treasury yields

A simple counterfactual is to assume that, in the absence of bond purchases by the Reserve Bank,

Graph 1

Change in AGS Yields

Over key event study days

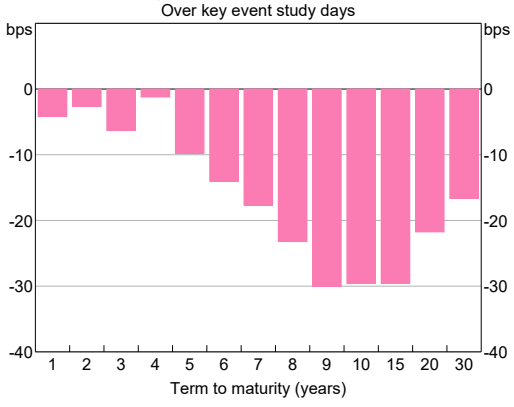


Sources: Bloomberg; RBA

Graph 2

Change in AGS Spread to OIS

Over key event study days



Sources: Bloomberg; RBA

longer-term AGS yields would have moved in line with the government bond yields of the United States.[9] Focusing on the spread between 10-year AGS yields and those of US Treasury bonds, after rising at the onset of the COVID-19 crisis as the relative outlook for US growth, inflation and interest rates deteriorated rapidly, the spread remained stable at around 25–30 basis points through to mid 2020 (Graph 4). However, as market participants began to price-in the likelihood of bond purchases in Australia over September and October 2020, this spread narrowed, reaching around zero when the Bank's bond purchase program was announced in early November. To the extent that the evolution of longer-term US Treasury yields provides a good counterfactual for what would have happened to longer-term AGS yields in the absence of a bond purchase program, this approach also suggests that the bond purchase program led to a fall in longer-term AGS yields of around 30 basis points. With the exception of a short-lived move higher in early 2021 associated with a global increase in bond yields, the spread has remained near zero, suggesting that this (counterfactual) fall in yield has been persistent. The accumulation of further market moving events and differing outcomes for the Australian and US economies will, over time, lessen the validity of this comparison, and we would not expect the spread to remain around zero indefinitely.

A model of AGS yields

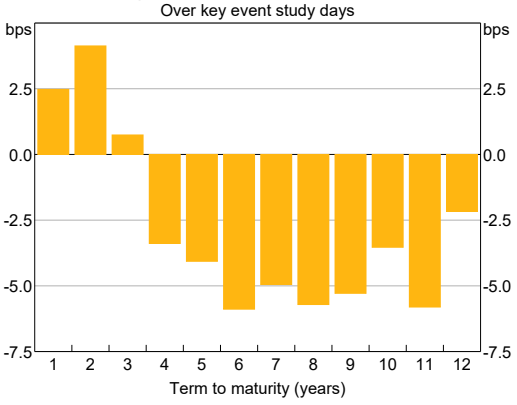
A slightly more sophisticated approach is to construct a model of AGS yields that controls for a range of domestic and international factors, but for the most part does not capture the effect of the Reserve Bank's bond purchase program, and then use the implied path of AGS yields resulting from this model as a counterfactual against which to measure the effect of bond purchases.[10]

The model we employ tries to explain changes in the 10-year AGS yield using changes in the Australian 10-year OIS rate, changes in the 10-year US Treasury yield, changes in US Federal Reserve bond holdings as a share of US GDP, and changes in the spread between the Australian 3-month Bank Bill Swap (BBSW) and 3-month OIS rates. As noted earlier, the 10-year OIS rate will capture market expectations for the cash rate path, and therefore any signalling effect of bond purchases. This implies that our measure will only capture the portfolio rebalancing and liquidity channels of bond purchases and not the signalling channel and, as such, should be taken as a lower bound rather than a central estimate. Regarding the other explanatory variables: the US Treasury yield captures international factors affecting long-term interest rates; US Federal Reserve bond holdings capture bond purchases in the United States; and the 3-month BBSW–OIS spread is a measure of domestic risk aversion. Overall, the counterfactual 10-year AGS yield implied by the model, in the absence of bond purchases, is around 20 basis points higher than the observed 10-year AGS yield,

Graph 3

Change in Semis Spread to AGS*

Over key event study days

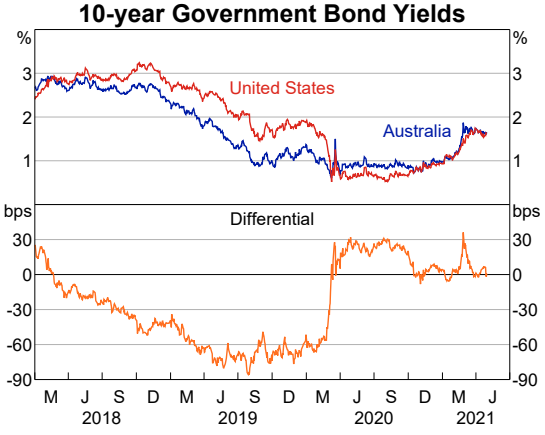


* Median for the states; excludes the territories

Sources: Bloomberg; RBA

Graph 4

10-year Government Bond Yields



Sources: Bloomberg; RBA; Yieldbroker

with the difference persistent over late 2020 and early 2021 (Graph 5). See Appendix for model results.[11]

The implementation (or flow) effect

In addition to the announcement (or stock) effect described above, the Reserve Bank's bond purchases may also have lowered yields as and when the purchases occurred. That is, there may have been effects on yields associated with the flow of purchases, in addition to the effect of the expected total stock of purchases. To assess this we use the fact that certain bonds at certain times were excluded from bond purchase operations, and measure the differential effect on AGS yields and semis spreads of these exclusions. In particular, for AGS purchase operations, the Reserve Bank alternated between purchasing shorter-dated (roughly 5 to 7 years residual maturity) and longer-dated (roughly 7 to 10 years residual maturity) bonds, and also excluded any bonds that had recently been tapped or issued. For semis, the Reserve Bank initially also alternated between shorter-dated and longer-dated bonds (although it combined these groupings in March 2021), and again excluded bonds that had recently been tapped or issued.

Considering first the shorter-dated and longer-dated groupings of bonds separately, we investigate the yield impact of a bond being excluded from an auction due to it being recently tapped or issued. To do this we regress the change in yield (for AGS) or spread to the AGS yield (for semis) over the auction day on a dummy variable indicating 'included' or 'excluded' status, and also control for the effect of each bond line and day. This is equivalent to performing an analysis of variance to test whether, on auction days, bonds that were eligible to be purchased saw statistically different yield changes to bonds that were not eligible to be purchased.[12] All else being equal, a bond being recently tapped or issued might be expected to lead its yield to increase, thus biasing our estimation in favour of finding a flow effect. We find, however, that 'included' status has no impact on a bond's change in yield or spread, suggesting no discernible flow effect.

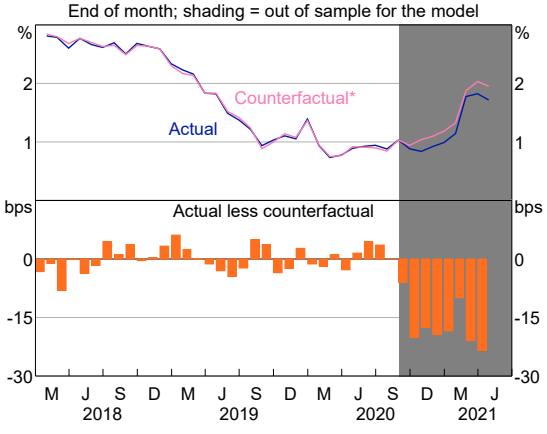
If we consider instead the shorter-dated and longer-dated groupings of bonds together (so that for each bond purchase operation the 'excluded' group of bonds now comprises recently tapped or issued bonds within the relevant maturity grouping, and also all bonds from the other maturity grouping), we find that purchases lowered AGS yields by 0.5 basis points on the day, and lowered semis spreads by 0.2 basis points on the day (see Appendix for model results). These results, combined with those discussed above, suggest that purchases in one segment of the yield curve affect yields and spreads in that part of the yield curve relative to other parts of the yield curve (even if they do not affect relative yields and spreads *within* that segment of the yield curve). However, this flow effect is modest and short lived, disappearing after just a few days.[13]

To summarise, we find that bond purchases can have a small flow effect, but that it is transitory; these findings are broadly in line with the international evidence on bond purchases.

Graph 5

10-year AGS Yield

End of month; shading = out of sample for the model



* Implied by cumulative modelled changes in the 10-year AGS yield

Sources: ASX; Bloomberg; RBA; Tullett Prebon; US Federal Reserve

Expected future short-term rates and term premia

So far we have focused on estimating the effect of the Reserve Bank's bond purchases on the overall level of government bond yields. Bond yields can also be thought of having 2 distinct components: the average short-term interest rate that is expected to prevail over the life of the bond; and the term

premium that investors demand for holding a long-term bond rather than investing in a series of shorter-term investments. Changes in expectations for future short-term interest rates give information on bond investors' expectations of policy rates over coming years, while changes in term premia give information on the level of interest rate and inflation risk that investors perceive, and their attitudes to these risks.

One cannot observe expected future short-term rates or term premia directly by looking at bond yields, since bond yields reflect the combination of both. One can, however, estimate these quantities using a model. A model that is often used for this purpose is a so-called affine term structure model, which assumes that expectations and term premia (and therefore yields) are driven by a few unobserved factors. By estimating those factors, and the model parameters, one can recover estimates of expectations and term premia. It is important to note, however, that a number of assumptions must be made to estimate an affine term structure model, some of which may not hold, and so model outputs should be taken as indicative.[14]

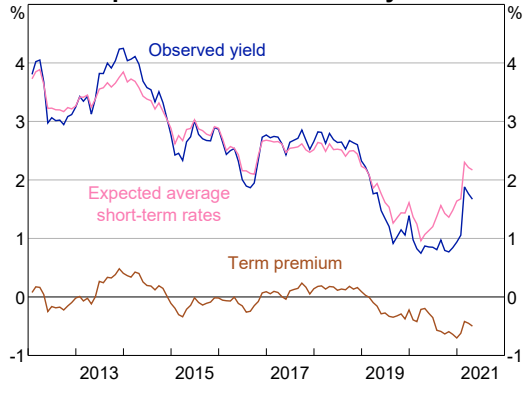
We use the model of Hambur and Finlay (2018) to estimate expected future short-term interest rates and term premia. Graph 6 shows that the 10-year nominal bond yield fell over the first few months of 2020 and reached a low in March of that year, as fears around the health and economic impact of COVID-19 grew. The 10-year yield stayed in a relatively narrow range over the remainder of 2020, before increasing in early 2021 alongside increasing optimism regarding the economic outlook. Underlying these movements, however, are divergent trends in estimates of expectations for future short-term rates and term premia. In particular, the onset of the crisis saw expectations of average future short-term rates over the following 10 years fall substantially, but they have since rebounded to be around the levels of 2017 and 2018. The term premium, by contrast, rose as the crisis intensified, but then fell over the remainder of 2020. These outcomes align with what one might have expected: as the crisis intensified investors began to expect that the Reserve Bank would hold policy rates low for many years into the future. At the same time, the amount of risk in the economy was clearly increasing, and investors' desire to bear that risk was falling, leading to higher term premia. But as governments and central banks responded to the crisis, and as effective vaccines were developed, investors became more optimistic about future prospects and so raised their expectations for average future short-term interest rates over the following 10 years. At the same time, the perceived riskiness of holding bonds fell, and investors' appetite to bear risk increased, pushing down on term premia.[15]

Purchases of government bonds by the Reserve Bank contributed to these developments in a few ways: these purchases reduced the risk that bond yields would rise in a dramatic and disorderly fashion, thereby reducing term premia; they pushed down on term premia directly via the portfolio rebalance channel; and by supporting the economy they helped to raise investors' expectations for future short-term interest rates.

One can decompose the 3 nominal time series presented in Graph 6 further, with each composed of a real component and an inflation-compensation component. That is, expectations for average future nominal short-term rates over the following 10 years can be thought of as comprising expectations for average future real (i.e. inflation-adjusted) short-term rates plus expectations for average future inflation, and similarly for term premia. These decompositions are shown in Graphs 7 and 8, and suggest that the fall and then increase in nominal short-term interest rate expectations was largely

Graph 6

Decomposition of Nominal 10-year Yield



Source: RBA

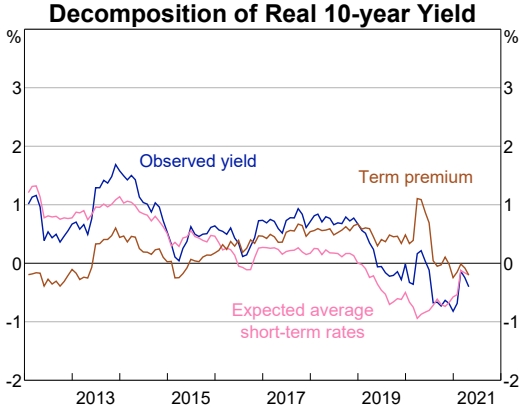
driven by moves in real rate expectations, which were likely to have been related to lower real growth expectations initially, which then recovered. Meanwhile, changes in inflation expectations were similar in direction but more muted. It was also a sharp move higher in real term premia in early 2020 that drove nominal term premia higher, while the inflation risk premium initially fell. These moves were then reversed over the rest of 2020 and into 2021. Higher real term premia reflect uncertainty around future real interest rates, in turn driven by uncertainty around economic growth, while lower inflation risk premia reflect less concern around the risk of high future inflation.

Potential effects on market functioning

As mentioned above, the international experience suggests that bond purchases can support good bond market function and lower liquidity premia, particularly in times of market stress. However, a central bank buying a large share of outstanding government bonds could, in principle, impinge on the operation of the government bond market. For example, if the Reserve Bank were to buy a very large share of a particular bond line so as to create considerable scarcity of that bond in the market, bond dealers may find it hard to source sufficient quantities of the bond to sell to their clients and so be reluctant to post prices or conduct trades. This could reduce liquidity in the market and contribute to an increase in market volatility, as well as lead to a widening in bid–offer spreads and the emergence of pricing anomalies (for example, bonds of a similar maturity having markedly different yields). At the extreme, this could diminish the attractiveness of the government bond market for investors and could contribute to a persistent rise in the liquidity premia for government bonds in Australia, which would be counterproductive given that the aim of the Bank's purchases is to contribute to lower yields. It could also lessen the extent to which government bond yields anchor other interest rates in the economy.

Graph 7

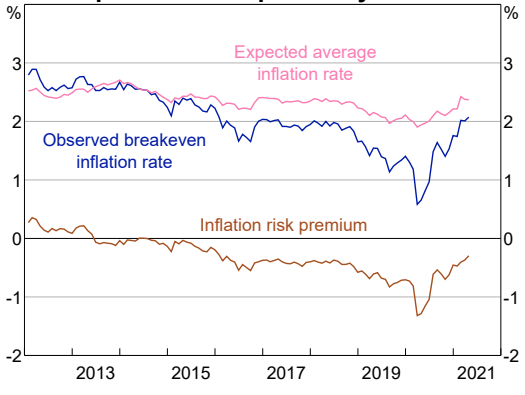
Decomposition of Real 10-year Yield



Source: RBA

Graph 8

Decomposition of Implied 10-year Inflation



Source: RBA

It is difficult to assess with any precision the point at which bond purchases might turn from supporting market function to adversely affecting it, but the evidence suggests that this point is some way off in Australia. Central banks in other advanced economies have purchased much larger shares of outstanding government bonds than the share implied by the Bank's bond purchase program. And these purchases have generally not contributed to a decline in market functioning. Additionally, the empirical literature is inconclusive about the *direction* of the effects of bond purchases on market function even when the central bank already holds a substantial share of the market, although there is clearer evidence of negative impacts emerging at very high shares of central bank holdings (see, for example, Han and Seneviratne 2018).

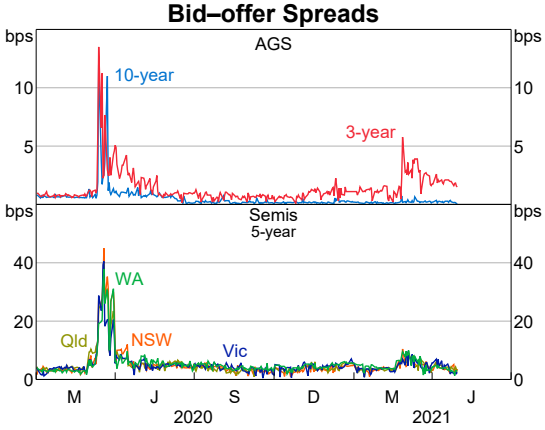
To date, there is no evidence of any adverse impacts of the Reserve Bank's bond purchase program, although there is some evidence that the Bank's 3-year yield target, and the sizeable holdings of the 3-year AGS, have resulted in some pricing anomalies in the short end of the yield curve. In particular,

bid–offer spreads are near historical lows for longer-term AGS and for semis, but are a little higher than usual for shorter-maturity AGS (although still well below the spreads observed during the period of market distress in March and April 2020; Graph 9). Yield curve fitting errors – which can be used as a measure of pricing discrepancies between otherwise similar bonds – are currently within their historical range for bonds that are eligible for the bond purchase program (Graph 10).[16]

To support good bond market function, the Bank has been willing to lend AGS and semis to market participants from its own portfolio, and the Bank also operates a lending facility on behalf of the Australian Office of Financial Management (AOFM). The Bank will also consider proposals to sell government bonds that it owns outright against an offsetting (duration-neutral) purchase of government bonds (so-called switches).[17]

Graph 9

Bid–offer Spreads

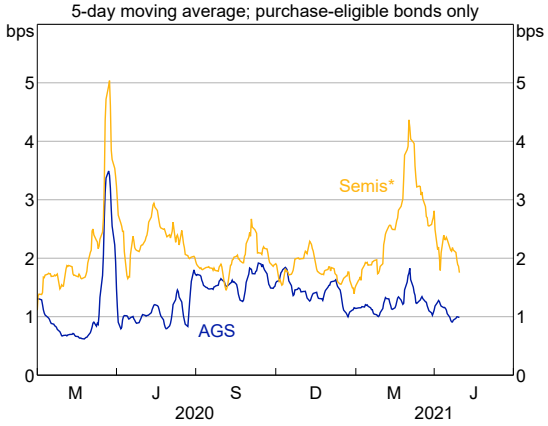


Sources: RBA; Yieldbroker

Graph 10

Yield Curve Fitting Errors

5-day moving average; purchase-eligible bonds only



* Simple average for the states and territories

Sources: Bloomberg; RBA

Appendix

Table A1: Linear Regressions of Changes in the 10-year AGS Yield

Percentage points; monthly, from start 2018 to end August 2020; all variables in first-difference terms[a]

	Model 1 Includes RBA bond holdings to Australian GDP[b]	Model 2 Includes 3-month USD LIBOR–OIS spread	Model 3 Includes 10-year US Treasury yield–OIS spread	Preferred model Insignificant variables dropped
10-year AUD OIS rate	0.79***	0.78***	0.81***	0.76***
	(0.09)	(0.09)	(0.09)	(0.08)
10-year US Treasury yield	0.23***	0.24***	0.22***	0.24***
	(0.07)	(0.07)	(0.07)	(0.06)
10-year US Treasury yield–OIS spread	0.32	0.30	0.32	
	(0.33)	(0.32)	(0.32)	
RBA bond holdings to GDP	0.02			
	(0.06)			
US Fed bond holdings to GDP	0.04**	0.04***	0.04***	0.04***
	(0.02)	(0.01)	(0.01)	(0.01)
3-month BBSW–OIS spread	0.20*	0.19*	0.21**	0.18*
	(0.10)	(0.10)	(0.10)	(0.09)
3-month USD LIBOR–OIS spread	0.02	0.03		
	(0.04)	(0.03)		
Intercept	0.00	0.00	0.00	–0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Adjusted R^2	0.94	0.94	0.94	0.94
Durbin-Watson statistic	2.37	2.36	2.50	2.57

(a) Parentheses show standard errors; *, ** and *** denote statistical significance at the 10, 5 and 1 per cent levels, respectively; estimated zero-coupon yields were used for AGS and US Treasury yields throughout the models

(b) Within the sample for the model, changes in RBA bond holdings were driven by purchases for liquidity management and maturities and, starting from March 2020, by purchases to support market functioning and the 3-year AGS yield target

Sources: ASX; Bloomberg; RBA; Tullett Prebon; US Federal Reserve

Table A2: Linear Regressions of Yield and Spread Changes on Bond Purchase Days

Yield and spread change in basis points; includes all bonds purchased under the bond purchase program[a]

	AGS yield	Semis spread
Purchase eligibility dummy	–0.51***	–0.19**
	(0.12)	(0.07)
Fixed effects	Bond and time	Bond and time
Adjusted R^2	0.91	0.34

(a) Parentheses show standard errors; *, ** and *** denote statistical significance at the 10, 5 and 1 per cent levels, respectively

Sources: RBA; Reuters

Footnotes

[*] The authors are from Domestic Markets Department.

[1] A poll by Reuters ahead of the February 2021 Board meeting found that market economists expected the Reserve Bank to announce a further program of purchases of around $80 billion on average, with the modal expectation being for a $100 billion extension.

[2] See for example Ihrig *et al* (2018) and Eser *et al* (2019).

[3] See for example Arrata and Nguyen (2017), De Santis and Holm-Hadulla (2017), and D'Amico and King (2013).

[4] See, for example, Bailey *et al* (2020), Bank of England (2021), CGFS (2019), and Gagnon (2016) for review papers.

[5] Note that in Australia long-dated OIS rates are priced based on the prevailing rates on 2 other types of financial instruments: fixed-to-floating interest rate swaps and basis swaps, both of which are liquid out to 10 or more years into the future. In a fixed-to-floating interest rate swap, one party receives a fixed interest rate (the 'swap rate') in exchange for paying a floating 3- or 6-month Bank Bill Swap (BBSW) rate. In a BBSW–OIS basis swap, one party pays the floating 3- or 6-month BBSW rate, and receives a floating rate that is linked to the realised cash rate. By entering both of these swaps, one can engineer an exposure where one receives a fixed rate and pays a floating rate linked to the realised cash rate, which is what an OIS contract delivers.

[6] This is unsurprising as the Reserve Bank Board also lowered the cash rate target and the target for the yield on the 3-year Australian Government bond from 25 basis points to 10 basis points at the November 2020 Board meeting.

[7] In fact, the expected impact of bond purchases on longer-term policy rate expectations is ambiguous. On the one hand, bond purchases serve to underline the central bank's commitment to keep policy rates low for a long period. But, conversely, bond purchases should boost economic activity and inflation and so bring forward the day when the policy rate needs to be increased.

[8] Semis are less liquid than AGS, and so measuring yield changes over a slightly longer window may be appropriate.

[9] This approach makes a few assumptions. In particular, it assumes that AGS yields tend to move with US Treasury yields in response to global news events (but not necessarily news pertaining to a change in the relative economic prospects or stance of monetary policy in each country). Another assumption is that the main news on relative monetary policy stances over the period in question related to domestic bond purchase expectations.

[10] See Kawamoto *et al* (2021) for a similar exercise focused on Japan. Ideally, we would prefer to construct a model of AGS yields that accurately captured the channels of a bond purchase program discussed earlier, and then use this model to directly measure the impact of bond purchases on yields. The relatively short time horizon over which the Reserve Bank has been conducting bond purchases, however, means that any such model would be poorly estimated. Further, and as discussed earlier, market participants' expectations of bond purchases are an important determinant of yields, and we do not have an accurate measure of these expectations through time. Together, these difficulties make estimating a model of yields that directly captures the effect of bond purchases unviable in the current context.

[11] Modelling the spread between 10-year AGS and US Treasury yields, and/or including additional explanatory variables (such as RBA bond holdings, the 10-year US OIS rate, and the 3-month USD LIBOR–OIS spread), all produced similar results. The additional explanatory variables that we tested were not statistically significant, and so we did not include them in our preferred model.

[12] See Fisher (1925).

[13] Other approaches to estimating flow effects, including regressing daily yield changes on the share of remaining free float of a bond line purchased by the Reserve Bank, and regressing the total change in yield between November 2020 and April 2021 for each bond on the total share of free float purchased by the Reserve Bank over that period, also suggested no significant flow effects.

[14] The model separates expectations from term premia using the time-series properties of the estimated factors (which evolve according to the distribution under which expectations are formed), and also survey data on economists' cash rate and inflation expectations (which do not contain term premia).

[15] Term premia are also estimated to be quite low in the years preceding the pandemic, and earlier bond purchase programs by other central banks are likely to have contributed to this.

[16] Yield curve fitting errors are measured as the difference between a smooth yield curve fitted to the underlying yield data, and the actual yields, which may not lie on a smooth curve; see Finlay, Seibold and Xiang (2020) for further discussion of this measure of market function.

[17] Switches are currently considered for semis only; details of these operations can be found in Statistical Table A3.2, available at https://www.rba.gov.au/statistics/tables/xls/a03-2hist.xlsx.

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