Bulletin

JUNE 2019

RESERVE BANK OF AUSTRALIA

Bulletin

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Contents

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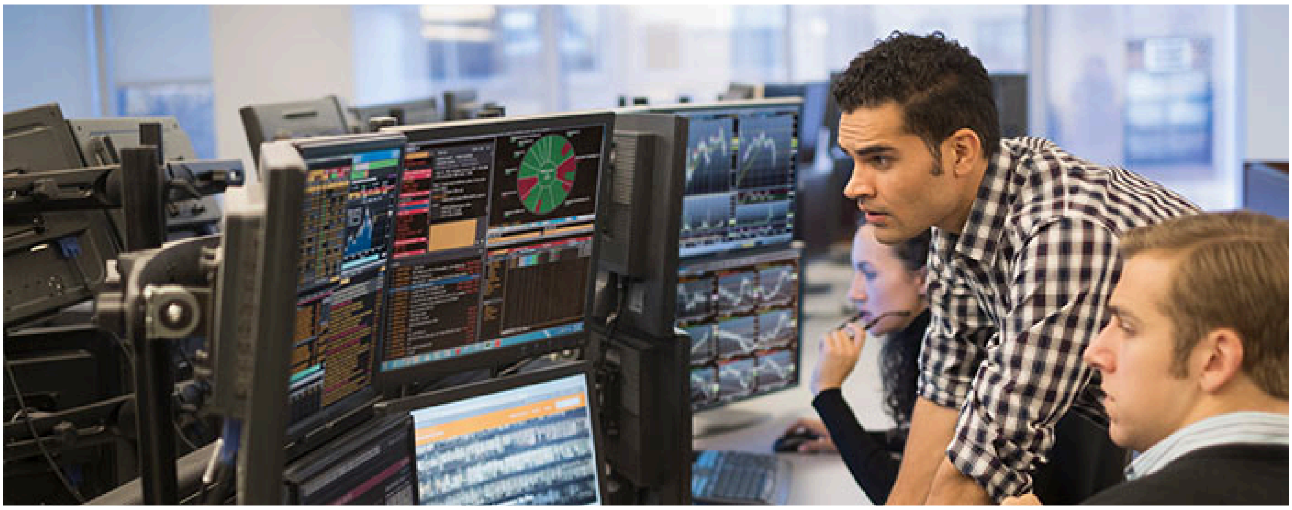
The Framework for Monetary Policy Implementation in Australia

Domestic Markets Department[*]



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Abstract

The Reserve Bank of Australia's domestic market operations are designed to ensure that the cash rate is consistent with the target set by the Reserve Bank Board. The most important tools to guide the cash rate to the target are the interest rate corridor and daily transactions to manage liquidity in the interbank overnight cash market. The RBA also ensures that there is sufficient liquidity in the cash market for it to function smoothly. This article provides an overview of the RBA's operational framework for implementing monetary policy.

The cash rate is an effective instrument for implementing monetary policy because it affects the broader interest rate structure in the domestic financial system. The cash rate is an important determinant of short-term money market rates, such as the bank bill swap rate (BBSW), and retail deposit rates (Graph 1). These rates – as well as a number of other factors – then influence the funding costs of financial institutions and the lending rates faced by households and businesses.[1] As a result, the cash rate influences economic activity and inflation, enabling the RBA to achieve its monetary policy objectives. However, while changes in the cash rate are very important, they are not the only determinant of market-based interest rates. Other factors, such as expectations, conditions in financial markets, changes in competition and risks associated with different types of loans are also important.

The Cash Market and the Interest Rate Corridor

The RBA implements monetary policy by setting a target for the cash rate. This is the interest rate at which banks lend to each other on an overnight unsecured basis, using the exchange settlement (ES) balances they hold with the RBA. ES balances are at-call deposits with the RBA that banks use to settle their payment obligations with other banks.

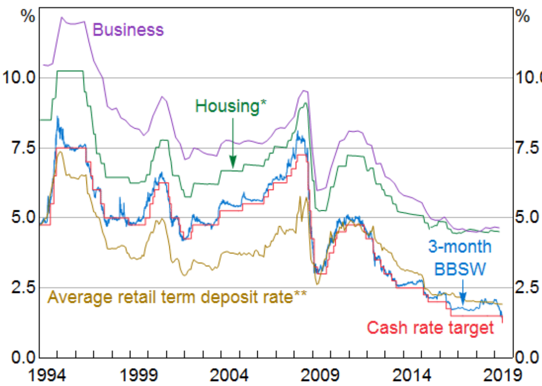
Banks are required to have a positive (or zero) ES balance at all times, including at the end of each day.[2] It is difficult for institutions to predict whether they will have adequate funds at the end of any particular day, which generates the need for an interbank overnight cash market. Those banks that need additional ES balances after they have settled all payment obligations of their customers, borrow from banks with surplus ES balances. The interbank cash market is the mechanism through which these balances are redistributed between participants.

The RBA sets the supply of ES balances to ensure that the cash market functions smoothly by providing an appropriate level of ES balances to facilitate the settlement of interbank payments. The RBA manages the supply of ES balances available to the financial system through its open market operations (see below). Excessive ES balances could lead institutions to lend below the target cash rate, while a shortage might result in the cash rate being bid up above the target.

The interest rate corridor ensures that banks have no incentive to deviate significantly from the cash rate target when borrowing or lending in the cash market. Banks can borrow ES balances overnight on a secured basis from the RBA at a margin set 25 basis points above the cash rate target. As a result, banks have no need to borrow from other banks at a higher rate. Similarly, banks receive interest on their surplus ES balances at 25 basis points below the cash rate target. Therefore, they have no incentive to lend to other banks at a lower rate.

Graph 1

Interest Rates



* To May 2015, RBA estimates based on advertised rates; data from Securitisation System thereafter

** RBA estimates

Sources: APRA; banks' websites; Bloomberg; Canstar; RBA; Securitisation System

The operation of the interest rate corridor means that there is no need for the RBA to adjust the supply of ES balances to bring about a change in the cash rate (Graph 2 and Graph 3). For example, when the RBA *lowered* the cash rate target by 25 basis points from 1.5 per cent to 1.25 per cent in early June, the rates associated with the corridor also moved lower, to be 1.0 per cent on overnight deposits and 1.5 per cent on overnight loans (down from 1.25 per cent and 1.75 per cent). A bank that would have previously required a return above 1.25 per cent to lend ES balances in the cash market is, under the new corridor, willing to lend at a lower return. And so a bank wanting to borrow cash pays a lower rate than before. Similarly, if the RBA had instead *raised* the cash rate by 25 basis points from 1.5 per cent, the corridor would have moved up, to be 1.5 per cent to 2.0 per cent. A bank that would have previously lent surplus ES funds to another in the cash market at 1.50 per cent would, under the new corridor, no longer have an incentive to do so. Indeed, it would require a higher return to lend ES balances, rather than leaving those funds in its ES account and receiving 1.50 per cent from the RBA. Hence, a bank wanting to borrow in the cash market would have to pay a higher interest rate than it did previously.

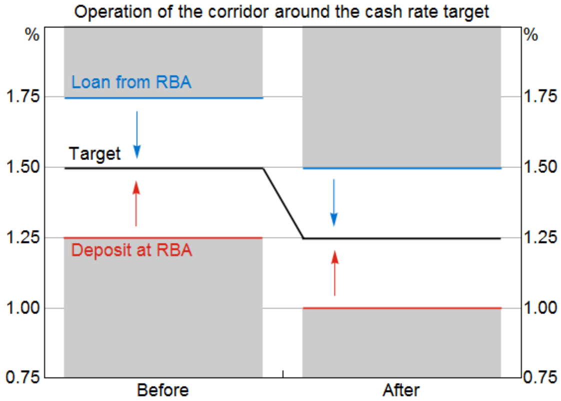
In other words, interbank transactions automatically occur within the interest rate corridor without the RBA needing to undertake transactions beyond its usual market operations to manage liquidity.[3]

The incentives underlying the corridor guide the cash rate to the target and ordinarily all transactions occur at the rate announced by the RBA. The last time there was a small deviation in the published cash rate (which is a weighted average of all transactions in the cash market) from the target (of 1 basis point for two days) was in January 2010 (Graph 4).[4] The lack of deviation of the cash rate from the target has brought about a self-reinforcing market convention where both borrowers and lenders in the cash market expect to transact at the prevailing target rate. This market convention helps to address the uncertainty that banks would otherwise face about the price at which they can borrow sufficient ES balances to cover their payment obligations each day. In 2018, daily transactions in the overnight interbank market were typically between $3 billion and $6 billion.

Graph 2

Monetary Policy Easing

Operation of the corridor around the cash rate target

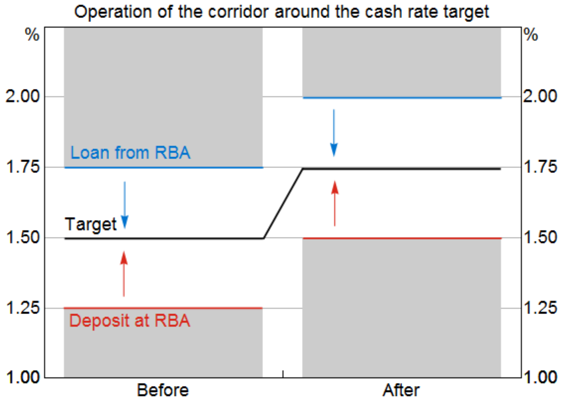


Source: RBA

Graph 3

Monetary Policy Tightening

Operation of the corridor around the cash rate target

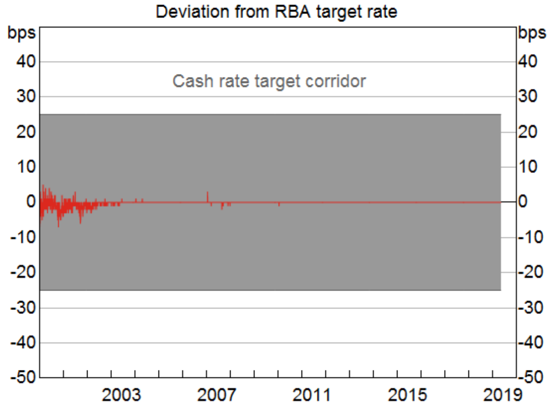


Source: RBA

Graph 4

Cash Rate

Deviation from RBA target rate



As in Australia, many other central banks implement monetary policy with an interest rate corridor to guide the policy rate. The width of the corridor tends to differ, typically from 50 to 200 basis points. The choice of the width of the corridor is seen as a reflection of a trade-off between interest rate control and the desire to avoid the central bank becoming an intermediary in the money market. All other things being equal, cross-country studies suggest that a narrower corridor is preferred by central banks that have a strong preference for low volatility of short-term interest rates, whereas a wider corridor is usually preferred by central banks that seek to encourage more interbank trading activity.[5]

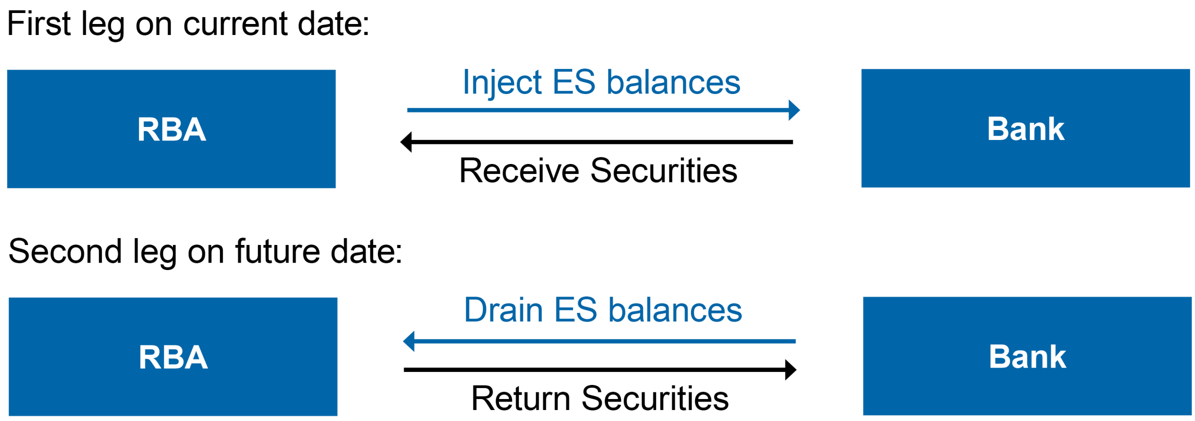
Over the past 10 years, many central banks (other than the RBA) have significantly expanded their balance sheets. This has resulted in significantly more liquidity in their respective systems and so banks typically do not need to borrow funds in the overnight cash market. In these cases, the policy rate typically converges toward the rate on deposits paid by the central bank; this is often referred to as a 'floor system'. Small changes in liquidity in such a system do not tend to have much effect on the policy rate.

Liquidity Management and Open Market Operations

Transactions between the government (which banks with the RBA) and the commercial banks would, by themselves, change the supply of ES balances on a daily basis.[6] ES balances in accounts of commercial banks increase whenever the government spends out of its accounts at the RBA. Similarly, when the government receives cash into its accounts at the RBA, such as from tax payments or debt issuance, ES balances decline.[7] The RBA monitors and forecasts these changes actively through the day. It offsets (i.e. 'sterilises') these changes in ES balances with its daily open market operations so that government receipts and payments do not affect the aggregate level of ES balances. If transactions that affect system liquidity were not offset by the RBA, ES balances would be much more volatile and the payments system would suffer frequent disruptions (Graph 5).

Figure 1

Repurchase Agreement



Source: RBA

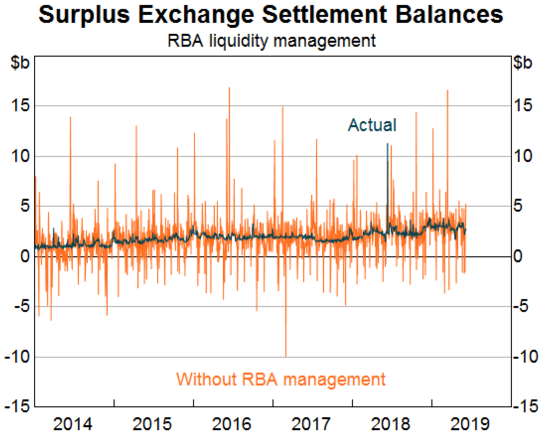
Ultimately this is likely to lead to a more volatile cash rate.

The main tools used in open market operations are repurchase (repo) agreements and foreign exchange swaps. Both repos and foreign exchange swaps involve a first and a second leg (Figures 1 and 2):[8]

- The first leg of a typical repo in open market operations (which injects ES balances) involves the RBA providing ES balances to a bank and the bank providing eligible debt securities as collateral to the RBA. Taking collateral safeguards the RBA against loss in the case of counterparty default. The second leg, which occurs at an agreed future date, unwinds the first leg: the bank returns the ES balances and the RBA returns the securities to the bank.
- The first leg of a foreign exchange swap designed to inject ES balances into the system involves the RBA providing ES balances to a bank and the bank providing collateral in the form of foreign currency to the RBA (typically US dollars, euros or Japanese yen). The second leg, at the agreed future date, consists of the bank returning the ES balances and the RBA returning the foreign exchange.

Graph 5

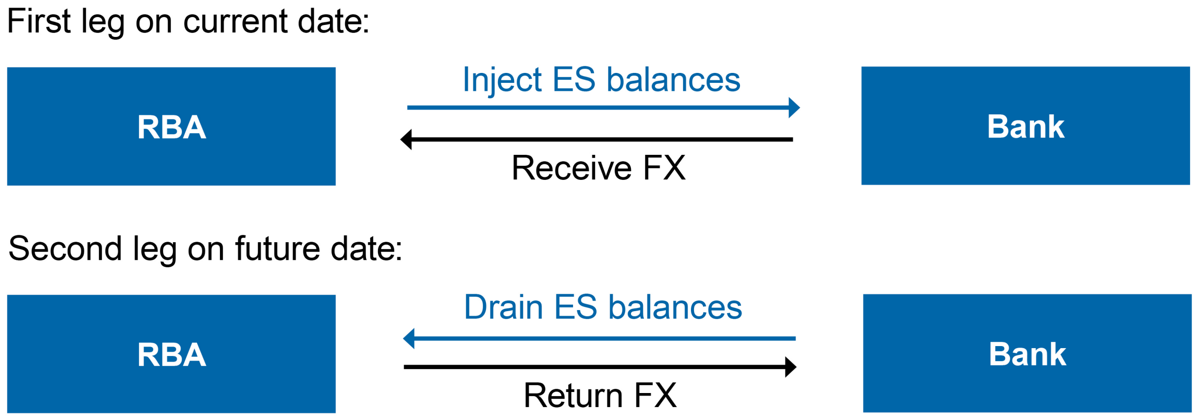
Surplus Exchange Settlement Balances



Source: RBA

Repos and swaps provide more flexibility for liquidity management than outright purchases or sales of assets since they involve a second leg (when the transaction unwinds) with a date chosen to support liquidity management on that day. It also allows the RBA to accept a much broader range of collateral, such as unsecured bank paper, than it would be willing to purchase outright.[9] By contrast, buying (and then selling) securities outright requires the RBA to take on the price and liquidity risk associated with owning the assets outright. Conducting open market operations by buying and selling government securities outright, while also ensuring that the RBA's market operations do not affect liquidity in the bond market, would require more government securities than are available in Australia.

Figure 2
Foreign Exchange Swap



Source: RBA

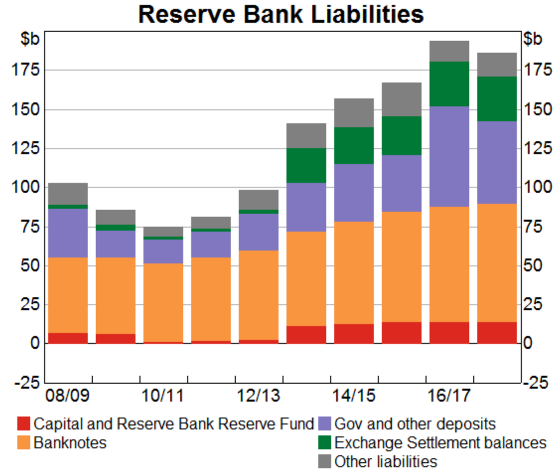
The size of daily open market operations is based on forecasts of daily liquidity flows between the RBA's clients (mainly the Australian Government) and the institutions with ES accounts. In a typical round of market operations, a public announcement is made at 9.20 am that the RBA is willing to auction ES balances against eligible collateral for a certain number of days (ranging from two days to several months, with an average term of around 30 days). Institutions have 15 minutes to submit their bid. The RBA ranks these bids from highest to lowest repo rate and then allocates ES balances to the highest bidders until the amount the RBA intends to auction has been dealt. All auction participants are informed electronically about their allocation. If they have been successful, they will pay the rate at which they bid for the amount allocated. The aggregate results of the auction, including the amount dealt, the average repo rate and the lowest repo rate accepted are published.

Market Operations and the RBA Balance Sheet

The transactions entered into as part of open market operations are reflected in changes in the RBA's balance sheet. Changes in the size and composition of liabilities (mainly issuance of banknotes and government deposits) may need to be offset via open market operations to ensure that the availability of ES balances remains appropriate for the smooth functioning of the cash market (Graph 6).

Open market operations affect the asset side of the balance sheet (Graph 7). When the RBA purchases securities under repo, it has a legal claim on the security that was transferred as collateral for the duration of the repo. These claims appear as assets on the balance sheet, along with outright holdings of domestic government securities.[10] When the RBA uses foreign exchange swaps to supply Australian dollars into the local market, the foreign currency-denominated investments associated with the swap are also reflected as assets on the balance

Graph 6
Reserve Bank Liabilities



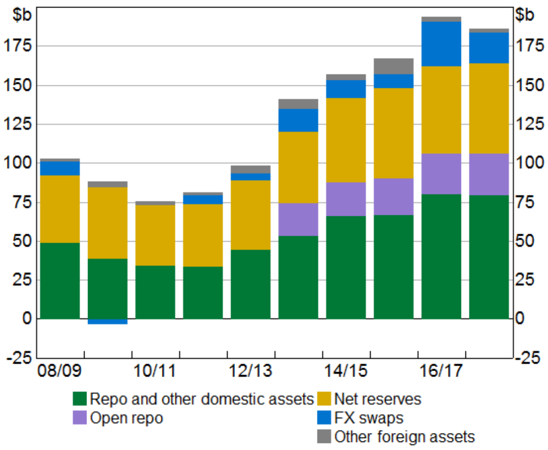
Source: RBA

sheet. The choice between using repo, foreign exchange swaps or outright purchases to adjust the supply of ES balances is determined by market conditions and pricing. When a large amount of ES balances needs to be supplied or drained, such as when a government bond matures, the RBA might choose to do so using a combination of instruments.

The RBA supplies ES balances not only for monetary policy implementation but also to facilitate the functioning of the payment system. Over recent years, the RBA has been providing more ES balances to banks to enable the settlement of payments outside normal banking hours, such as through direct-entry and the New Payments Platform. These ES balances are supplied under 'open repos'. An open repo is set up in a similar way to the repo explained in Figure 1, with the initial leg transferring ES balances to banks in return for eligible debt securities as collateral. However, the date of the second leg is not specified, so it is open ended. The ES balances are available (and the claim on

Graph 7

Reserve Bank Assets



Source: RBA

securities remain on the RBA's balance sheet) until the open repo is closed out. These ES balances provided under open repo are held purely to facilitate the effective operation of the payments system after hours and cannot be lent overnight in the cash market. As a result, they have no implications for the implementation of monetary policy. Currently, these balances are around $27 billion. The remainder of ES balances that are available for trading in the cash market are referred to as 'surplus ES balances', and are the focus of daily open market operations. Recently, surplus ES balances have been around $2–3 billion. This amount has increased in recent years as demand for balances has risen, partly in response to new prudential regulations on liquidity.

Summary

The RBA's operations in domestic markets support the implementation of monetary policy. The most important tool to guide the cash rate to the target set by the Board is the interest rate corridor. To support this, the RBA pursues daily open market operations in order to keep the pool of ES balances at the appropriate level for the cash market to function smoothly. The daily market operations are conducted to offset the effects on liquidity of the many transactions between the banking system and the Australian Government. Open market operations are primarily conducted through repos and FX swaps. These provide flexibility for liquidity management and also help to manage risk for the RBA's balance sheet.

The cash rate is a key determinant of interest rates in domestic financial markets and hence underpins the structure of the interest rates that influence economic activity and financial conditions more generally. ✠

Footnotes

[*] A number of staff from Domestic Markets Department contributed to this article.

[1] In addition to the transmission of the cash rate to interest rates faced by households and businesses there are also other transmission channels of monetary policy, such as the exchange rate or wealth effects from asset price changes. For a discussion see Atkin and La Cava (2017).

[2] In order to smooth settlement of payment obligations during the day, banks have access to intra-day liquidity from the RBA to ensure that their ES balances remain non-negative at all times.

[3] For detailed explanations see Becker and Woon (2019).

[4] The introduction of the announcement of the cash rate target to markets in 1990 played a significant role in

reducing volatility in the overnight cash market (see Battellino, Broadbent and Lowe (1997)). The current corridor was introduced in 1997; in the first few years after its introduction, daily deviations of the cash rate from the target were still frequent (though typically less than before the introduction of the corridor). The volatility of the cash rate gradually diminished as the effectiveness of the corridor was tested and the new market convention was being established.

[5] Bindseil and Jablecki (2011).

[6] Other factors that can move ES balances are transactions the RBA undertakes on behalf of its other clients (such as foreign central banks), the sale and return of banknotes, and transactions the RBA undertakes on its own behalf (such as foreign exchange intervention); see Baker and Jacobs (2010) for further detail.

[7] Over the course of a financial year the cumulative sum of government payments, receipts and securities issuance broadly net out.

[8] For simplicity, the interest payments accruing to either party in a repo or a foreign exchange swap have not been spelled out in these figures.

[9] For a list of eligible collateral see the Technical Notes for Domestic Market Operations at https://www.rba.gov.au/mkt-operations/resources/tech-notes/eligible-securities.html. A wide range of institutions participate in open market operations, including some that do not participate in the overnight cash market because they do not have ES accounts with the RBA.

[10] The RBA purchases Australian Government Securities (AGS) on an outright basis in the year leading up to their maturity. This helps to offset the large increase in ES balances that would otherwise occur on the maturity date when the government repays bond holders. Because the government repays the RBA instead of a private bond holder on the day of maturity, there is no change to ES balances from the repayment of the RBA's outright holdings.

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Cash Withdrawal Symptoms

Luc Delaney, Aidan O'Hara and Richard Finlay[*]

Photo: Astrakan Images – Getty Images

Abstract

Most Australians don't have to travel more than a few kilometres to deposit or withdraw cash. Cash use is declining, however, and with it the number of ATMs and other cash access points. This trend seems likely to continue. While it will probably have relatively little impact on those living in metropolitan areas, it is important that reasonable access to cash services is maintained for people in regional or remote locations as long as such access is needed.

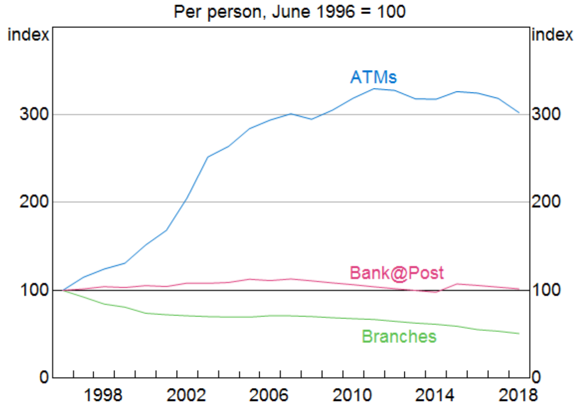
Background

The number of ATMs per person increased three-fold over the 15 years to 2011, although it has started to fall more recently (Graph 1). Meanwhile, the total value of cash withdrawals made via Australia's ATM network peaked a decade ago, and has fallen by around 20 per cent since then, while the number of daily withdrawals per ATM has been falling since the mid 1990s (Graph 2). This increase in ATM numbers, coupled with generally falling use, is likely to have reduced the economic viability of some machines and is likely to prompt further rationalisation of the ATM network in future. While a fall in the number of ATMs or other cash access points may be warranted from an efficiency perspective, it may raise public concerns if there were to be a significant decline in coverage that makes it difficult for people to access cash, particularly in regional or remote locations.

Graph 1

Cash Access Points

Per person, June 1996 = 100



Sources: ABS; APRA; AusPayNet; RBA

This article considers this distributional aspect of access to cash withdrawal and deposit services, making use of:

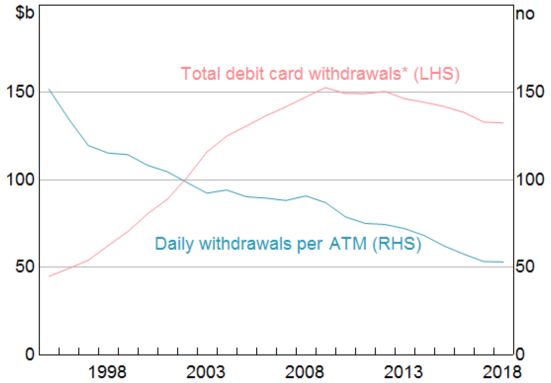
- the Australian Prudential Regulation Authority's (APRA's) Authorised Deposit-taking Institutions' (ADIs') Points of Presence publication, which gives the geographic coordinates of all ADI ATMs and branches, and all Australia Post Bank@Post outlets, as at June 2018;[1]
- data from independent ATM deployer Banktech on the location of its roughly 2,500 ATMs (accounting for around 15 per cent of independently deployed ATMs);[2] and
- the Australian Bureau of Statistic's (ABS's) Australian Population Grid 2017 release, which presents the population data from the 2016 Census in one square kilometre grids.

Figures 1 and 2 display these data to show where Australia's population and cash access points are respectively located; it's unsurprising to see that the two maps broadly mirror each other, with a high density of people and cash access points in the major cities and surrounding areas, and declining population and cash access points as the distance from the major metropolitan areas increases.

In addition to the APRA and Banktech data, we use partial data on the location of an additional 6,000 or so independent deployer ATMs located outside of metropolitan areas as obtained from the Google Maps platform, although we note that this data-gathering method is imperfect and may under- or over-represent the true number of ATMs

Graph 2

ATM Withdrawals



* 12-month ended

Sources: AusPayNet; RBA

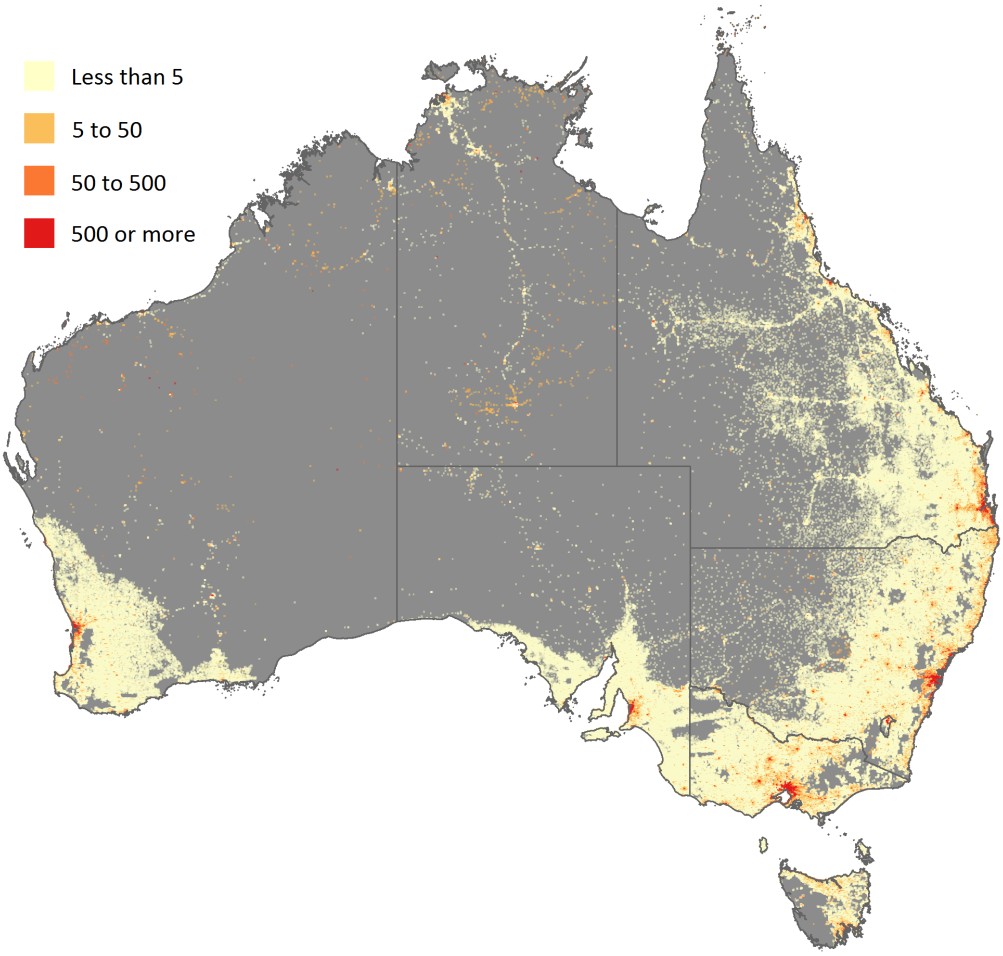
somewhat.[4] Overall, and despite the likelihood that we are not capturing all cash access points, our data suggest that the vast majority of Australians have good access to cash withdrawal and deposit services. It will be important to monitor this over time, however, given that the number of ATMs and ADI branches has been falling. It is important to note that these findings relate only to the distributional aspect of cash access; the cost of cash access is not considered. While the cost of cash access is not an issue for most Australians, there are some communities where it has been a major concern. See Box A for a discussion of the joint RBA-Treasury ATM Taskforce, which worked with banks and independent ATM deployers to ensure fee-free access to cash for many remote Indigenous communities.

Access to Cash Withdrawal and Deposit Services

Most people can withdraw cash without having to travel very far, with an estimated 95 per cent of Australians living within 4 kilometres of an identified ATM, ADI branch, or Australia Post Bank@Post outlet, and 99 per cent of people living within 15 kilometres as at June 2018 (Table 1 and Graph 3; note that Graphs 3 and 4 plot the cumulative distribution function of the distance to cash withdrawal and deposit locations, respectively, for the Australian population; that is, they show what share of the population (vertical axis) lives within a certain distance (horizontal axis) of a cash withdrawal or deposit location).[5] For most people, especially those living in cities, ATMs are the closet cash withdrawal point, with 95 per cent of Australians living within 6 kilometres of an identified ATM. For those living in more remote areas, however, our data suggest that Bank@Post outlets rather than ATMs or ADI branches may be the closest access point for cash: if one ranked the Australian population on the distance to the nearest cash access point, the person who had to travel further than 99 per cent of all other Australians would be an estimated 24 kilometres from their nearest ATM and 29 kilometres from the nearest ADI branch, but only 18 kilometres from their nearest Bank@Post outlet (Table 1).

Figure 1: Population Density

People per square kilometre



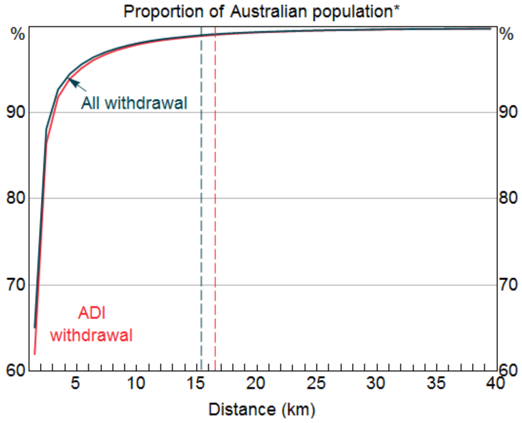
Sources: ABS; RBA

Focusing on just ADIs, for which we have two years of data, access as measured by the distance the

Graph 3

Distance to Cash Withdrawal Point

Proportion of Australian population*



* The dashed line represents the 99th percentile

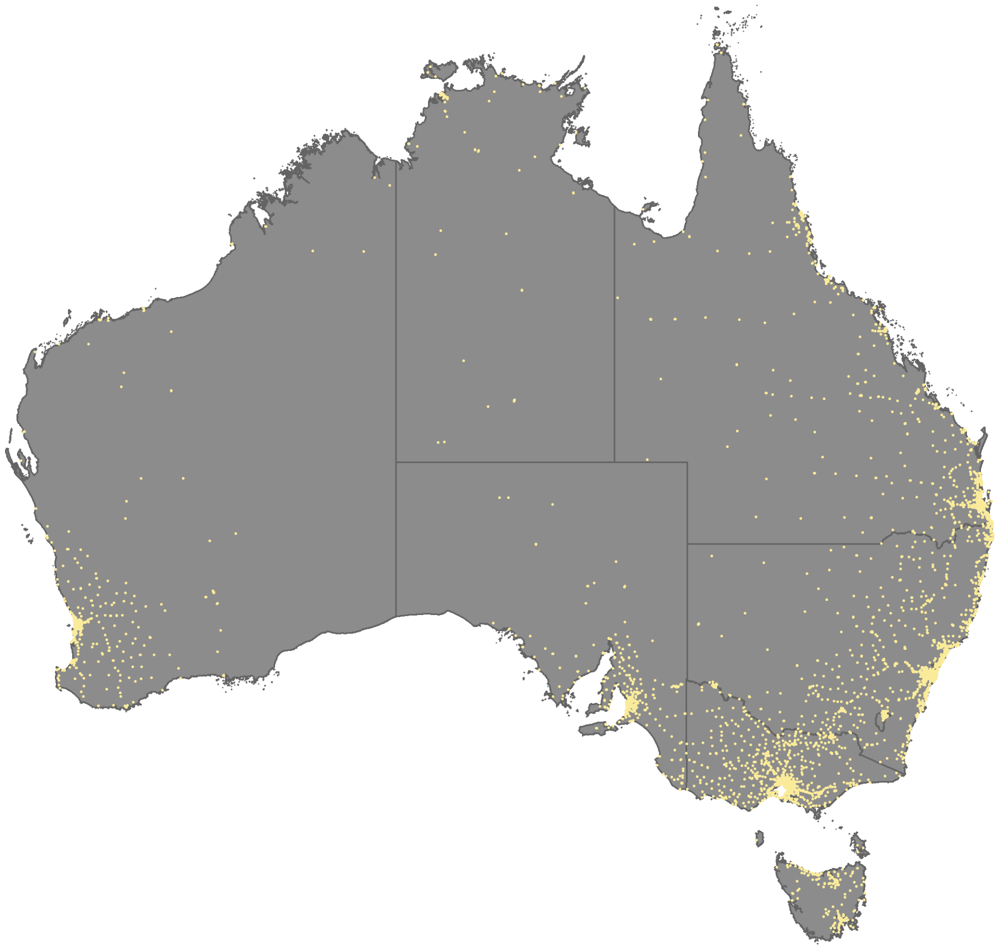
Sources: ABS; APRA; Banktech; Google; RBA

95th and 99th percentile person had to travel to withdraw cash remained largely unchanged over the year to June 2018 according to the APRA data, despite the closure of a net 1,466 withdrawal locations.[6] This suggests that the discontinued locations were mostly located in areas with other cash access points close by.

Most Australians can also deposit cash without having to travel too far, with an estimated 95 per cent of the population living within 5 kilometres of a deposit location (defined as branches and Bank@Post outlets) and 99 per cent living within 17 kilometres as at June 2018 (Table 1 and Graph 4). While some ATMs allow people to deposit cash, these machines are typically located at bank branches.

Figure 2: Cash Access Points

Branches, ATMs and Bank@Post



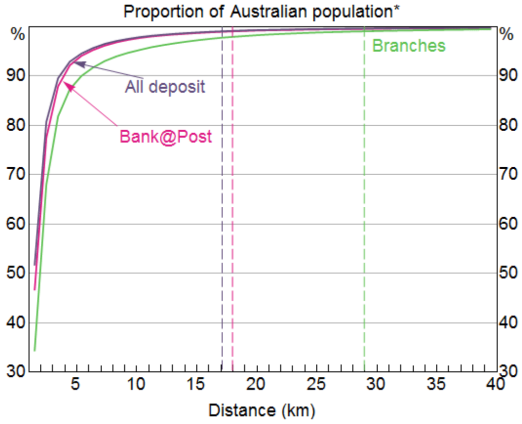
Sources: APRA; Banktech; RBA

Despite the APRA data showing the closure of a net 290 deposit locations over the year to June 2018, deposit access as measured by the distance to the nearest deposit location for the 95th and 99th percentile person appears to have remained largely unchanged, with an increase in distance to branches offset by a small fall in distance to Bank@Post outlets. This suggests an increase in the efficiency with which deposit locations are distributed, and that closures have for the most part occurred in areas with other deposit locations relatively close by.[7] One year is a relatively short period over which to measure changes in access to cash, however, and it will be important to monitor access over coming years.

Graph 4

Distance to Cash Deposit Point

Proportion of Australian population*



* The dashed line represents the 99th percentile

Sources: ABS; APRA; RBA

Branches, Bank@Post, and rural access to cash services

One striking feature of Table 1 and Graph 4 is that despite there being only around half as many

Box A
Fee-free ATM Services in Remote Indigenous Communities

Introduction

In 2010 the Treasury and the Reserve Bank, in collaboration with participating banks and independent ATM deployers, launched the ATM Taskforce investigation (Treasury and RBA, 2011). The investigation was, in part, prompted by reports of high ATM fees being paid by members of some Indigenous communities in very remote parts of Western Australia, Queensland, South Australia and the Northern Territory. The goal of the taskforce was to find ways to make access to cash more affordable in these communities.

The taskforce found that people living in remote Indigenous communities tended to pay significantly more in ATM fees than those in urban Australia. This reflected a number of factors:

- Unlike in urban areas, there were often no fee-free bank-owned ATMs in remote communities. Rather, many communities contained only one fee-charging ATM, operated by an independent ATM deployer (with the fee income generated by the ATM an important incentive for service provision in these very remote areas).
- Transaction fees for cash out with a card purchase were often also levied, with reports of fees as high as $5 per $50 withdrawal (Financial Counselling Australia, 2010).
- Community members often made repeated balance enquiries and small withdrawals, both of which attracted fees. The ATM Taskforce report noted that this behaviour was driven in part by a lack of financial literacy and, in part, out of necessity (for example due to irregular payments into and out of accounts, and a desire to not hold large amounts of cash).

As a result of this, it was not unusual for community members to incur ATM fees of $20 to $40 on Centrelink payment days.

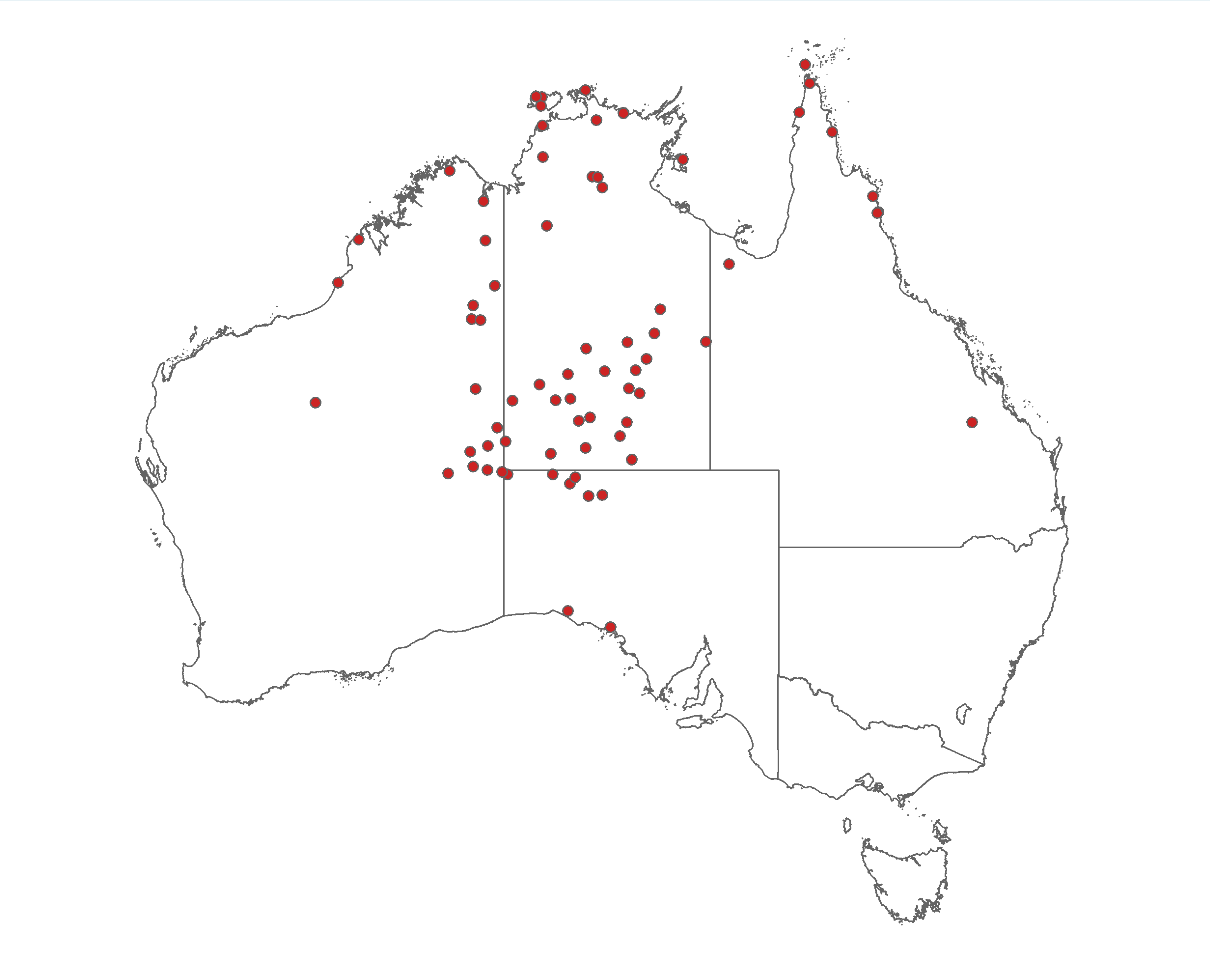
The Program

In 2012, following a recommendation of the taskforce, the banking industry launched a 5-year initiative to provide fee-free ATMs to very remote Indigenous communities (Figure A1). The criteria for participation in the initiative were that:

- the ATM is in a very remote Indigenous community as defined by the ABS;
- the ATM is located in a community store (which cannot also provide alcohol or gambling services); and
- the community lacks access to alternative banking services such as bank or credit union branches, ATMs or Bank@Post outlets.

Independent ATM deployers that provide ATMs to the remote communities covered by the initiative can still charge fees to cover their costs, but participating commercial banks – rather than community members – reimburse the ATM operators for the usual withdrawal and balance check fees. With 12 per cent of Indigenous Australians living in very remote Australia, this initiative is important in ensuring equitable cash access for people living in those communities. The original agreement to provide fee-free ATMs has expired, but participating institutions have extended the current arrangements and are working towards renewing the agreement for a further five years.

Figure A1: Taskforce Fee-free ATM Locations



Sources: ABA; Open Street Maps; RBA

Bank@Post outlets as ADI branches, Bank@Post provides broader geographic coverage than the combined branches of Australia's ADIs. This reflects commercial banks and other ADIs for the most part locating their branches and ATMs in relatively populous areas that can service more customers (that is, in cities and larger towns). Australia Post on the other hand arranges its network of post offices to deliver broad geographic coverage. Indeed, this is mandated by the *Australian Postal Corporation Act 1989* which requires that the mail service be 'reasonably accessible to all people in Australia on an equitable basis', which the *Australian Postal Corporation (Performance Standards) Regulations 1998* in turn interprets to mean that, in non-metropolitan areas, at least 85 per cent of residents be located within 7.5 kilometres of a postal outlet. It is important to note, however, that this universal service obligation relates to the postal service, not Bank@Post, and so the ongoing financial viability of Bank@Post will be a major determinant in Australia Post continuing to provide this service in future (Australia Post, 2019).

Reflecting this wider geographic spread, Australia Post's Bank@Post service is the only in-person banking facility within a reasonable distance for many Australians living in regional or remote areas. For example, in regional New South Wales we identified 17 Bank@Post outlets which are 50 kilometres or further from the nearest ADI branch, shown as red dots in Figure 3; for the country as a whole, we identified 90 Bank@Post

Table 1: Australians' access to cash services

	June 2018			Change from June 2017		
	Distance in kilometres[(a)]		Number[(b)]	Distance in kilometres[(a)]		Number[(b)]
	95 per cent	99 per cent		95 per cent	99 per cent	
ADI deposit[(c)]	5	17	10,195	0.0	–0.1	–290
ADI branches[(d)]	10	29	6,630	0.3	1.0	–277
Bank@Post outlets	6	18	3,565	0.0	–0.1	–13
ADI withdrawal[(e)]	5	16	22,834	0.0	–0.1	–1,466
ADI ATMs	9	35	12,639	0.0	0.4	–1,176
Memo: non-ADI ATMs						
All identified withdrawal points[(e)]	4	15				
All identified ATMs	6	24				

(a) Distance within which 95 per cent and 99 per cent of Australia's usual resident population lives, to nearest kilometre

(b) Total number of access points of given type

(c) Deposit locations are branches and Bank@Post outlets (some ATMs also have deposit capabilities, but these tend to be located in branches)

(d) ADI branches includes 'other face-to-face' outlets but excludes Citibank branches, which are cash-free

(e) Withdrawal locations are ATMs, branches and Bank@Post outlets

Sources: ABS; APRA; Banktech; Google; RBA

outlets that are 50 kilometres or further from the nearest ADI branch (Figure 4).

Defining towns as all urban centres and localities in Australia with populations greater than 1,000 people (which excludes around 500,000 Australians living in localities of fewer than 1,000 people), we found only 47 towns that did not have a branch, Bank@Post outlet or ATM as at June 2018 (Figure 5). Further, all of these towns had at least three cash access points within a 20 kilometre radius, suggesting that even the removal of one or two access points would not leave these communities without some access to cash. As we do not have an exhaustive list of ATMs or retail cash-out access points in Australia, it is likely that there are even fewer towns without close cash access.

More generally, the current network of cash access points appears to be relatively robust. The removal of the closest access point results in a relatively modest increase in distance to the next closest point for most people, although the additional distance grows as more cash access points are removed (Graph 5). Of course, this assessment is based on data from June 2018 and would need to be revisited if the number of cash access points were to fall significantly.

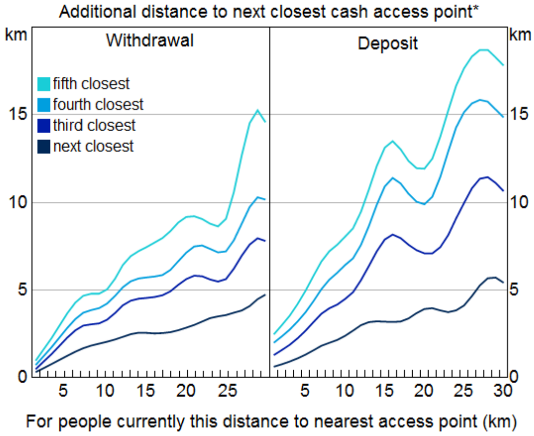
The other 1 per cent

While an estimated 99 per cent of the population has a cash withdrawal location within 15 kilometres (and a cash deposit location within 17 kilometres), the other 1 per cent – about 250,000 people – need to travel more than 15 kilometres to their nearest cash access point. These people live in rural areas, where cash use also tends to be higher and infrastructure that might enable alternative payment methods, such as mobile phone coverage, tends to be less developed, so it will be important to

Graph 5

Robustness of Cash Access

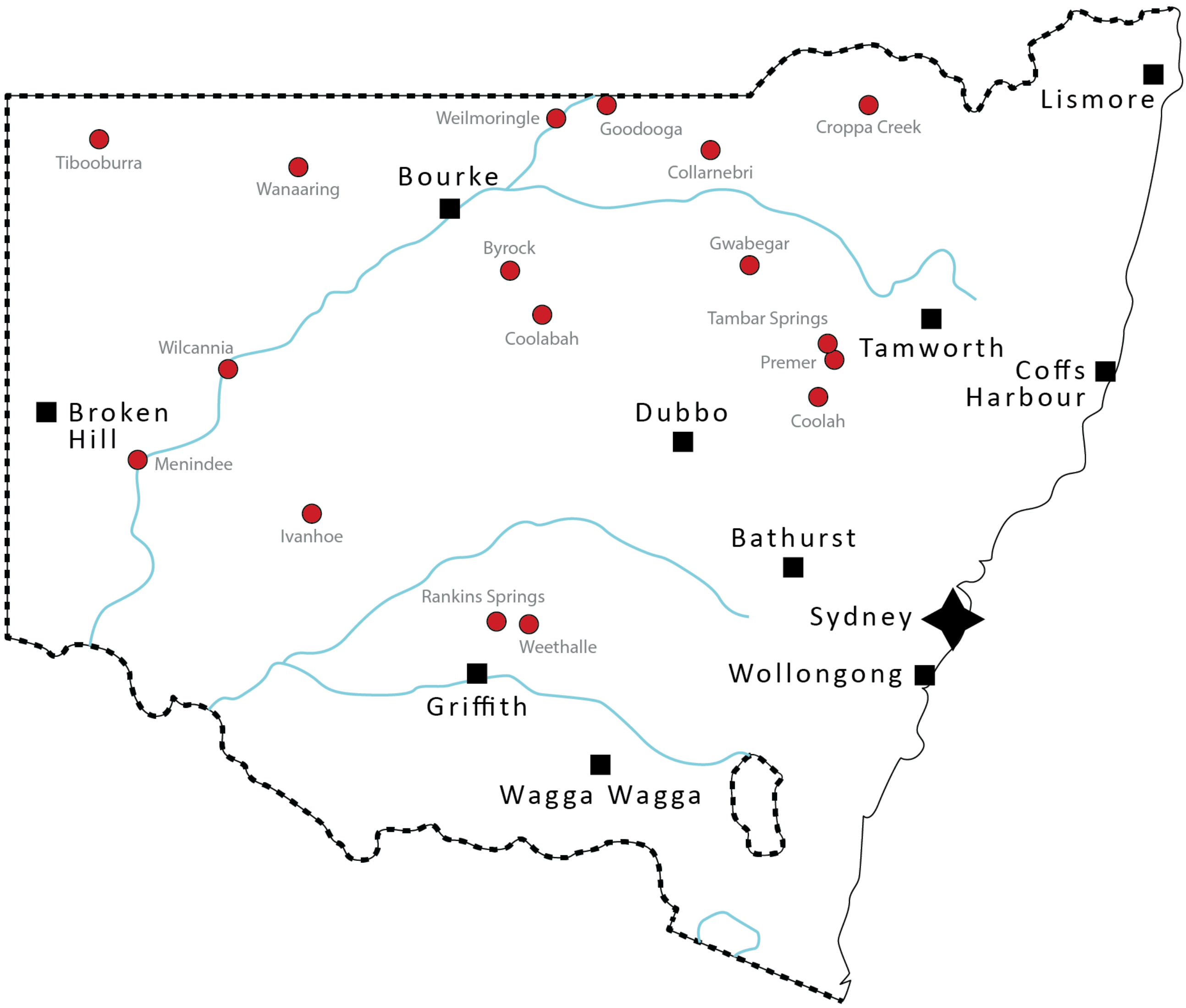
Additional distance to next closest cash access point*



* Population weighted; smoothed

Sources: ABS; APRA; Banktech; Google; RBA

Figure 3: NSW Bank@Post Outlets Further than 50 Kilometres from Nearest ADI Branch



Sources: APRA; RBA

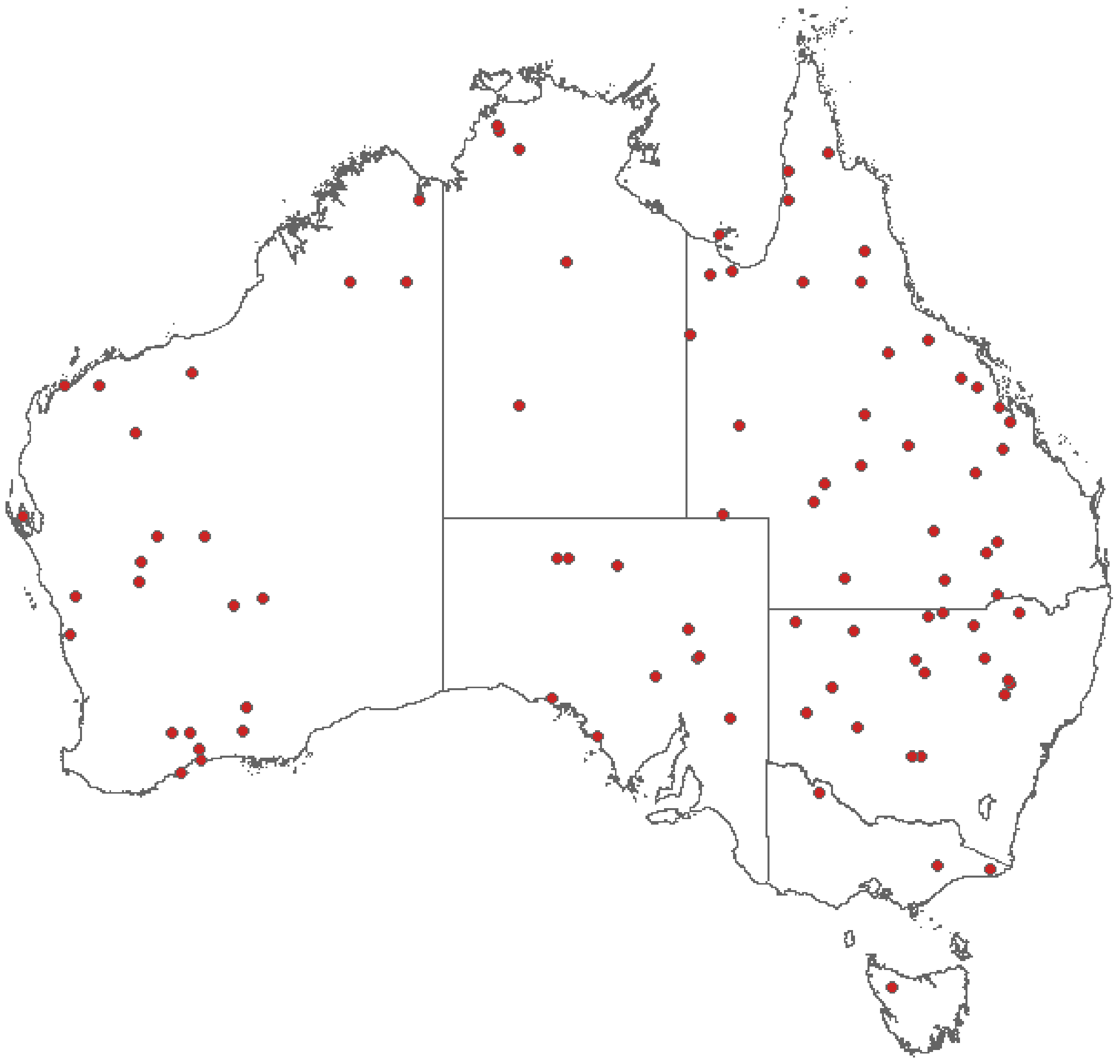
monitor their access over time (Figure 6; see Box B for more information regarding which demographic groups tend to use cash relatively more).

Looking Forward

Australians appear to have relatively good access to cash services, especially given the size of the Australian landmass. For example, only 0.5 per cent of the Australian population live further than 25 kilometres from their nearest cash withdrawal point, and 0.5 per cent live further than 25 kilometres from a deposit location. By comparison, in Sweden – the third-largest country by land size in western Europe, but nonetheless 17 times smaller than Australia – the government's Riksbank Committee recommended that a maximum of 0.3 per cent of the population should have to travel more than 25 kilometres to withdraw cash, and a maximum of 1.2 per cent of the population should have to travel more than 25 kilometres to deposit cash (Swedish Government, 2018).

Looking to the future, it seems likely that the number of ATMs deployed in Australia will continue to fall. As discussed by Mitchell and Thompson (2017) and Richards (2018), to the extent that this occurs in metropolitan areas that are already well served by ATMs, and/or it occurs alongside the creation of a so-called 'ATM utility' that pools ATMs from a number of financial institutions under a single operator, this is probably to be expected and need not be a concern. Indeed, the establishment

Figure 4: Bank@Post Outlets Further than 50 Kilometres from Nearest ADI Branch

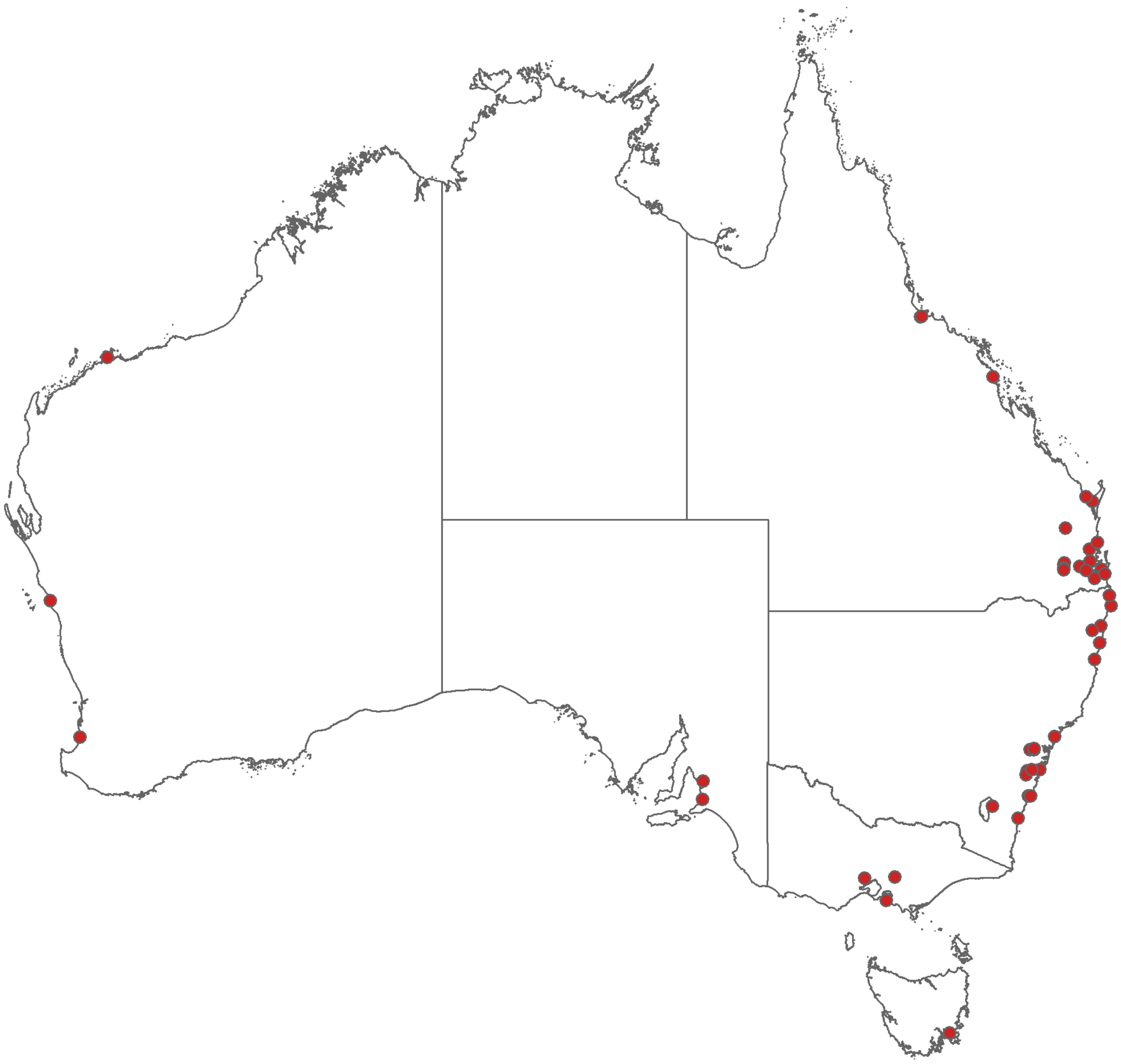


Sources: APRA; RBA

of an ATM utility could prove desirable from an efficiency and accessibility viewpoint if it sought to remove duplicate machines from over-serviced locations and increase provision in under-serviced locations. However, cash access could become a significant issue in regional and remote communities, where the cost of providing ATM services is highest, people tend to rely on cash more, and alternative banking services are often less accessible.

Focusing on the ability to deposit cash, which is important to businesses as well as households, our analysis suggests that, for many regional and remote communities, Australia Post's Bank@Post service is the only reasonably accessible cash deposit point. Although government owned, Australia Post is required to make a commercial rate of return and be self-funded, and so the ongoing financial viability of Bank@Post will be important to the continued existence of this service (Australia Post, 2019). ✠

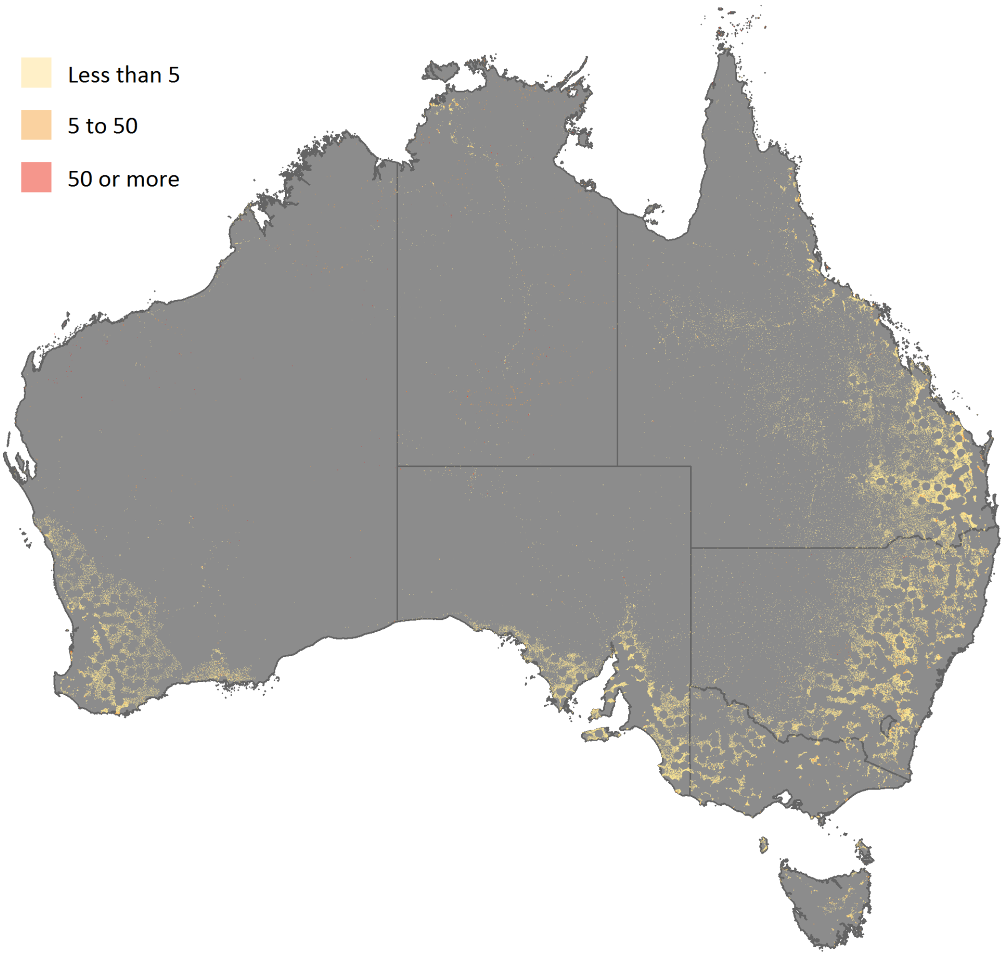
Figure 5: Towns without a Cash Access Point



Sources: APRA; Banktech; RBA

Figure 6: Population with Least Access to Cash

People per square kilometre needing to travel more than 15 km to access cash

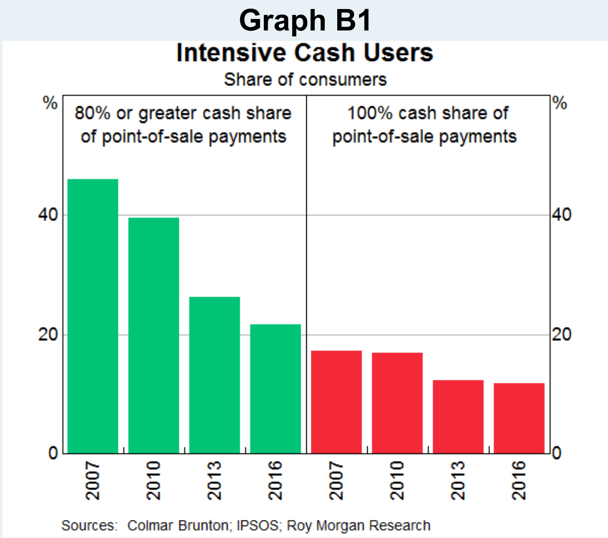


Sources: ABS; APRA; Banktech; RBA

Box B
The Demographics of Intensive Cash Users

Introduction

While cash use at the point of sale has been falling for several years, the Bank's 2016 Consumer Payments Survey indicated that around 20 per cent of Australians used cash for more than four-fifths of their in-person purchases, and 12 per cent of Australians relied on cash for all in-person purchases (Graph B1)[8]. Although the share of people falling into each of these groups has declined over the past decade, there remains a group of citizens who strongly prefer, or need, to use cash.



Demographics of High Cash Users

While many different types of people are intensive cash users, they are disproportionately likely to be older, poorer and less-educated than average. They also tend to reside in regional areas and are less likely to be employed, and a disproportionate share do not regularly access the internet (Table B1).

Table B1: Cash use among different groups

Per cent of consumers in that group who use cash for more than 80 per cent of in-person payments

Age	
Less than 65	18
65 and over	35
Income	
Bottom half of distribution	32
Top half of distribution	12
Highest level of education obtained	
Year 12 or below	30
Trade, apprenticeship, diploma or certificate	23
Bachelor degree or above	12
Area of residence	
Metropolitan	18
Regional	29
Employment status	
Employed	13
Not employed[(a)]	28
Retired	37
Internet	
Regularly access the internet	19
Do not regularly access the internet	57

(a) Employed persons worked full time, part time, or were self-employed; not employed includes the unemployed, students, and others not in the workforce but not retired.

Sources: Authors' calculations based on data from Ipsos

Footnotes

[*] The authors are from Note Issue Department and would like to thank James Caddy, Lowenna Clemence, Nicolas Rebuli, Tony Richards and Max Wakefield for their help and suggestions.

[1] ADIs include banks, credit unions, and building societies. More than 70 ADIs offer deposit and withdrawal services through Bank@Post.

[2] Other independent ATM deployers were invited to contribute data on the location of their ATMs but declined.

[3] The maps in this article are © OpenStreetMap contributors; see <https://www.openstreetmap.org/copyright> for further information. The APRA points of presence data are available from <https://www.apra.gov.au/publications/authorised-deposit-taking-institutions-points-presence>.

[4] While Google Maps provides a valuable additional data source on the location of ATMs not otherwise captured, we cannot be sure that all such ATMs have been located, or that ATMs listed as existing in Google Maps have not subsequently been removed. The existence of a 'cash-out' option when one pays by card at some retail outlets is another potential source of cash access. We do not have comprehensive data on the locations of retailers providing cash out with a card purchase, but we have identified the locations of the major supermarket and service station chains, which provide this option, and incorporating these partial data does not change our results.

[5] Note that all distances in this article are calculated as the shortest distance between two points, i.e. as the crow flies.

[6] The 95th percentile person is the person who has to travel further than 95 per cent of all other Australians (but less distance than 5 per cent of Australians) to access cash, with the 99th percentile person similarly defined.

[7] It is worth noting that the Australian Banking Association's Branch Closure Protocol calls for member banks to give 24 weeks' notice to customers in the event that a branch is closed and alternative face-to-face banking services within 20 kilometres are not available (Australian Banking Association, 2015).

[8] See also (Doyle *et al* 2017).

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Bank Fees in Australia

Susan Black, Dmitry Titkov and Lydia Wang[*]

Photo: SammyVision – Getty Images

Abstract

The Reserve Bank has conducted a survey on bank fees each year since 1997. Banks' overall income from fees was little changed in 2018. The removal of ATM withdrawal fees by a number of banks reduced total fees charged to households. However, this was largely offset by the continued increase in fee income from small businesses, reflecting strong growth in credit card and debit card transactions.

Overall, Bank Income from Fees Was Little Changed in 2018

The Reserve Bank's annual bank fee survey provides information on the fees charged by banks' Australian operations.[1] The survey focuses on fee income from the provision of loans, deposit services and payment services. The 2018 survey included 16 institutions, capturing 90 per cent of the Australian banking sector by balance sheet size.[2] Fee income from operations outside of Australia and other fee income obtained through funds management and insurance operations were not covered by the survey. This article summarises the results from the latest survey, covering banks' financial years ending in 2018.[3]

In 2018, domestic banking fee income was little changed, partly reflecting subdued growth in lending assets and deposits (Table 1). The ratios of fees to assets and deposits remained flat (Graph 1). A decrease in fee income from households was largely offset by an increase in fee income from small businesses. Fees charged to households accounted for around one-third of banks' fee income; fees charged to businesses accounted for the remainder.

Fee income from households decreased …

Bank fees charged to households decreased by 7 per cent in 2018, after having grown moderately in recent years. Fee income from households continued to be largely made up of fees on credit cards (41 per cent), housing loans (28 per cent) and deposits (22 per cent). The decrease in fee income in 2018 was primarily driven by a significant decrease in fee income from household deposits (Table 2; Graph 2). Fee income from housing loans

Table 1: Banks' Fee Income

	Households		Businesses		Total	
	Level $ million	**Growth** Per cent	**Level** $ million	**Growth** Per cent	**Level** $ million	**Growth** Per cent
2015	4,357	4.4	8,145	3.5	12,502	3.8
2016[(a)]	4,349	–0.2	8,250	1.3	12,598	0.8
2017	4,481	3.0	8,561	3.8	13,042	3.5
2018	4,189	–6.5	8,795	2.7	12,984	–0.4

(a) Fee income from households in 2016 was affected by a transfer of assets

Source: RBA

Table 2: Banks' Fee Income from Households

	2016 $ million	**2017** $ million	**2018** $ million	**Annual growth 2018** Per cent	**Average annual growth 2012–17** Per cent
Loans:	3,155	3,269	3,222	–1.5	2.7
– Housing	1,258	1,263	1,175	–7.0	1.0
– Personal[(a)]	331	336	341	1.5	0.4
– Credit cards	1,565	1,670	1,706	2.2	4.8
Deposits	1,123	1,138	912	–19.9	0.9
Other fees[(b)]	71	67	56	–17.1	–8.1
Total	4,349	4,481	4,189	–6.5	2.1

(a) Fee income from personal loans in 2016 was affected by a transfer of assets

(b) Includes banking-related fee income from households that cannot be directly related to an individual deposit or loan account (e.g. travellers' cheque or foreign exchange fees)

Source: RBA

also declined.[4] Fee income from credit cards continued to grow, though more slowly than in the past few years.

Fee income from deposit accounts fell by 20 per cent in 2018 largely owing to a number of banks, including the four major banks, abolishing the ATM withdrawal fees charged to cardholders from other financial institutions in late 2017 (Graph 3). The decline in fee income also reflected a decline in the number of ATM withdrawals. The decline of ATM use in recent years has been associated with a fall in the use of cash for transactions as consumers have been increasingly using electronic payment methods, particularly payment cards.[5]

Income from exception fees on transaction deposits – which include overdrawn, dishonour and honour fees – also decreased substantially. This owed to lower overdrawn fees, both because of reductions in unit fees on some accounts and fewer overdrawn accounts. Fee income from non-transaction deposit accounts was little changed.

Income from fees on housing loans decreased by 7 per cent in 2018. This was largely driven by lower volumes of new and refinanced housing loans over the year. The decline in fee income from housing loans also partly reflected reductions in unit fees on a number of products, with some banks waiving account servicing fees for customers with package arrangements. Fee income from personal loans remained stable.[6]

Fee income from credit cards continued to be the largest single source of banks' fee income from households. Credit card fees charged to households

Table 3: Unit Fees on Credit Cards[(a)]

	2016	2017	2018	Annual growth 2018 Per cent
Annual fees ($)				
– Non-rewards cards	53	60	57	–6.0
– Rewards cards	191	199	204	2.4
– All cards	137	147	150	1.8
Other fees				
– Foreign currency conversion fees (per cent of value)	2.8	2.8	2.7	–0.1 ppts
– Late payment fee ($)	18	19	19	3.7

(a) Simple average of advertised fees for cards issued by a sample of seven banks; only cards that are available to new cardholders are included in the sample; note that changes in the sample affect the average fee; includes fee-free cards; does not include any fee waivers or reductions; as at June of each year

Sources: Credit card issuers' websites; RBA

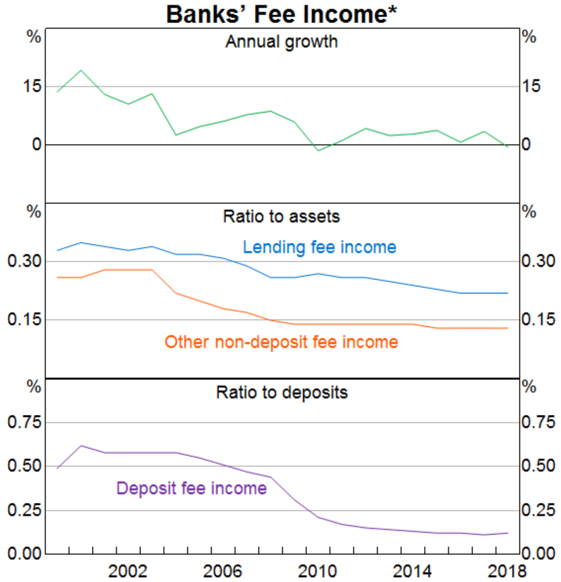
continued to grow in 2018, but at a slower pace compared with previous years, reflecting in part a decline in income from exception fees. Changes in unit fees were mixed in 2018 – late payment fees and annual fees on rewards cards increased, while foreign currency conversion fees and annual fees on non-rewards cards declined (Table 3).

… but this was largely offset by higher fee income from small businesses

Total fee income from businesses increased by 3 per cent in 2018, almost entirely due to higher fee

Graph 1

Banks' Fee Income*



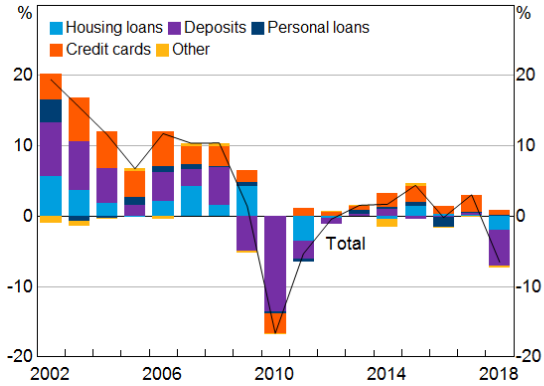
* Adjusted for breaks in series due to changes in banks' reporting; financial-year average assets and deposits have been used

Sources: APRA; RBA

Graph 2

Growth in Household Fee Income

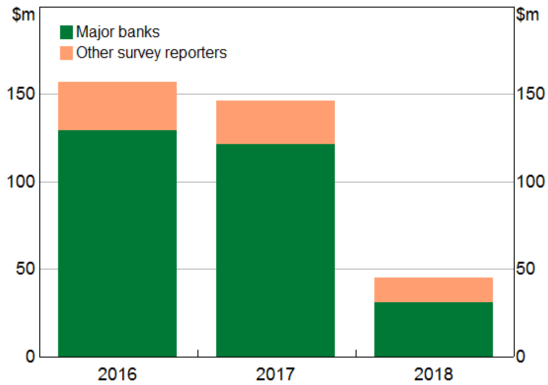
Contribution by product



Source: RBA

Graph 3

Banks' ATM Fee Income*



* Independent ATM deployers, such as Cardtronics, are not included in the RBA's bank fee survey

Source: RBA

Table 4: Banks' Fee Income from Businesses

	2016 $ million	2017 $ million	2018 $ million	Annual growth 2018 Per cent	Average annual growth 2012–17 Per cent
Deposit accounts	600	601	583	–3.1	–1.0
– *of which: exception fees*	60	62	70	12.0	6.6
Loans	3,512	3,718	3,741	0.6	3.1
– *of which: exception fees*	55	50	47	–6.1	7.0
Merchant service fees	2,736	2,911	3,145	8.0	7.0
Bank bills	179	176	157	–10.9	–6.3
Other[(a)]	1,222	1,162	1,169	0.5	–1.4
Total	8,250	8,561	8,795	2.7	3.0
– *of which: exception fees*	115	113	117	3.9	6.8

(a) Includes banking-related fee income from businesses that cannot be directly related to a deposit or loan account, merchant or bank bill facility (e.g. guarantees or foreign exchange fees)

Source: RBA

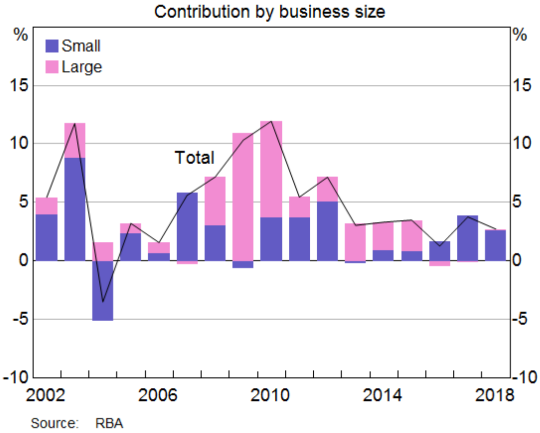
income from small businesses (Graph 4; Table 4). By product, the main driver for growth in fee income from businesses was the continued increase in income from merchant service fees on card transactions (Graph 5). Fees charged for business loans also increased slightly, while fee income from business deposit services and bank bills both decreased. Fee income from businesses continued to be made up mostly of fee income on loans (43 per cent) and merchant service fees (36 per cent).

Merchant service fee income continued to grow strongly in 2018 amid double-digit growth in the volume of card transactions (Mitchell and Wang 2019). Banks reported that growth was driven by fees charged to small businesses for accepting card transactions, although merchant service fees charged to large businesses also increased. Non-transaction merchant service fee income (for example, from set-up fees, annual fees, and terminal rental costs) increased slightly, but remained small relative to card transaction fees. Unit fees on debit card transactions were affected by the RBA's new interchange fee standards, which became effective in July 2017. These standards lowered the benchmark for debit card interchange fees from 12 cents to 8 cents per transaction. As interchange

Graph 4

Growth in Business Fee Income

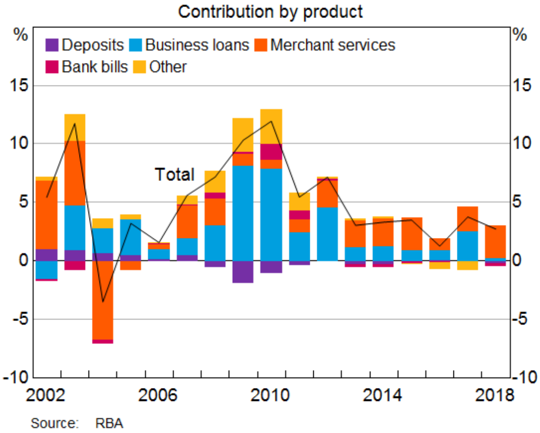
Contribution by business size



Graph 5

Growth in Business Fee Income

Contribution by product

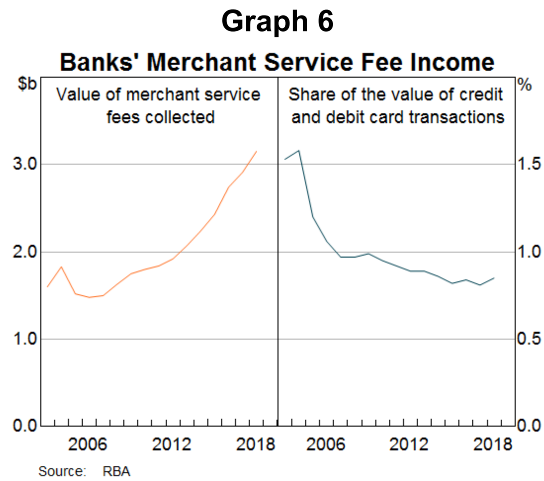


fees (which are paid by banks) are a significant component of the cost of providing payment services to merchants (RBA 2016), reductions in these fees typically flow through to lower merchant service fees. However, merchant service fee income remained relatively stable as a share of transaction value in 2018 (Graph 6). This was largely due to a compositional shift in the value of card transactions processed by network, away from the cheaper eftpos network to the relatively more expensive Mastercard and Visa networks. Although merchant service fees for Mastercard and Visa debit card transactions declined as a share of transaction value over the year (consistent with the lower benchmark for interchange fees), they remained well above the average merchant service fee for the eftpos system.[7] Some banks also reported changes in their merchant service fee structures over the past year. The implementation of least-cost routing by the banks – which will allow businesses to direct contactless debit card payments to the network with the lowest fees – is likely to put downward pressure on the unit fees paid by merchants (RBA 2019).

The increase in fees charged for business loans in 2018 reflected higher fee income from small businesses, partly offset by a decrease in the fees charged to large businesses. The changes in fee income from both small and large businesses owed to movements in account servicing fees, which make up the bulk of business loan fees. Lower average unit fees contributed to the decrease in fees from large businesses; overall lending to large businesses increased notably over the survey period (while lending to small businesses increased only slightly).

The decline in fee income from business deposits was driven by a decrease in fees charged to small businesses, though this largely reflected fees refunded for customer remediation. Around two-thirds of fee income from business deposits was for deposit services provided to small businesses.

Fee income from bank bills declined sharply, as businesses continued to shift from bank bills to other, more flexible lending products. In particular, bank bill fees charged to large businesses dropped to a negligible level in 2018, making up less than 1 per cent of total fee income from bank bills.



Footnotes

[*] The authors are from Domestic Markets Department.

[1] The data from the survey are published in the Reserve Bank's Statistical Table C9 and are subject to revision.

[2] Survey results have been affected by mergers and acquisitions among participating institutions and some changes in participants' methodology (where possible, this has been reflected in revisions to data reported in previous years).

[3] All data from the survey are based on individual banks' financial years, which differ across banks (the data in Table 3 were not collected through the survey and are instead based on calendar years). Improved data on bank fees will be reported from 2020 in the new Economic and Financial Statistics (EFS) collection – these data are designed to be more consistent across institutions, including because they will be based on a consistent reporting period. For more information on the EFS collection, see Bank, Durrani and Hatzvi (2019).

[4] For more information on the types of fees charged on housing loans, see ACCC (2018a and 2018b).

[5] For more information, see Mitchell and Thompson (2017).

[6] The personal loan category includes fees associated with term loans, margin loans to households, and home-equity loans where the predominant purpose is not known; the category excludes credit card lending.

[7] For more information, see the Reserve Bank's Statistical Table C3.

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A Decade of Post-crisis G20 Financial Sector Reforms

Mustafa Yuksel[*]

Photo: KTSDesign/Science Photo Library – Getty Images

Abstract

The global financial crisis resulted in significant disruption to markets, financial systems and economies. It also led to comprehensive reform of the financial sector by the G20 group of countries. After a decade of policy design and implementation, standards in the global financial system and regulatory approaches in many countries have changed substantially to improve financial system resilience. Australia, as a G20 member, has been active in implementing these reforms. This article looks at the main financial sector reforms developed in the immediate post-crisis period, their implementation in Australia and the more recent shift in international bodies' focus to assessing whether these reforms have met their intended objectives.

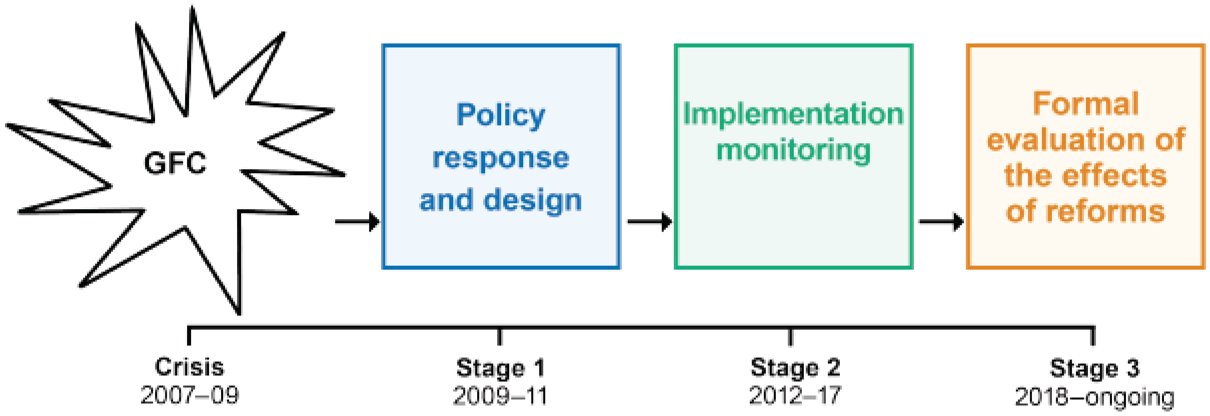
Introduction

Following the onset of the global financial crisis (GFC) just over a decade ago, the G20[1] and key international bodies, together with authorities in individual countries, embarked on a broad-ranging reform of financial sector regulation and supervisory frameworks. The reforms were intended to have a medium- and long-term focus, to address the vulnerabilities and regulatory gaps revealed by the crisis.

The initial post-crisis focus of the G20, the Financial Stability Board (FSB) and global standard-setting bodies (SSBs)[2] was on four core reform areas: building resilient financial institutions, mitigating the 'too big to fail' problem, and addressing risks in both over-the-counter (OTC) derivatives markets and the shadow banking sector. Substantial reforms were developed in each of these areas, with timelines set for implementation. There were also many reforms beyond these core areas, such as macroprudential frameworks and tools, credit rating agencies and accounting standards.

More than a decade has passed since the peak of the crisis. This article looks back at the G20 financial

Figure 1: Evolution of the G20 Crisis Response – Changing Priorities(a)



(a) The dates shown are indicative only

Sources: RBA

sector reforms, with a particular focus on their implementation in Australia.[3] It also looks ahead, as the international community has more recently shifted its focus to evaluating the effects of the reforms to assess whether they are meeting their objectives. This evaluation work is likely to continue to feature prominently on the financial reform agenda in the coming years.

The Different Stages of the G20's Post-crisis Policy Response

The post-crisis policy response by the G20 can be broadly thought of as having three overlapping stages (Figure 1).

The key elements of each stage are discussed below.

Stage 1: Policy response and design. Globally, in addition to restoring confidence, the immediate post-crisis response was to identify the sources of the problems that led to the GFC. After identifying these root causes, international bodies worked on the design and release of important elements of the core reforms. The process began with the G20 Leaders statement of 2009 heralding a sweeping set of financial reforms. This was followed by the development of specific key reforms, discussed in more detail below, to give effect to the G20's broad vision.

Stage 2: Implementation monitoring. As reforms and new standards were developed and published, they typically came with implementation timetables, which often stretched over several years. To help ensure the full, complete and timely implementation of the reforms, SSBs embarked on a detailed monitoring program to review the adoption of the reforms across countries. Each SSB generally monitored the implementation of their own standards.[4] However, the FSB had a major overall monitoring role. Its Coordination Framework for Implementation Monitoring followed progress in the adoption of the core G20 reforms, while an associated Implementation Monitoring Network (IMN) tracked progress in other reform areas. The results of this ongoing monitoring are summarised in the FSB's annual report on the implementation and effects of reforms (first issued in 2015), as well as in the FSB's jurisdiction-specific annual updates on implementation. The former report mainly covered implementation monitoring, but it also conveyed the initial work by the FSB on assessing the effects of the reforms. This early FSB work on the effects of reforms was to an extent limited, likely reflecting the fact that sufficient experience with many reforms had not been gained as they were only just beginning to be implemented during this period.

Stage 3: Formal evaluation of the effects of reforms. As policy design and implementation has progressed, the G20, FSB and SSBs have shifted their focus towards assessing the effects of the reforms, to determine whether they are meeting their intended objectives. Using a formal evaluation framework released by the FSB in 2017, the first two formal evaluations were completed in 2018. Another key aim of the evaluations is to identify unintended material consequences of the reforms that may need addressing. These are to be assessed by the SSBs that developed the relevant policies, to determine whether a policy response is required.

These stages were, and are, overlapping. For example, during the implementation monitoring stage of the early Basel III reforms, policy design work continued on finalising aspects of the Basel III capital reforms (which were not completed until the end of 2017). And, in Stage 3, the evaluation work is being conducted while implementation monitoring is ongoing. But the stages give a broad sense of how the priorities of the international bodies have evolved through time. Key features of these stages are discussed in more detail below, with the Stage 2 discussion focused on Australia.

Initial Post-crisis Policy Response

The GFC led to an almost unprecedented disruption to financial markets and systems, as well as having significant negative effects on the real economy, including a large drop in output and falls in international trade.[5] As described in Schwartz (2013), the scale and breadth of disruption prompted a comprehensive post-crisis response from the G20. The initial effort centred on the four core areas of reform noted earlier, with each involving a range of policy actions (Table 1). This focus, particularly on bank resilience and the risks posed by systemically important financial institutions (SIFIs), reflected the immediate vulnerabilities exposed by the crisis. The core reforms are discussed below, with a particular focus on developments in recent years (see Schwartz (2013) for a more detailed summary of the earlier reforms).

The first core reform area was 'building more resilient financial institutions'. The failure or near failure of many banks highlighted the inadequacy of banks' capital and liquidity buffers. This prompted a major rewrite of global banking standards by the Basel Committee on Banking Supervision (BCBS) in what has become known as the Basel III reforms, which were released in 2010. These focused on significantly increasing the *quality* and *quantity* of capital held by banks, and enhancing the liquidity resilience of banks (both over short horizons with the 30-day Liquidity Coverage Ratio (LCR), and over the longer term, with the Net Stable Funding Ratio (NSFR)). These reforms also included a constraint on overall leverage to complement the risk-based capital requirements. Further changes were agreed at the end of 2017. These changes sought to address the significant variation in the value of risk weights calculated by banks, even among those with similar business models and risk profiles. This issue had been revealed by the BCBS's monitoring of Basel III implementation. A key change was that banks that use 'internal models' to calculate regulatory capital requirements must hold at least 72.5 per cent of the capital that they would hold under the 'standardised approach' (using parameters set by the regulator), even if their models suggest a lower amount of capital.

Another element of the building resilient financial institutions reforms related to compensation standards. This reflected the view that excessive risk-taking by financial institutions had contributed to the crisis, which, in turn, had been partly driven by remuneration and wider compensation practices that rewarded such risk-taking. Moreover, these practices tended to reward short-term results, with limited scope to punish poor outcomes over the medium or longer term. In response, the FSB developed its *Principles for Sound Compensation Practices* and their *Implementation Standards*, which aim to align employees' risk-taking incentives with the risk appetite and long-term profitability of the firm, particularly at significant financial institutions. Notably, the standards recommend the ability to claw back part of employees' (unvested) remuneration at a later date.

During the crisis, authorities in numerous countries were called upon to bail out banks and other financial institutions using public funds, thereby exposing taxpayers to potentially large losses and generating moral hazard.[6] These actions were taken because the disorderly failure of such institutions, due to their size, complexity or systemic interconnectedness, would have caused significant

Table 1: Core Post-crisis G20 Financial Sector Reforms

Area	Lead bodies[(a)]	Key elements[(b)]
Building resilient financial institutions	BCBS (banks) IAIS (insurers) FSB	• Basel III capital and liquidity reforms • Capital standard for insurers • Compensation standards
Ending 'too big to fail'	BCBS, CPMI, FSB, IAIS, IOSCO	• Identifying SIFIs • Greater ability to absorb losses for global SIFIs • Enhancing resolution regimes for SIFIs (banks, insurers, CCPs) • Enhancing supervisory intensity and effectiveness (especially for SIFIs)
Making derivatives markets safer	BCBS, CPMI, IOSCO	• Greater use of central clearing • Moving standardised derivatives trading to exchanges or electronic platforms, where appropriate • Derivatives trades to be centrally reported to trade repositories • Enhanced capital, risk and margining requirements for non-centrally cleared derivatives
Addressing risks in shadow banking	BCBS, FSB, IOSCO	• Reduce the susceptibility of money market funds (MMFs) to 'runs' • Mitigate the spillover effect between the banking system and the shadow banking system • Mitigate systemic risks posed by other (non-MMF) shadow banking entities and activities • Assess and align the incentives of lenders/issuers and buyers in securitisation • Dampen risks and pro-cyclical incentives associated with repurchase agreements (repos) and securities lending

(a) BCBS = Basel Committee on Banking Supervision; CPMI = Committee on Payments and Market Infrastructures; FSB = Financial Stability Board; IAIS = International Association of Insurance Supervisors; IOSCO = International Organization of Securities Commissions

(b) This is not an exhaustive list of all the elements covered by the core reforms. For more detail on these, see Schwartz (2013) and FSB (2018).

Sources: BCBS; CPMI; FSB; IAIS; IOSCO

difficulties for the wider financial system and broader economy. That is, the institutions were 'too big to fail'. Addressing this problem was the second core reform area, with global bodies taking a range of actions:

- The FSB introduced a framework for addressing the risks posed by SIFIs in 2010, with an early focus on *global* SIFIs (G-SIFIs), as their failure can affect multiple countries. The following year, the FSB outlined a suite of more specific G-SIFI policy measures. A key element was a new resolution standard, the *Key Attributes of Effective Resolution Regimes for Financial Institutions* (*Key Attributes*).[7] The focus on effective resolution regimes reflects the goal of avoiding the severe costs of financial institution failures as seen during the crisis. Reducing (if not eliminating) the need to use public funds to support stressed financial institutions became a goal of international bodies and several individual jurisdictions.[8] Other G-SIFI measures included higher loss absorbency requirements as well as establishing networks of supervisors to cover banks operating in several jurisdictions (cross-border supervisory colleges) and crisis management groups for these institutions.

  While the initial focus of implementing the *Key Attributes* was on banks, in recent years, global efforts have focused on applying them to insurers and financial market infrastructures (FMIs), such as central counterparties (CCPs), with additional guidance specific to these sectors.

- In parallel with the FSB's broad SIFI policy work, the BCBS and the IAIS developed methodologies for identifying banks and insurers that were 'clearly systemic in a global context'.[9] Lists of global systemically important banks (G-SIBs) and insurers were first published by the FSB in 2011, and 2013, respectively.

A subsequent key development in the effort to address the 'too big to fail' problem is the FSB's 2015 total loss-absorbing capacity (TLAC) standard for G-SIBs. The standard is intended to ensure that G-SIBs can be resolved in an orderly way by requiring G-SIBs to have a minimum amount of TLAC, which is composed of both regulatory capital and other eligible debt, with the latter able to be 'bailed in' (that is, written down or converted into equity). The minimum TLAC requirement will be phased in from 2019, reaching 18 per cent of risk-weighted assets (RWAs) when fully implemented by 2022. G-SIBs headquartered in emerging market economies (EMEs) have extra time to meet the requirements.

The third core reform area relates to OTC derivative markets. The crisis showed that the complex network of OTC derivative exposures between financial institutions made it difficult to monitor concentrations of risk and greatly increased the scope for contagion. As a result, in September 2009, the G20 leaders agreed that 'all standardised OTC derivative contracts should be traded on exchanges or electronic trading platforms, where appropriate, and cleared through central counterparties by the end of 2012 at the latest. OTC derivative contracts should be reported to trade repositories. Non-centrally cleared contracts should be subject to higher capital requirements.' The goal of mandatory central clearing was to replace financial institutions' bilateral derivative exposures with a single net exposure to a CCP, thereby simplifying the network of interconnections and reducing total exposure. In addition, a series of reforms were introduced for those OTC derivatives that are not centrally cleared. For these trades, under 2013 reforms, financial institutions are required to exchange collateral (in the form of margin) to reduce the risks associated with these contracts.[10] In 2015, standards were also issued on risk mitigation techniques for non-centrally cleared derivatives. Collectively, these reforms aimed to provide incentives to centrally clear OTC derivatives trades, and to ensure that the risks associated with *non-centrally cleared* trades were effectively recognised and managed. The combined effect of the reforms to promote increased use of central clearing also had the effect of concentrating risks in CCPs, which led to global efforts to enhance their regulation and resilience as discussed below.

Financial institutions and activities outside the formal banking system, such as money market funds (MMFs) and securitisation, amplified both the build-up of vulnerabilities before the GFC and the ensuing financial instability. As a result, the fourth core area of reform addressed 'shadow banking' risks. Early reforms focused on MMFs, securitisation, shadow banking entities other than MMFs, and securities financing transactions (SFTs) such as repurchase agreements (repos) and securities lending. Subsequent reforms have focused on addressing structural vulnerabilities in the asset management sector (namely redemption run risk and leverage), and the risks posed by shadow banks to the banking sector. In terms of the latter, capital requirements for banks' equity investments in funds have been tightened, with banks required to apply risk weights to the underlying exposures of a fund as if the exposures were directly held. Guidelines on 'step-in' risk have also been issued. These seek to mitigate the risk that banks, to avoid reputational damage, 'step in' to support unconsolidated but related entities (such as MMFs and other funds) which could transfer financial distress to the bank.

Financial Sector Reforms beyond the Core Areas

Beyond the four core reform areas, international bodies and national authorities have also made substantial reforms in other areas. The FSB's IMN monitors 10 broad areas of other post-crisis G20 financial sector reforms, with numerous individual elements within each category (Table 2). These reforms cover different types of financial institutions and markets, as well as multiple areas of regulatory and supervisory practices and standards.

Table 2: Other Post-crisis G20 Financial Sector Reforms

Area	Specific elements
Hedge funds	• Registration, appropriate disclosures and oversight of funds • Establish international information-sharing framework • Enhance counterparty risk management
Securitisation	• Strengthen regulatory and capital framework for monoline insurers in relation to structured credit • Strengthen supervisory requirements or best practices for investment in structured products • Enhance disclosure of securitised products
Enhancing supervision	• Consistent, consolidated supervision and regulation of SIFIs • Establish supervisory colleges and conduct risk assessments • Supervisory exchange of information and coordination • Strengthen resources and effective supervision
Building and implementing macroprudential frameworks and tools	• Establish regulatory framework for macroprudential oversight • Enhance system-wide monitoring and the use of macroprudential instruments
Improving oversight of credit rating agencies (CRAs)	• Enhance regulation and supervision of CRAs • Reduce the reliance by SSBs, market participants, supervisors and central banks on ratings
Enhancing and aligning accounting standards	• Implement policy measures to apply fair value recognition, measurement and disclosure • Require measures of expected credit losses on financial assets
Enhancing risk management	• Enhance guidance to strengthen banks' risk management practices, including on liquidity and foreign currency funding risks • Enhance risk disclosures by financial institutions
Strengthening deposit insurance	• Adopt explicit deposit insurance schemes (DISs) • Carry out self-assessments of DISs against International Association of Deposit Insurers' core principles for DISs, and address any gaps
Safeguarding the integrity and efficiency of financial markets	• Enhance market integrity and efficiency • Regulation and supervision of commodity markets • Reform of financial benchmarks
Enhancing financial consumer protection	• Implement the Organisation for Economic Cooperation and Development's high-level principles on financial consumer protection

Source: FSB

These non-core reforms involve a mix of (ongoing) improvements to existing standards or regulatory approaches (such as improving deposit insurance schemes (DISs) or enhancing consumer protection) and addressing perceived gaps in the pre-crisis regulatory framework that were exposed by the GFC. There are several key examples of the latter:

- A focus on reforms related to securitisation reflects the fact that the early stages of the crisis centred on structured products involving securitisation. There was considerable uncertainty about the quality and value of asset-backed securities and the assets underlying them. In addition to potentially misleading ratings being applied by credit rating agencies (CRAs) – which prompted a separate reform effort (discussed below) – these products had inherent risks due to misaligned incentives. For example, in securitising assets off their balance sheets, many financial institutions did not accurately assess or monitor the risks that were being transferred, because they had no financial interest in the securitised assets, i.e. no 'skin in the game'.[11]

- The work on enhancing macroprudential frameworks reflects the view that, before the crisis, banking sector regulators had a mostly *micro*prudential focus. That is, regulators focused excessively on addressing the risks posed by *individual* institutions. In doing so, they largely missed the build-up of broad-based, systemic risks posed by the collective activities of multiple financial institutions, such as in the US subprime housing loan market. This failing required an expanded focus, to include *macro*prudential policymaking and tools to address systemic risks, either by establishing new bodies for that purpose or assigning macroprudential goals and tools to the existing regulator(s).
- The CRA reforms were, in part, triggered by concerns that the very high credit ratings assigned by CRAs to many structured products (such as collaterised loan obligations) contributed to the crisis. In hindsight, these ratings were overly optimistic and led to the actual risk of those products being underpriced, which fuelled their marketing and sale, adding to the pre-crisis build-up of risk within the financial system. The GFC also highlighted the scope for conflicts of interest, as CRAs were being remunerated by clients who would benefit by receiving higher ratings for their financial products such as debt securities and structured products. Such incentives were seen as jeopardising the independence of CRA's analysis.

Australia's Implementation of the G20 Financial Regulatory Reforms

As members of the G20 and the FSB, and of the SSBs, Australia's main financial regulatory agencies (those on the Council of Financial Regulators (CFR)) were able to contribute to the policy design discussions that led to the main reforms agreed in Stage 1.[12] The agencies' objective was not only to achieve good policy outcomes, but also to bring Australia's perspective and domestic circumstances to the discussion and, where appropriate, build in a degree of flexibility and proportionality for the adoption of global standards domestically.

Australia was not as badly affected by the GFC as were many other economies, especially those in the north Atlantic. For example, Australia's banks remained profitable with capital ratios comfortably above regulatory minimums as asset quality was relatively resilient. At least in part, this reflected the effectiveness of the domestic regulatory and supervisory framework, with local bank rules that were 'super equivalent' to (i.e. stricter than) global standards. The Australian Prudential Regulation Authority (APRA) for example applied more conservative definitions of capital than the international standard.[13]

Even though Australia was not as severely affected by the crisis as many other economies, nonetheless, Australian authorities implemented many of the core global financial sector core reforms, as required of G20 members (Table 3). As noted by Schwartz (2013), Australia adopted these global reforms as there was room for improvement within Australia's domestic arrangements and there were lessons to be learnt from international experience. Meeting or exceeding the new global standards also assured investors, both domestic and overseas, that Australia's regulatory framework would continue to evolve to match best practice. It was also in Australia's interests to demonstrate a commitment to new standards and to support the 'level playing field' provided by global standards. As financial markets are global in scope, regulatory weaknesses in one or more jurisdictions can contribute to systemic risks, and lead to regulatory arbitrage and an associated decline in prudential standards. Adherence to global standards by Australia and other countries helps make the global financial system safer.

Of particular note is that, in the immediate post-crisis years, APRA implemented the Basel III reforms often in full and earlier than was required by the

Table 3: Selected Core Post-crisis G20 Reforms and Australian Implementation

Global reform (and implementation date where applicable)	**Australian implementation** (with Australian variations)
Building resilient financial institutions	
Basel III Capital	
Common Equity Tier 1 (CET1): 3.5% (2013) ⟶ 4.5% (2015)	4.5% (2013)[(a)]
Capital conservation buffer (CCB): 0.625% (2016) ⟶ 2.5% (2019)	2.5% (2016)[(a)]
Leverage ratio 3% original exposure definition (2018) revised exposure definition (2022)	Internal ratings-based approach banks: proposed 3.5% (2022) Standardised approach banks: proposed 3% (2022)
Basel III Liquidity	
Liquidity Coverage Ratio 60% (2015) ⟶ 100% (2019)	100% (2015)[(a)] RBA Committed Liquidity Facility (2015)
Net Stable Funding Ratio (2018)	100% (2018)
Ending 'too big to fail'	
G-SIB higher loss absorbency: 1.0-2.5% (2016 ⟶ 2019)[(b)] Additional requirements[(c)]	Not applicable (no Australian G-SIBs)
D-SIB higher loss absorbency (2016 ⟶ 2019)	D-SIB (2016)[(a)] – 1% CET1 add-on for major banks
TLAC: 16% (2019) ⟶ 18% (2022)[(d)] *except* for G-SIBs in EMEs: 16% (2025) ⟶ 18% (2028)	APRA loss-absorbing capacity proposals (2018): – additional requirement of 4–5% of capital for the four major banks – proposed implementation by 2023
Making derivatives markets safer	
Greater use of central clearing (2012)	Mandatory central clearing regime for OTC interest rate derivatives denominated in AUD, USD, EUR, GBP and JPY (2016)[(e)]
Reporting of trades to trade repositories (2012)	2013 (initially for major financial institutions)
Margin requirements for non-centrally cleared trades (2016 ⟶ 2020)	2017 ⟶ 2020
Addressing risks in shadow banking	
Mitigate risks posed by shadow banks	Enhanced capital (2011) and risk management requirements (2017) for managed investment schemes (including retail hedge funds) Reduced ability of finance companies and other registered financial corporations to offer deposit-type products (2014) Powers to address financial stability risks posed by non-ADI lenders (2018) Annual RBA update to CFR on developments in non-bank financial intermediation
Repos and securities lending	
Evaluate case for a CCP for repos	RBA-conducted review of the costs and benefits of a repo CCP in Australia (2015)
Enhancing data reporting standards	New APRA Economic and Financial Statistics data collection includes enhanced data reporting standards

Global reform (and implementation date where applicable)	**Australian implementation** (with Australian variations)
	for repos and securities lending (to start late 2019)

(a) No phase in

(b) Timeline applies to 2014 list of G-SIBs

(c) In addition to a capital surcharge, G-SIBs have to meet additional requirements covering areas such as the establishment of a crisis management group, development of a resolution strategy and higher expectations for data aggregation capabilities and risk reporting. These have varying timelines for implementation, namely between six months and three years of G-SIB designation

(d) Timeline applies to 2015 list of G-SIBs

(e) As a small open economy in which many OTC derivatives transactions in the Australian market involve foreign entities it was important that the Australian requirements were consistent with overseas requirements. Therefore, the Australian regulators aimed to be 'fast followers' – implementing the OTC derivatives market reforms after they were implemented in major overseas jurisdictions.

Sources: APRA; ASIC; BCBS; FSB; IOSCO; RBA

BCBS. This was the case with the capital reforms (the Common Equity Tier 1 (CET1) and capital conservation buffer requirements) and the short-term liquidity requirement (the LCR). In conjunction with the domestic implementation of the LCR, the RBA introduced a Committed Liquidity Facility (CLF) for qualifying banks. This was necessary because Australian banks would not have been able to meet the LCR with existing liquid assets, due to the limited amount of government debt on issue in Australia. This highlights the flexibility of global standards, which are often minimums or allow national discretion (or use of built-in flexibility) to reflect domestic financial, legal or regulatory circumstances. In discussions on the development of Basel III, the RBA and APRA argued for the inclusion of alternative liquidity arrangements such as the CLF for countries with a limited supply of high-quality liquid assets. The CLF provides eligible banks with access to a pre-specified amount of liquidity, for a fee, through repurchase agreements of eligible securities outside the RBA's normal market operations. As well as implementing the reforms earlier than required, APRA also generally took a more conservative approach than the BCBS standards. For example, APRA did not adopt the Basel III concessional treatment for certain capital items.

In recent years, APRA has implemented further elements of the Basel III reforms. In 2018, in line with the BCBS deadlines, it implemented the NSFR (which was the last remaining key element of the Basel III liquidity reforms). In the same year, APRA also released its plans to implement the Basel III leverage ratio, as well as other revisions to the capital framework to reflect the finalisation of outstanding Basel III capital reforms by the BCBS the previous year.

In Australia, APRA implemented the FSB compensation principles for banks and insurers through a new prudential standard on remuneration in 2010. The key principle underlying this standard is that performance-based remuneration must be designed to encourage behaviour that supports the firm's risk management framework and long-term financial soundness. More recently, the Banking Executive Accountability Regime, which applies to all banks from 1 July 2019, introduces stricter rules on the remuneration of banks' senior executives and directors. In particular, a proportion of variable remuneration must be deferred for at least four years, and variable remuneration must be reduced for accountable persons who do not meet their accountability obligations.

The extensive 'too big to fail' reforms applying to G-SIFIs were not directly implemented in Australia as no G-SIFI banks or insurers are headquartered here. However, domestic variants of these global rules have been pursued in many jurisdictions, including Australia.

- There are many cases where banks and other financial institutions, while not having a global systemic footprint, are nonetheless systemic in their local jurisdiction. Australia – like many other small jurisdictions – adopted the BCBS's 2012 domestic SIB (D-SIB) framework, tailored to local conditions. APRA's D-SIB framework was released in 2013, identifying the four major Australian banks as D-SIBs and imposing an additional capital surcharge of 1 per cent of CET1 on each of them.

- The TLAC standard noted earlier explicitly applies to the 30 or so banks identified as G-SIBs. However, like regulators in several other countries, APRA has been working on building a loss-absorbing and recapitalisation capacity framework, to deal with a bank failure or near failure. This is in keeping with a government-endorsed recommendation of the 2014 Financial System Inquiry. APRA released a discussion paper detailing its proposed approach to loss-absorbing capacity for banks in 2018. It proposed increasing the total capital requirement of the Australian D-SIBs by between 4 and 5 per cent of RWAs. While the additional requirement can be met with other types of regulatory capital (for instance, through retained earnings or issuance of Additional Tier 1 instruments), it is expected that this would be mostly met through increased issuance of Tier 2 capital instruments because of its lower cost. This means using existing capital instruments rather than the more novel structural, contractual or statutory approaches used in other jurisdictions to increase the liabilities that can be 'bailed in'. APRA is expected to release its response to the consultation in mid 2019.

Australian reform efforts in recent years have also focused on resolution regimes. In 2012, Treasury released a consultation paper on expanding APRA's crisis management powers. APRA's powers were ultimately significantly enhanced through new legislation in 2018, so that it can more effectively prepare for, and manage, a distressed bank or insurer, as well as any affiliated group entities. In particular, the legislation clarifies APRA's powers to set requirements for resolution planning for banks and insurers (for example, by issuing prudential standards for resolution and recovery planning, supported by formal powers to direct firms to address barriers to their orderly resolution, such as by changing their business, structure or organisation).

A resolution regime for FMIs is also being developed. In 2015, Treasury issued a consultation paper seeking views on proposals to establish a special resolution regime for FMIs, consistent with international standards (in particular, the *Key Attributes*). The paper requested feedback in areas such as the scope of the resolution regime, resolution powers such as statutory management, transfer and directions, funding arrangements and international cooperation. The CFR agencies are currently developing detailed designs for the regime, with a further public consultation expected later in 2019.

APRA, the Australian Securities and Investments Commission (ASIC) and the RBA have been working towards implementing the OTC derivatives market reforms since 2009. As with many other G20 reforms, implementation has required strong collaboration between the Australian regulators, largely through the CFR. Based on their joint recommendations, the government required that, from 2016, all Australian OTC interest rate derivatives denominated in Australian dollars, US dollars, euro, Japanese yen and British pounds must be centrally cleared. Reporting of OTC derivatives trades to trade repositories was also required from 2013 for major financial institutions, and from 2014 for other financial entities. APRA has also imposed margin and risk management requirements for derivatives that are not centrally cleared.

Several key global reforms did not have direct applicability to Australia, or were already largely included in existing regulations, and hence were not adopted locally.

- The shadow banking reforms were adopted to only a limited extent in Australia. The shadow banking sector is a relatively small share of the domestic financial system which, under the proportionality built into the FSB's shadow banking framework, reduces the extent to which global reforms need to be applied. Further relevant points are noted below.
  - Australia already largely met several of the key post-crisis recommendations on shadow banking. For example, IOSCO recommended that constant net asset value (NAV) MMFs should move to a floating NAV where possible; in Australia, most MMF-type funds

were already operating on a floating NAV basis.

- A 2016 peer review report by the FSB on the regulation of shadow banking concluded that Australia already had a systematic process to review the regulatory perimeter (which determines the population of financial institutions/activities that are within the scope of regulation and/or supervision).[14]
- There was limited need to change the regulation of repos and other SFTs. Australia's SFT market is relatively small and below thresholds set for implementation of key FSB recommendations (such as applying 'haircut floors' on 'non-bank to non-bank' SFTs). Several recommendations, however, were followed through. The FSB recommended that authorities should evaluate the costs and benefits of introducing CCPs for inter-dealer repos, where CCPs do not already exist. In 2015, and following a consultation, the RBA assessed the costs and benefits of a repo CCP in Australia and determined that, while under certain circumstances it would be open to a market-led CCP, it would not at that time mandate central clearing for repos. Further, also in keeping with FSB recommendations, Australia adopted enhanced data reporting standards for ADI's and registered financial corporation's repos and securities lending, as part of APRA's modernised 'economic and financial statistics' collection (with these entities expected to commence reporting the new data in late 2019).
- The key role of banks in the financial system was a factor in ASIC deciding not to adopt an IOSCO securitisation recommendation, which was to impose mandatory risk retention requirements on issuers. Specifically, ASIC came to the view that bank issuers had sufficient 'skin in the game' as servicers of the underlying assets, as well as through entitlements to residual income and brand risk.[15]

- In terms of enhancing macroprudential frameworks and tools, significant changes have not been implemented in Australia. APRA's supervision and analysis of risks already incorporated a system-wide perspective that was less evident in some other regulators. The broader than simply microprudential approach is consistent with APRA's statutory financial stability mandate and arguably helped limit the build-up of vulnerabilities in Australia before the GFC. Moreover, APRA already has an extensive set of prudential tools that it can use for both micro- and macroprudential purposes (in the case of the latter, this was demonstrated by APRA's implementation of housing-related prudential measures in 2014 and 2017).[16] Finally, the CFR agencies have a long tradition of strong cooperation on financial stability matters, reducing the need to establish a new macroprudential body, or change existing arrangements by assigning explicit new macroprudential goals, powers and tools to one or more agencies.

Overall, Australia has demonstrated strong commitment to the international reform effort. It has typically implemented the core G20 financial sector reforms in full, without taking advantage of phase-in periods, along with many of the 22 other G20 policy reforms monitored by the FSB.

The Evaluation of Reforms Is a Key G20/FSB Focus

With the design of the reforms largely complete, and many having been implemented, the G20 and international bodies have started to formally evaluate their effects. This new work aims to determine whether the post-crisis reforms have achieved their intended aims, and whether there are any material unintended consequences that may need to be addressed (without compromising the agreed level of resilience). These evaluations will be a key feature of the financial regulatory work of the G20, FSB and SSBs in the period ahead.

The main evaluations to date are being coordinated by the FSB. The FSB sees the evaluations of the effects of reforms as an important element of its accountability to the G20 and the public. It also informs structured policy discussions among FSB members and SSBs. The first two formal evaluations launched by the FSB and SSBs focused on the effects of reforms on (a) the incentives to centrally clear derivatives and (b) infrastructure finance, with both evaluations concluding in 2018.

- As discussed earlier, the clearing of standardised OTC derivatives through a CCP was a key element of the reforms of OTC derivatives markets. The FSB and relevant SSBs concluded that the changes observed in OTC derivatives markets were consistent with the G20 aim of promoting central clearing, especially for the most systemic market participants. In particular, the capital, margin and clearing reforms combined to create an incentive to centrally clear OTC derivatives, at least for dealers and larger and more active clients. However, it was also found that the provision of client clearing services is concentrated in a relatively small number of bank-affiliated clearing firms. This can make access to central clearing difficult and costly for some smaller clients. The evaluation also found that the Basel III leverage ratio can be a disincentive for client clearing service providers to offer or expand client clearing (discussed below).
- The second evaluation concluded that the effects of reforms on infrastructure finance were of a second order relative to other factors, such as the macrofinancial environment, government policy and institutional factors. No material negative effects of key reforms on the provision and cost of infrastructure finance were identified.

An evaluation is now underway to assess the effects of reforms on financing for small to medium-sized enterprises. In recent months, the FSB launched an evaluation of the effects of the 'too big to fail' reforms in the banking sector. It will: (i) explore whether the reforms have addressed the systemic and moral hazard risks associated with SIBs; and (ii) analyse broader effects (positive or negative) on the financial system, such as overall resilience, the functioning of markets, global financial integration, and the cost and availability of financing.

To enhance transparency and rigour, these evaluations will seek a broad range of input and feedback, including from academic advisers and through a public consultation process. Importantly, the FSB envisages adjusting the post-crisis reforms where there is evidence of material unintended consequences. For example, the evaluation on the incentives to centrally clear OTC derivatives found that the treatment of initial client margin in the Basel III leverage ratio calculation may be reducing the incentive to offer client clearing services. This in turn could contribute to the concentration in, or even withdrawal of, client clearing services. The BCBS has since consulted on a targeted and limited revision to the leverage ratio exposure measure to address this issue.

Separate to the evaluation program, international bodies have been conscious of the implications of their promotion of central clearing of OTC derivatives. At the same time that the G20 and SSBs have been working to reduce the 'too big to fail' problem, CCPs have emerged as a new set of financially systemic entities, in part due to the reforms. Given their high degree of interconnectedness and their position at the heart of the financial system there is a risk that CCPs could be one possible location of the next financial crisis.[17] International bodies are alert to the financial stability risks posed by CCPs, especially those that operate across multiple jurisdictions. In 2017, the FSB and relevant SSBs identified 12 (now 13) CCPs that are systemically important in more than one jurisdiction. Reflecting these concerns, recent efforts by the FSB, CPMI and IOSCO aim to enhance the regulation and supervision of CCPs, and to increase their resilience and resolvability.[18] In certain jurisdictions, such as the United States, FMIs have been designated as SIFIs, resulting in stricter regulation and supervision.[19]

Another lasting effect of the GFC is that global bodies are especially focused on avoiding a repeat of the huge economic and social costs of crisis by actively looking for, and addressing, emerging vulnerabilities. A key part of the FSB's mandate, agreed in 2009, is that it will assess vulnerabilities affecting the global financial system and identify and review the actions needed to address them.

This focus has been emphasised by the new FSB Chair, who stated recently that assessing and mitigating vulnerabilities is 'the core piece of the FSB's mission'.[20] In addition to assessing current global vulnerabilities (such as high private and public debt), this mandate underpins recent work by the FSB on more medium-term emerging vulnerabilities, often in collaboration with the SSBs. Such work includes assessing the financial stability implications of crypto-assets and financial innovation more broadly, encouraging climate-related disclosures by financial institutions, and building financial sector resilience to cyber-related attacks and risks.

Conclusion

The GFC led to a decade of enormous change in financial regulation and, in turn, the global financial system. Reforms were made across a wide range of areas, with an initial focus on four core areas to address the most prominent vulnerabilities revealed by the crisis. In recent years, global focus has turned to evaluating the effects of reforms, with a view to addressing any material unintended consequences. Australia has embraced these changes, which have made its financial system more resilient. However, as the financial system evolves, including in response to those same reforms, it is inevitable that new threats to financial stability will emerge and authorities will need to remain vigilant.

Footnotes

[*] The author is from Financial Stability Department.

[1] The Group of Twenty (G20) is the main international forum for global economic cooperation, and is comprised of 19 countries (including Australia) plus the European Union.

[2] The key SSBs relevant for the G20 financial sector reforms are: the Basel Committee on Banking Supervision (BCBS); the Committee on Payments and Market Infrastructures (CPMI); the International Association of Insurance Supervisors (IAIS); and the International Organization of Securities Commissions (IOSCO). The FSB is an international body that monitors and makes recommendations about the global financial system and, in this context, helps coordinate the policy development work of the SSBs.

[3] In doing so, this article also updates an earlier Reserve Bank of Australia (RBA) *Bulletin* article on these themes. See Schwartz C (2013).

[4] The BCBS, in particular, set up an in-depth monitoring and reporting process for the new global banking rules (known as Basel III), as part of its Regulatory Consistency Assessment Programme (RCAP). The BCBS issued its first report on Basel III implementation in October 2011, with semi-annual updates since then. The BCBS's RCAP has two streams. It monitors implementation according to stated timelines, as well as assessing the consistency and completeness of implementation that is conducted on both a jurisdictional and thematic (e.g. liquidity reforms) basis.

[5] These financial and real effects are discussed in a recent speech by the Reserve Bank's Deputy Governor. See Debelle G (2018).

[6] Moral hazard in this context refers to the possibility that, under official regulation and supervision, banks could adopt riskier business strategies, lending and investments in the expectation of a public sector bailout if problems occur, or that depositors and other creditors will be less motivated in regularly assessing the soundness of the bank they lend to.

[7] In terms of a bank, resolution can be seen as the actions by a resolution authority (or authorities) to use available tools to manage a bank in stress in an orderly manner so as to safeguard financial stability (and for other aims such as the continuity of the bank's critical functions and the protection of depositors) with minimal costs to taxpayers.

[8] For example, in the United States, the 2010 Dodd-Frank Act changed the US Federal Reserve (the Fed)'s authority to carry out emergency measures. Under the new law, the Fed must obtain approval from the Treasury Department before exercising its extraordinary lending authority. In addition, the Fed may extend credit only under a program with broad eligibility – it cannot create programs designed to support individual institutions. In the European Union, the Bank Recovery and Resolution Directive applies strict limits on when public funds (for example, resolution funds) can be used in resolution.

[9] For more on the assessment methodologies for identifying G-SIFIs, see Yuksel M (2014).

[10] Margin reduces two risks: it prevents the build-up of exposures as prices and interest rates fluctuate each day ('variation margin'); and can be used to cover losses if one of the parties to the derivative defaults ('initial margin').

[11] Following IOSCO's initial post-crisis recommendations on securitisation, which were part of the wider shadow banking reform effort, securitisation reform has become a separate workstream under other G20 reform work. For example, work continues on enhancing disclosure and

strengthening best practices for investment in structured finance products.

[12] The CFR is the coordinating body of Australia's main financial regulatory agencies (the Australian Prudential Regulation Authority (APRA), the Australian Securities and Investments Commission (ASIC), the RBA and the Australian Treasury). For further details on the CFR, see RBA (2018).

[13] As Kearns (2013) notes, APRA had a conservative approach to setting capital rules even before the crisis. For example, 80 per cent of Tier 1 capital had to be of the highest form – ordinary shares and retained earnings – and APRA excluded from Tier 1 items such as intangible assets that had uncertain liquidation values. Rules such as these helped ensure that Australian banks' capital was of a high quality going into the crisis.

[14] The RBA coordinates an annual update to the CFR on developments in, and risks arising from, Australia's shadow banking system, which provides the basis for a CFR discussion. See FSB (2016).

[15] See Medcraft G (2017).

[16] See Orsmond D and F Price (2016).

[17] For a discussion of the concerns regarding CCPs, see Debelle G (2018). On a related point, the financial difficulties at Nasdaq Clearing AB (a Swedish CCP) in September 2018 highlights the types of financial stability issues CCPs can raise. For a discussion of the Nasdaq episode, see RBA (2019), pp 53–54.

[18] See, for example, FSB (2017).

[19] In 2012, the US Financial Stability Oversight Council designated eight 'financial market utilities' as systemically important, including several CCPs.

[20] See Quarles R (2019).

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Wages Growth by Pay-setting Method

James Bishop and Natasha Cassidy[*]

Photo: Alex Segre – Getty Images

Abstract

Using job-level micro data, we show that the dynamics of wages growth differ across pay-setting methods. In recent years, wages growth has been strongest for award-reliant workers, stable at low levels for those on enterprise bargaining agreements (EBAs), and low but rising for those on individual arrangements. These trends reflect differences in the arrangements governing each pay-setting method, and differences in the types of workers covered by them. For instance, individual agreements react most flexibly to changes in labour market spare capacity, while government policies have kept public sector wages growth in EBAs relatively unchanged of late. This new disaggregation of wages growth allows for an estimation of the pass-through of award wage increases to other wage outcomes in the economy. We also find that the new breakdown provides a useful framework for forecasting aggregate wages growth.

Motivation

The low wages growth in recent years has contributed to a decline in the growth of household disposable income and consumption, and has been associated with a decline in inflation. Using job-level wage price index (WPI) data, we provide some key insights into the dynamics driving low wages growth. This analysis is the result of a recent collaboration between the Reserve Bank and the Australian Bureau of Statistics (ABS) using WPI data for around 18,000 jobs. Previous work using these data demonstrated that the decline in wages growth between 2012 and 2016 reflected a decline in both the average size of wage rises and the frequency of wage changes (Bishop and Cassidy 2017). In this article, we use the job-level WPI data to disaggregate wages growth by pay-setting method: awards, EBAs and individual arrangements.[1]

WPI growth declined across all three pay-setting methods between 2012 and 2016 (Graph 1). Since then, award wages growth has picked up as a result of Fair Work Commission (FWC) decisions to increase award and minimum wages at a faster pace than average. There has also been some pass-through of these award wage increases to workers whose pay is determined by other methods. Overall, however, there has been little change in average wages growth for workers on EBAs. This is because government policies have capped wages growth in most public sector EBAs, while delays in renegotiating some EBAs have resulted in a temporary wage freeze. Wages growth for those workers on individual arrangements has increased a little since its 2016 low, in part reflecting some pass-through of award wage changes, as well as the tightening in the labour market over this period.

Pay-setting in Australia

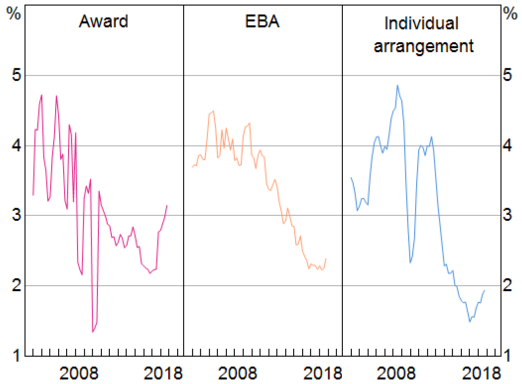
As set out by the *Fair Work Act 2009* (Cwlth) and other workplace legislation, the majority of Australian workers have their pay and workplace conditions set by one of three different methods: awards, EBAs and individual arrangements.[2]

Awards are legally enforceable determinations that set out minimum terms and conditions of employment in addition to any legislated minimum terms.[3] In recent years, the share of employees on an award or minimum wage (i.e. in an award-reliant job) has increased a little to around 20 per cent in 2018 (representing around 13 per cent of the total wage bill; Graph 2). Award-reliant workers tend to earn less per hour than workers who have their pay set by other methods. Award coverage is highest in

Graph 1

Wages Growth by Pay-setting Method*

Year-ended



* Excludes bonuses and commissions

Sources: ABS; RBA

some service industries and retail trade (Graph 3). Employees on awards are more likely to work part time, and around half of all award-reliant employees are engaged on a casual basis.

EBAs are collective agreements negotiated at the enterprise level between an employer and a group of employees. An EBA must leave an employee better off overall compared with the relevant award and the FWC is responsible for approving most agreements. The share of employees on EBAs has declined a little since 2010, to be around 40 per cent (Graph 2). As 80 per cent of public sector employees are covered by an EBA, EBAs are most prevalent in industries with a higher share of public provision, such as health and education.

Individual arrangements have wages and conditions set on an individual basis.[4] This is a broad category capturing all employees not on an EBA and not paid the exact award rate. The share of employees on individual arrangements has been around 40 per cent over the past two decades (Graph 2). Nearly all of these employees work in the private sector and most work on a permanent, full-time basis. Employees on these arrangements are also more likely to work in small-to-medium size firms and in the business services sector. Although some of these employees are paid close to the award (e.g. those paid a small fixed percentage above the rate of pay specified in the award), others are highly paid professionals and managers at the top of the wage distribution. Reflecting the relatively high average earnings for employees on these arrangements, they account for a larger share of the wage bill than those on EBAs.

In the remainder of this article we consider the determinants of wages growth for each pay-setting method using the WPI micro data. The WPI is designed to measure changes in wage rates for a given quantity and quality of labour. It compares the wage for a given job across time, excluding any changes in wages resulting from changes in the nature of the job or the quality of the work performed. All measures in this article are of base hourly wages, excluding bonuses and commissions. The weight applied to each job in the WPI survey reflects that job's share of the total wage bill of the economy. However, the implied share of the total wage bill accounted for by each pay-setting method will differ from that reported in the Employee Earnings and Hours (EEH) survey, which is the ABS's preferred measure of the distribution of earnings across the pay-setting methods.

Awards

In its Annual Wage Review, the FWC decides what the increase in award wages in the national workplace relations system will be. On 1 July 2019, the FWC will increase all award wages by 3.0 per cent, following an increase of 3.5 per cent in the previous year (Graph 4). In undertaking these reviews, the FWC is required to consider a range of factors, such as the effects of its decision on inequality, relative living standards and needs of the low-paid, and various macro outcomes such as productivity, competitiveness, inflation and employment growth.

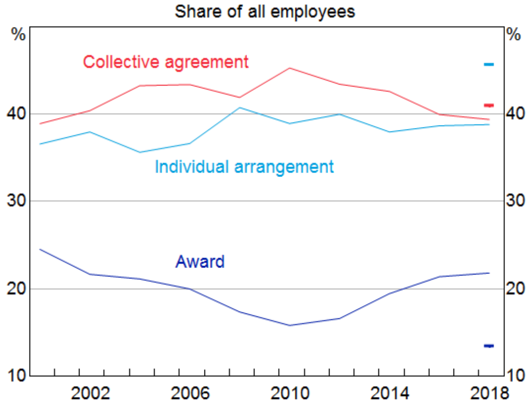
There is not necessarily full pass-through of FWC award wage decisions to the wages of those workers in award-reliant jobs because firms might not comply with the ruling. Nevertheless, the job-level data suggest there is considerable pass-through of award wage changes to wages for award-reliant jobs, as measured by the WPI. To see this, we need to distinguish between the 'modern awards' set by the FWC (which cover most award-reliant employees) and awards determined by separate state industrial commissions. Several state industrial commissions continue to set award wages for some employees. When we restrict the data to jobs covered by modern awards, there tends to be a tight relationship between the size of FWC increases and the size of wage rises for award-reliant jobs (Graph 5).[5] This is consistent with earlier analysis for the 1998 to 2008 period, which found that changes to awards were almost fully passed on to wages in award-reliant jobs (Bishop 2018). This earlier analysis also found no evidence to suggest that the modest, incremental increases to award wages during that period had an adverse effect on hours worked or the job destruction rate for award-reliant jobs.

The recent step-up in the size of FWC adjustments has provided support to wages growth at the lower end of the skill distribution, given the prevalence of award-reliant jobs in this part of the labour market.

Graph 2

Methods of Setting Pay*

Share of all employees



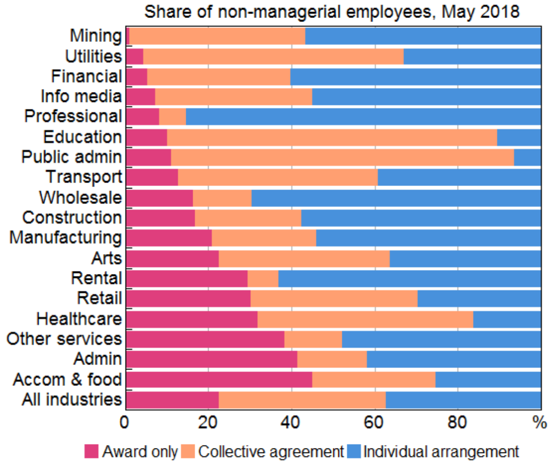
* Excluding owner-managers of incorporated enterprises; small dashed lines indicate share of the wage bill of each method in 2018

Sources: ABS; RBA

Graph 3

Pay Setting Methods by Industry

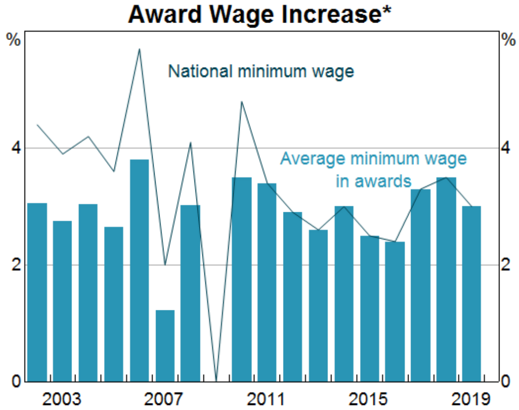
Share of non-managerial employees, May 2018



Source: ABS

Graph 4

Award Wage Increase*



* RBA calculations; the time period over which each increase applies varies

Sources: AFPC; AIRC; FWC; RBA

Wages growth for the least-skilled jobs (as defined by the ABS) has outpaced all other skill groups since around 2013 (Graph 6). This contrasts with the commodity price boom period, when wages growth was strongest for higher-skilled jobs. Consistent with this, the ratio of average hourly earnings of award reliant employees to those of other employees has risen since 2012, largely reversing the falls seen in the earlier period.

The four industries with the highest shares of award-reliant employees are accommodation & food services, administrative & support services, other services and retail trade. In these industries, more than 30 per cent of all employees are paid the award rate. Despite this, overall wages growth in these industries has not picked up materially because wages growth in the other pay-setting methods has been weak (Graph 7). This has occurred in part because wage freezes (where wages are unchanged for one year or longer) have become more common.

Enterprise Bargaining Agreements

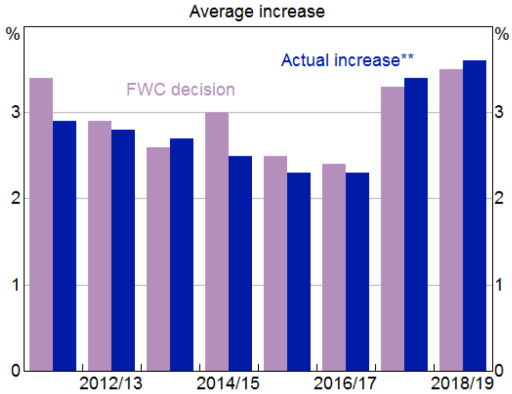
EBAs can be negotiated with or without union involvement although, under current legislation, unions are the default bargaining representatives of the employees provided that at least one of their members would be covered by the agreement. EBAs tend to have a duration of around three years; after the nominal expiry date, the terms and conditions in EBAs continue to operate until they are replaced with a new EBA or terminated by the FWC.

Wages growth in EBAs has been relatively steady at a low level in recent years. This reflects that public sector workers account for around two thirds of EBA employees and government policies have been in place in many jurisdictions to keep public wages growth steady at 2.5 per cent in recent years (Graph 8). There have, however, been some clear differences in recent outcomes across the public sector. Average wages growth for Commonwealth government jobs was around 1 per cent between 2014 and 2017, as protracted negotiations over new EBAs led to widespread wage freezes. Western Australian public sector wages growth is now the lowest across state governments following a period of above-average growth during the mining boom,

Graph 5

Pass-through of Award Changes to Wages*

Average increase



* Jobs covered by a modern award

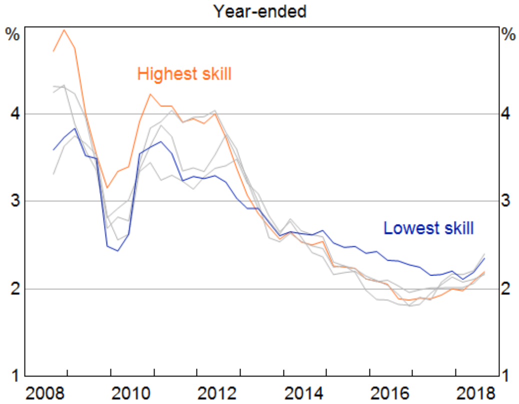
** 2018/19 is an estimate based on the September quarter 2018 data and an assumption about the pass-through over the remaining quarters

Sources: ABS; FWC; RBA

Graph 6

Wages Growth by Skill Level*

Year-ended



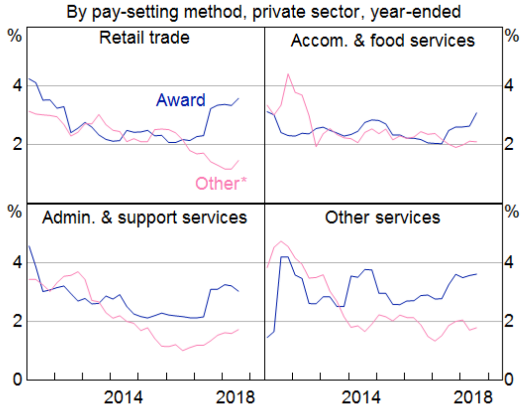
* The 'highest' and 'lowest' skill categories are ABS occupational skill levels 1 and 5, respectively; grey lines denote wages growth for skill levels 2–4

Sources: ABS; RBA

Graph 7

Wages Growth in Award-reliant Industries

By pay-setting method, private sector, year-ended



* Other includes jobs covered by EBAs and individual arrangements

Sources: ABS; RBA

while Victorian public sector wages growth has been relatively strong in recent years due to many workers receiving wage increases of around 3 per cent.

Within the private sector, wage freezes have become increasingly common due to lengthy negotiation delays for new EBAs. This has been most evident in the retail trade industry, with several of the major retailers operating under expired EBAs for an extended period of time during which employees' wages are frozen. More recently, several large retailers have signed new EBAs which should increase average wages growth in the industry.

Average wages growth for EBAs adjusts relatively slowly to changing conditions in the labour market because a new agreement is typically negotiated only every three years. However, wages growth in *new* EBAs can provide some leading information about the likely direction of average EBA wages growth. Information on wage outcomes in new EBAs is available in the Department of Employment, Skills, Small and Family Business Workplace Agreement Database (WAD). The WAD contains information on all federally registered EBAs, including the annualised average wage increases (AAWI) over the duration of the agreement and the nominal expiry date for each agreement. The AAWI in new private sector EBAs declined steadily between 2012 and 2017 (Graph 9). As expiring EBAs were replaced by new EBAs that had lower average wage growth outcomes, average EBA wages growth in current agreements also declined. More recently, the AAWI for new private sector EBAs has increased, which will put upward pressure on average EBA wages growth over time.

There are several important differences in how wages growth in EBAs is measured in the WPI and the AAWI. The AAWI measure does not capture the effect of wage freezes, while the WPI measure has been dampened by the effect of workers receiving no change in their pay for a period of time. The AAWI also only captures those agreements where wage increases are 'quantifiable'. That is, if wages in an EBA are linked in some way to something that cannot be quantified at the outset of the agreement, such as future FWC decisions or CPI outcomes, then they are not captured in the AAWI. This also includes cases where an EBA provides different wage rises for different groups of employees, or links wage increases to performance. Finally, the WAD will only include federally registered agreements, so will not capture AAWI for EBAs for most state public sector workers. Nevertheless, the AAWI for new agreements remains a key source of information for the outlook of aggregate wages growth.

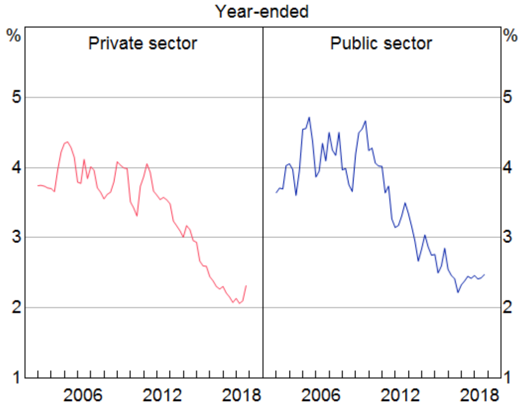
Individual Arrangements

Wages set by individual arrangements tend to be more responsive to the economic cycle than wages set by other pay-setting methods. In particular, the inverse relationship between wages growth and the unemployment gap, known as the wages Phillips Curve, is stronger for those on individual

Graph 8

WPI Growth in EBAs

Year-ended

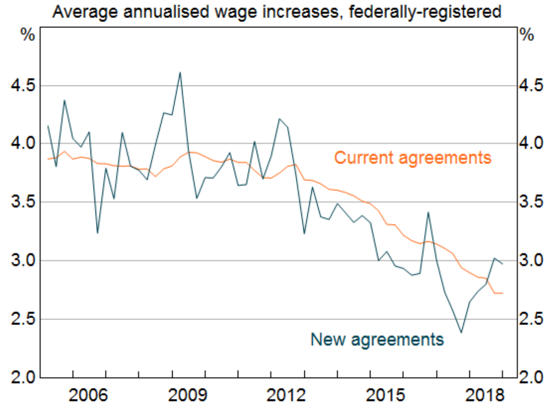


Sources: ABS; RBA

Graph 9

Private Sector EBAs

Average annualised wage increases, federally-registered



Source: Department of Employment, Skills, Small and Family Business arrangements than for other pay-setting methods (Graph 10).[6] We find that a 1 percentage point decline in the unemployment gap tends to increase annual wages growth for jobs on individual arrangements by around 1.1 percentage points, which is larger than the response for EBAs and awards. Further analysis suggests that this does not simply reflect that individual arrangements are more prevalent in cyclical industries, such as mining and professional, scientific & technical services.

The cyclical sensitivity of individual arrangements was evident during the 2000s mining boom. During the boom, wages growth for jobs on individual arrangements in mining and mining exposed parts of the labour market rose strongly, as competition for labour intensified (Graph 11). Then from 2012, wages growth declined sharply as demand for labour softened after the boom. Wages growth for individual arrangements also fell sharply when the unemployment rate increased in 2009. By comparison, wages growth for EBAs was broadly unchanged over these periods (Graph 1). The cyclical sensitivity of individual arrangements, along with their large weight in the wage bill, means they account for much of the high-frequency cyclical variation in the WPI.

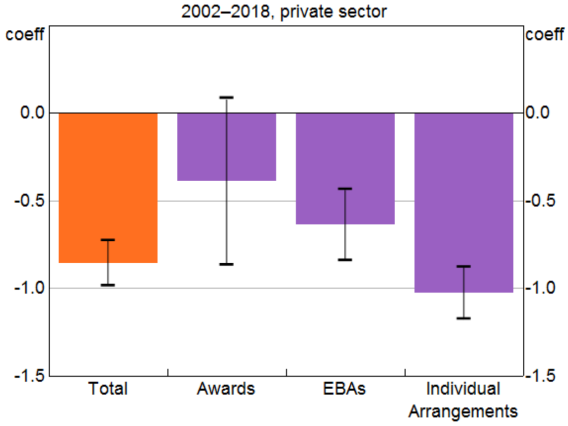
Although wages growth in individual arrangements is more responsive to changes in demand, the wage *levels* for these arrangement are still very rigid downwards. That is, while firms adjust the *growth rate* of wages in response to changing demand, they are usually unable or unwilling to cut the *level* of wages. The share of jobs on individual arrangements that experienced cuts to their base wage was only 4 per cent between 2011 and 2014, and is now less than 2 per cent. Rather than seeing wage cuts during a period of ample spare capacity in the labour market, workers on individual arrangements were frequently subject to wage freezes (Graph 12). Indeed, until recently, close to 40 per cent of all jobs on individual arrangements had their wages frozen for at least a year.[7] However, even during periods of strong labour demand, around one in every four jobs on individual arrangements tends to have their pay reset less than once a year.

Year-ended wages growth for individual arrangements has picked up recently, rising by

Graph 10

Slope of Wage Phillips Curve*

2002–2018, private sector



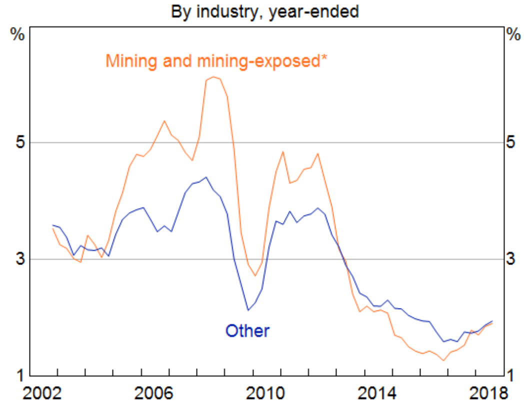
* Black lines denote 95 per cent confidence intervals; data are annualised

Sources: ABS; RBA

Graph 11

Wages Growth in Individual Arrangements

By industry, year-ended



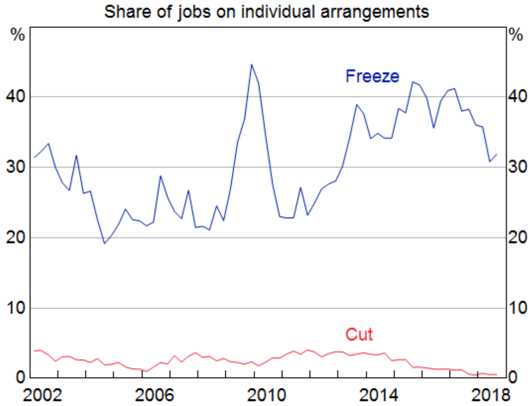
* Includes mining, construction and professional, scientific & technical services

Sources: ABS; RBA

Graph 12

Wage Freezes and Cuts

Share of jobs on individual arrangements



Sources: ABS; RBA

½ percentage point since 2016 (Graph 1). Two thirds of this recovery has been driven by a cessation of earlier wage freezes. The average size of wage changes – conditional on a change – has also ticked up slightly for jobs on individual arrangements. In part, these developments reflect the decline in the unemployment rate over the period, which our analysis suggests will show up first in wages growth for individual arrangements before any other pay-setting method. Part of the recovery also reflects spillover effects from the larger-than-average award increases, as discussed below.

Effect of the Annual Wage Review on Other Wages

The FWC's Annual Wage Review can affect wages for those on individual arrangements or EBAs. For example, some employees on EBAs or individual arrangements have their wages set above the award, but are directly linked in some way to FWC decisions.[8]

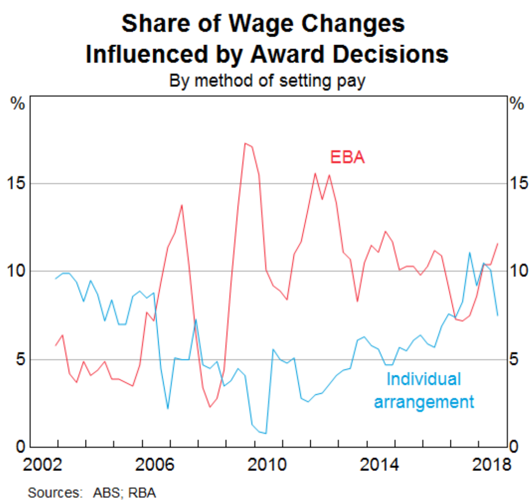
Using the micro WPI data, we use two methods to estimate the share of 'award-influenced' jobs. These estimates will essentially be a lower bound because they only capture direct effect and cannot capture indirect effects, such as a change to other wages within a firm to maintain wage differentials between award-reliant and other employees.[9] The first method uses information provided by a firm in the WPI survey about *why* a particular job's wage changed in the quarter. For EBAs and individual arrangements, we can estimate the share of award-influenced jobs by looking at the share of wage changes for which 'FWC decision' or 'State wage case' was listed as a factor contributing to the wage change.[10] This suggests that around 12 per cent of all wage changes in EBAs and 8 per cent of all wage changes in individual arrangements (after accounting for each job's overall weight in the WPI) are influenced by award decisions (Graph 13). The share of jobs on individual arrangements for which pay is influenced by award decisions has more than doubled since 2012.

The second method is to look for evidence of a clustering of wage changes around FWC decisions. To see this, we compute the wages growth for all jobs covered by an EBA or individual arrangement in recent years, and then 're-centre' them on the FWC increase for that year by subtracting the size of the FWC increase (Graph 14). This shows that around 6–6½ per cent of jobs on EBAs and individual arrangements had wage rises that fell within ±0.05 percentage points of the FWC decision between 2015 and 2017. The reason these estimated shares are smaller than those estimated using the first approach is that this method can only identify cases where the job received the same *percentage* wage increase as the FWC outcome. For example, in some of the retail EBAs that have recently been agreed upon, new employees will be paid a fixed *dollar* amount above the wage specified in an award, but will generally receive a smaller *percentage* increase in their hourly wage than that announced by the FWC.

In addition to the increase in the share of individual arrangements linked to FWC decisions as reported in the WPI survey, data from the WAD suggests that there has also been a recent increase in private sector EBAs that have pay rises that will be linked automatically to FWC award decisions; this includes a number of the larger retail EBAs that have been negotiated over the past year.

This analysis is useful in estimating the overall contribution of FWC decisions to aggregate wages growth. However, it is less appropriate for estimating how many *jobs* have wages that are affected by FWC decisions. The share of jobs affected by FWC decisions is likely to be higher than

Graph 13



the (wage-bill-adjusted) shares presented in this section because jobs with wages linked to FWC decisions are likely to be paid less on average than other jobs in the same pay-setting stream, and therefore have lower wage-bill shares. This also helps to reconcile why the WPI micro data appear to generate smaller estimates of award spillovers than Wright and Buchanan (2013), who found that around 20 per cent of private sector employees surveyed had their pay 'set, influenced or guided' by the award (excluding those on EBAs with pay rises linked to awards).

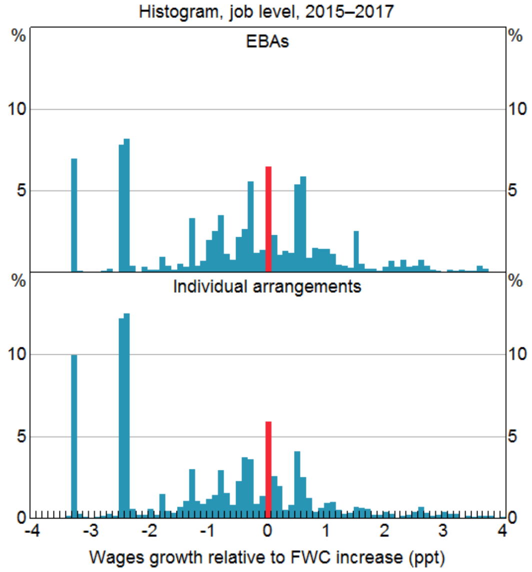
Outlook for Wages Growth

Differences in wage dynamics across the pay-setting methods suggest there is value in deriving separate wages growth forecasts for each method, which can then be aggregated using their expenditure weights in the EEH. While the data on wages by pay-setting method are not currently updated by the ABS on an ongoing basis, considering the outlook for wages based on the available data discussed here can provide a useful cross-check on conventional forecasts of economy-wide wages growth. It is also be useful for scenario analysis, including modelling the impact of award

Graph 14

Wages Growth Relative to FWC Increase*

Histogram, job level, 2015–2017



* Wages growth is year-to-June and weighted using WPI weights; jobs with wages growth more than 4 percentage points above or below the FWC are included in the histogram but not shown; height of red bar indicates share of jobs with wages growth equal to FWC increase

Sources: ABS; RBA

wage increases or a change in government policies for public sector wages.

To forecast awards, we use recent actual outcomes and judgement about the likely future outcomes of the FWC's Annual Wage Reviews to project wages growth over the two years of the forecast period. Judgement is used for future outcomes because the broad considerations and objectives of the FWC in the Annual Wage Review make it difficult to model award wages growth statistically using the traditional determinants of wages growth. The 3.0 per cent increase in award wages from 1 July 2019 is expected to directly contribute around ¼ percentage points to aggregate wages growth over the year, which is similar to recent years. However, as discussed earlier, the contribution of the FWC's Annual Wage Review to aggregate wages growth *as measured by the WPI* may differ from this estimate to the extent that the WPI uses a different assumption to the EEH about the wage-bill share of award-reliant employees.

For EBAs, we largely use information from the WAD on federally registered EBAs to develop forecasts. We also collect similar information for current public sector EBAs that are not captured in the WAD. Because EBAs can lock in a profile of wage rises for up to four years, we can be quite certain about the wage outcomes of those agreements up to the nominal expiry date. If an agreement expires during our forecast period, we assume it is rolled over to a new agreement with a wage outcome that is consistent with government policies for public sector wages and other factors, such as the state of the labour market, which is forecast to strengthen a little further in the next couple of years. Average wages growth for EBAs is expected to increase a little over the next few years, as wage freezes are expected to become less common and as wages growth in new private sector EBAs moves higher.

As wages growth in individual arrangements were shown to have the tightest relationship with the unemployment gap, we use the specification of our preferred Phillips Curve model for private sector WPI growth to forecast wages growth for individual arrangements. The model includes variables capturing growth in domestic prices, changes in the unemployment rate, the unemployment gap, inflation expectations and lagged wages growth. The model 'fits' the data better for individual arrangements than for other wages; around 82 per cent of the variation in wages growth for individual arrangements over the period 2002–18 can be explained based on these cyclical factors. For this reason, these wages can be thought of as a bellwether for broader wage pressures arising from a tight labour market (or conversely, disinflationary pressure from excess labour market slack). Overall, we expect the forecast gradual tightening of the labour market over the next couple of years to feed through into slightly stronger wages growth for those on individual arrangements. However, one risk to the outlook is that those firms that had been unable to reduce wages during the period of ample capacity may instead give their employees smaller wage rises than usual as the labour market tightens.

Overall, these outlooks for the various pay-setting methods support the forecast for wages growth as published in the Bank's recent *Statement on Monetary Policy*, which suggests a gradual pick-up in wages growth over the next couple of years.

Conclusion

Disaggregating wages growth by pay-setting method has improved our understanding of the drivers of the low wages growth in recent years. The disaggregation can also be used to produce a more detailed outlook for wages growth. At this stage, this disaggregation is not available to be updated by the ABS on a regular basis. Nevertheless, using this framework and the available information on wages growth for each pay-setting method, such as award wage decisions and new EBAs, can usefully inform our outlook for wages growth on an ongoing basis.

Footnotes

[*] James Bishop is from the Economic Research Department and Natasha Cassidy is from the Economic Analysis Department. The authors would like to thank the Prices Branch at the ABS, in particular Darryl Malam and Luci Burrage, for sharing their time and expertise.

[1] The period covered in this analysis is March quarter 2002 to September quarter 2018. The ABS has also conducted analysis of the WPI by pay-setting method (Page 2018).

[2] This analysis excludes owner-managers of incorporated enterprises as they determine their own rate of pay. In 2018, these workers accounted for 6 per cent of total employment.

[3] In Australia, the National Minimum Wage sets a legal floor on wages. There is also a detailed system of award wages that are layered on top of the National Minimum Wage, and these rates depend on the industry, age, skill level and qualifications of an employee. In this analysis, employees are classified as award reliant if they are paid at the rate of pay specified in the relevant award.

[4] An individual arrangement can include an individual contract, individual agreement registered with a Federal or State industrial tribunal or authority, common law contract (including for award- or agreement-free employees), or an agreement to receive over-award payments.

[5] The WPI data show that four fifths of the wage adjustment to FWC decisions comes through in the September quarter, although some award-reliant jobs also experience wage adjustments in subsequent quarters. Graph 5 calculates the cumulative change in wages from the June quarter prior to the FWC decision to the June quarter of the following year.

[6] The slope coefficient is estimated using a simple regression of annualised quarterly wages growth on the first lag of the unemployment gap (difference between the unemployment rate and the Reserve Bank's estimate of the non-accelerating inflation rate of unemployment (NAIRU)). Confidence intervals are based on Newey-West standard errors.

[7] A broader measure of hourly earnings that include bonuses also displays downward rigidity, but to a lesser extent than base wages.

[8] In some cases, these 'spillovers' are even more direct. For example, some employees classified by the ABS as being on an EBA have their wage set at the exact award rate. These employees are generally entitled to receive the full award increase handed down by the FWC. This classification reflects that there are other non-monetary conditions in the EBA that separate it from the Award conditions.

[9] Influential surveys by Bewley (2002) suggest firms are acutely aware that their workers make wage comparisons with their colleagues. In Australia, awards also provide the benchmark for the 'better off overall test' for EBAs. See Autor, Manning and Smith (2016) and Low Pay Commission (2019) for recent empirical estimates of spillover effects for the United States and United Kingdom respectively.

[10] The other response options in the survey are 'Change in grade or class', 'Change in age scale or increment within level', 'Collective agreement', 'Salary review' and 'other'. Data on the sources of wage changes are available in around 70 per cent of all instances in which a wage change is observed. We restrict our attention to the sample of wage changes for which information on the source of the wage change is available.

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Spillovers to Australia from the Chinese Economy

Rochelle Guttmann, Kate Hickie, Peter Rickards and Ivan Roberts[*]

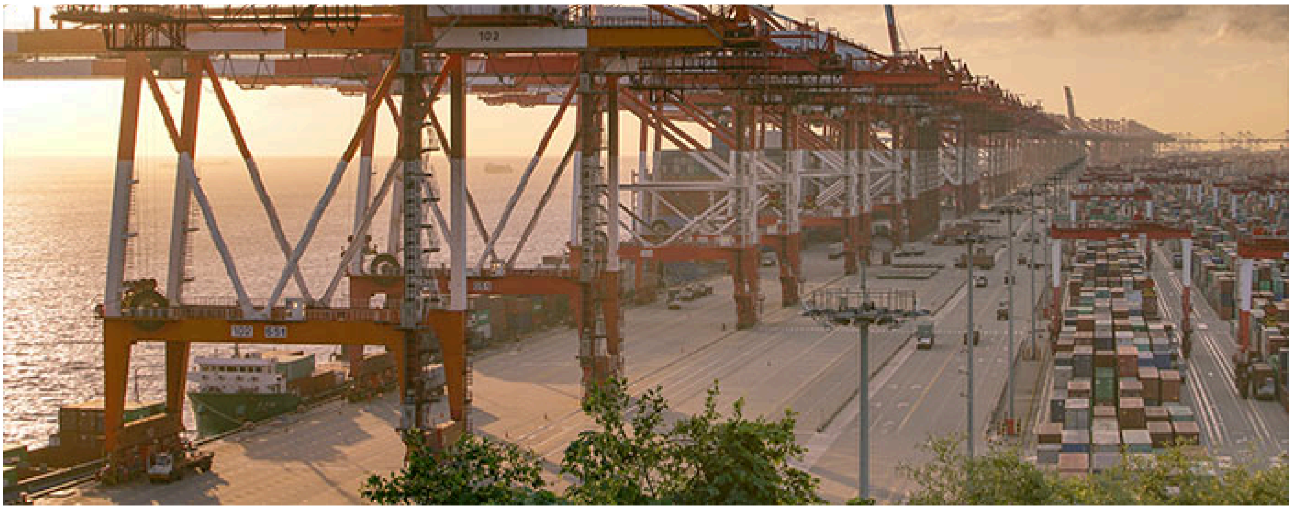


Photo: Yaorusheng – Getty Images

Abstract

China is Australia's largest trading partner. The strong links between the two economies raises the question of how a sizeable slowdown in Chinese activity would affect Australia. Through our research we have attempted to quantify how such a scenario could play out and its implications. We consider the main transmission channels, notably trade and financial market effects, and describe possible scenarios that could lead to a material slowing in China. We apply a stylised shock encapsulating features of these scenarios to a medium-sized macroeconometric model of the Australian economy and analyse how the shock is transmitted through real and financial channels. The potential for the exchange rate and monetary policy to offset some of those effects is also examined.

Introduction

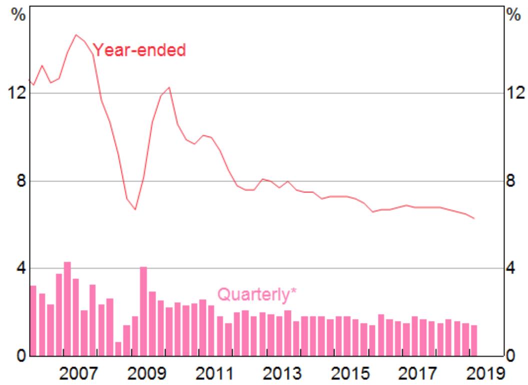
Over the past decade, the Chinese economy has experienced growth averaging almost 8 per cent annually, underpinned by rapid urbanisation, industrialisation and increasing openness to world trade (Graph 1). The resource-intensive nature of China's development has meant that Australia's exports to China have expanded quickly over this period, driven by bulk commodities such as iron ore and coking coal. As a result, China has become Australia's largest trading partner, accounting for nearly one-third of Australia's exports, and around one-fifth of Australia's imports. Given the strong links between the two economies, the risk of a slowdown in China is often highlighted as a key uncertainty for Australia's economic outlook.

The pace and composition of China's growth has been changing. The sharp stimulus-driven increase in activity that occurred in the aftermath of the 2008–09 global financial crisis (GFC) was led by infrastructure investment and residential construction, funded largely by debt, which drove a surge in Australian commodity exports to China. However, this surge proved temporary. Since the early 2010s, growth has eased, accommodated by Chinese Government policies designed to put the economic trajectory on a more sustainable footing. Official statistics indicate that Chinese GDP growth declined from around 10 per cent in 2011 to 6.6 per cent in 2018. Over that period, the investment share of GDP declined from 45 per cent to 43 per cent, while the household consumption share rose from 36 per cent to 39 per cent (Graph 2).

While Australia's exports of commodities to China have remained high, the nascent rebalancing of the Chinese economy towards a more consumption-driven pattern of growth is likely to weigh on resource exports in the longer term (Ma, Roberts and Kelly 2016, 2017; Roberts *et al* 2016). Nonetheless, changing patterns of Chinese demand are creating new opportunities for Australian exporters. Exports of services, especially education, have recorded double-digit growth in recent years and manufactured food exports (such as dairy products and food supplements) have expanded rapidly due to demand from China's growing legion of middle-class consumers.

Graph 1

China – GDP Growth



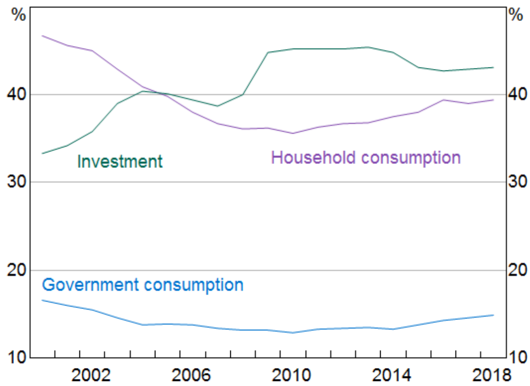
* Seasonally adjusted RBA estimates prior to December quarter 2010

Sources: CEIC Data; RBA

Graph 2

China – Components of GDP

Share of nominal GDP



Sources: CEIC Data; RBA

The considerable exposure of the Australian economy to the pace and composition of growth in China raises the question of how the Australian economy would be affected by a substantial shock to Chinese growth. In recent years, Australian Government agencies and private sector analysts have repeatedly acknowledged the risk posed by a potential financial disruption, and related economic downturn, in China for the Australian economy (for example, see Australian Treasury 2018; RBA 2019). In this article, we attempt to quantify how such a scenario could play out in practice and its implications. The first section discusses key trade, investment and financial linkages between the Chinese and Australian economies that constitute the main channels through which a shock could be expected to spill over from one economy to the other. The second section considers how a large negative shock could plausibly occur in China and the possible forms it could take. The third section analyses the transmission of such a shock to the Australian economy through the lens of a medium-sized macroeconometric model of the Australian economy. We conclude with an assessment of how this exercise helps inform assessments of the risks that fluctuations in the growth of our largest trading partner pose to domestic conditions in Australia.

Main Channels of Transmission to Australia

A shock to the Chinese economy could affect Australia via a range of channels. Trade is likely to be the most significant channel given the strong direct trade links between Australia and China. In the event of a sharp slowdown in China, it is also likely that global commodity and financial markets would be affected, which could amplify the negative effects of a decline in export volumes. Of course, the exact nature of the slowdown in China would have ramifications for the size and nature of the spillovers to Australia.

Trade

Over the past decade, China has overtaken Japan as Australia's largest destination for exports, and has overtaken the United States to become Australia's second-largest source of imports (Graph 3). China's share of Australian exports has roughly tripled, and its share of imports roughly doubled, over this period. Since early in the current decade, China has steadily displaced all other major trading partners (MTPs) as a destination for Australian exports (Graph 4).

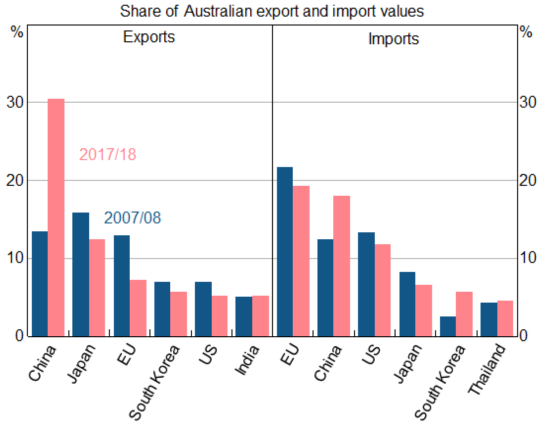
Resource exports continue to play an important role in Australia's strong trade links with China. Indeed, although iron ore export volumes to China have been relatively stable in recent years, they have remained at a high level (Graph 5). Meanwhile, exports of both coking and thermal coal have been rising. The continuing importance of resource commodities in bilateral trade between the two economies implies that Australia would be particularly susceptible to any easing in Chinese growth that led to a fall in steel production, and hence demand for imported iron ore and coking coal. Nevertheless, the fact that Australia is a low-cost supplier of iron ore and supplies a higher average quality of coking coal than can be mined domestically in China, may help to limit the impact (RBA 2014). Furthermore, Chinese demand for some other resources that Australia produces is less dominant. Overall, China accounts for around 40 per cent of Australia's resource exports.

Other exports could also be affected materially by a negative shock to growth in China. Since the early 2010s, China has become the largest market for Australian service exports. Education and tourism services are the two largest categories of service exports to China, suggesting that Australia is likely to be vulnerable to a shock to the Chinese economy that causes a sizeable easing in household income growth (Graph 6). As noted above, China is also the largest destination for a range of other export categories (Graph 7). These include alcoholic beverages, such as wine; they also include food items, such as milk products, which make their way to China both via direct trade and more informal retail mail-order ('*daigou*') businesses. Furthermore, since a slowdown in activity in China is also likely to trigger an easing in activity in a range of other

Graph 3

Australia – Key Trading Partners

Share of Australian export and import values

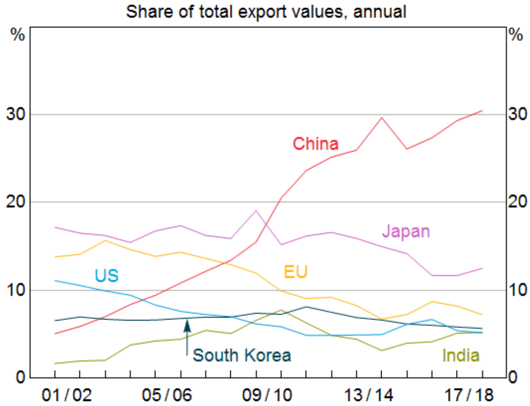


Sources: ABS; RBA

Graph 4

Australia – Exports by Destination

Share of total export values, annual

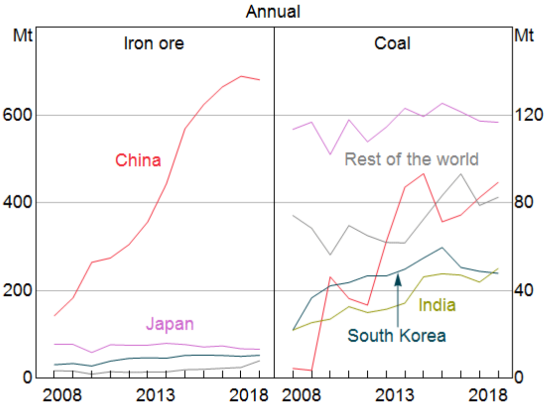


Sources: ABS; RBA

Graph 5

Australia – Exports by Destination

Annual



Sources: ABS; RBA

economies, the impact on the external sector is likely to extend well beyond the direct trade channels discussed above.

Global commodity and financial markets

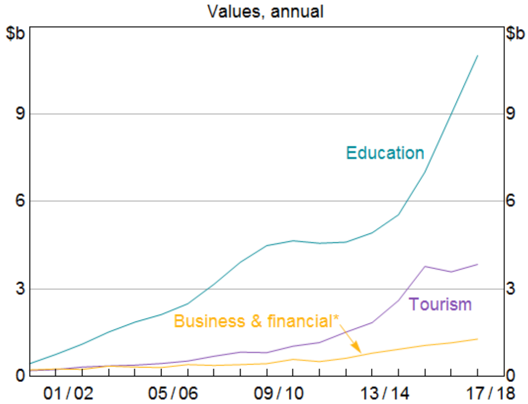
China is a key source of demand in a number of major commodity markets and, as a consequence, a slowdown in economic activity in China could lead to sizeable falls in some commodity prices. Most relevant for Australia, China consumes almost half of the world's steel and is the largest consumer of its raw components – iron ore and coking coal (Graph 8). All else being equal, a surprise slowdown in Chinese economic growth would be likely to trigger a decline in the prices of these commodities, which in turn would weigh on Australia's terms of trade. In addition, as China is now the world's largest importer of oil, a slowdown in China is likely to weigh on oil prices (EIA 2018). Significant growth in exports of liquefied natural gas in recent years has seen Australia shift from being a net importer to a net exporter of oil-related products; therefore, a decline in the price of oil would also tend to reduce the terms of trade. Falls in commodity prices would have direct implications for mining revenues and investment, and indirect consequences for government revenue, shareholder profits and the demand for (and wages of) workers in the resources sector.

A substantial slowdown in Chinese economic growth could have a significant impact on global confidence and financial markets, especially equity prices, with implications for confidence and financial conditions in Australia. However, direct financial linkages between Australia and China are relatively small. Chinese direct investment in Australia accounted for only 4 per cent of the total flow of foreign direct investment into Australia in 2018. Meanwhile, at the end of 2018, Australian direct investment in China accounted for only around 2 per cent of the total stock of Australia's direct investment abroad. Australia's exposure to China via banking links is also fairly limited (Graph 9). While banking exposures have increased significantly from a very small base over the past decade, in 2018, only 4 per cent of the total international exposure of Australian-owned banks related to China. There has been a rise in lending by Chinese banks in Australia, which could be unwound in a Chinese slowdown scenario.

Graph 6

Australia – Service Exports to China

Values, annual



* Includes business travel, insurance & pension, financial, use of intellectual property, telecommunications, computer & information services and other business services

Sources: ABS; RBA

Graph 7

Australia – Manufactured Food Exports*

Values, annual

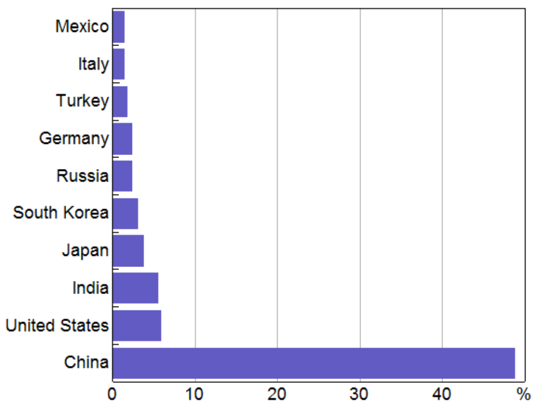
* Includes some items classified as rural exports in Balance of Payments

Sources: ABS; RBA

Graph 8

Steel Demand*

Share of world steel demand in 2018



* Finished steel products

Sources: RBA; World Steel Association

Nonetheless, lending by Chinese banks still only accounts for around 4 per cent of all business loans issued and less than 1 per cent of all loans issued to households.

Potential Scenarios for a Sharper Economic Slowdown in China

As noted above, Chinese economic growth has been trending lower since the early 2010s as structural factors, such as a declining working age population, have weighed on growth. So far the slowdown has been fairly contained and most forecasters are predicting a further relatively modest decline in growth in the coming years. The consensus among private sector analysts is that growth will ease to 6.3 per cent in 2019 and 6.0 per cent by 2020. That said, there are a number of conceivable scenarios in which economic growth could slow much more sharply than this in the period ahead.

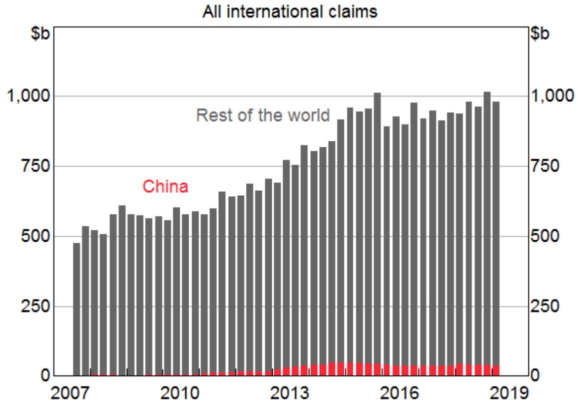
If a sharper slowdown in economic growth were to occur in China, it is likely that it would result from some combination of the following factors:

1. *Property market shock:* As in many economies, property (and land) is a crucial component of the collateral base of the entire Chinese financial system. Residential construction activity also makes a significant contribution to economic growth. Eftimoski and McLoughlin (2019) estimate that, taking account of direct and indirect industry linkages, real estate investment contributed an average of 2.0 percentage points to annual real GDP growth between 2003 and 2017.
2. *External demand shock:* While net exports were a small drag on Chinese GDP growth in 2018, the manufacturing export sector accounts for a significant amount of employment and has close linkages with a wide range of upstream sectors. Moreover, there is a precedent for the export sector to have a large effect on growth in the event of a sharp decline in foreign demand. Following the sharp decline in external demand associated with the GFC, net exports reduced Chinese GDP growth by 4.0 percentage points and 1.3 percentage points in 2009 and 2010.
3. *Policy coordination issues:* As economic activity has continued to moderate in China, authorities have emphasised that they will not resort to the magnitude of fiscal and monetary easing introduced during the GFC and that policy will remain fairly targeted. Such an approach allows the authorities to continue to implement 'supply side' policies aimed at making growth more sustainable by reducing debt and overcapacity (see Boulter 2018). But it does present the risk that, if the current measured policy easing proves ineffective, the slowing in GDP growth could accelerate before policy has time to react.
4. *Systemic financial disruption:* China has relied heavily on investment, funded by debt, as an engine of growth. While effective at improving living standards over time, it has also generated additional risks for the economy. These risks stem not just from high debt levels, but also broader risks in the financial sector as a result of off-balance sheet lending and concerns around the quality of some of the debt issued. The interconnectedness between the banking and shadow banking sectors means any shock could spread rapidly throughout the financial system.

Graph 9

Australian-owned Banks' Total International Exposures*

All international claims



* Ultimate risk basis

Sources: APRA; RBA

While there is a broad range of potential triggers for a more severe slowdown in economic growth in China, in recent years authorities have proved capable of responding to individual episodes that posed systemic risk. For example, in mid 2015, the government managed to contain the fallout from sharp declines in the Chinese stock market, prompted by the collapse of sentiment among retail investors at the height of a leverage-fuelled speculative 'bubble' in the market. Similarly, in 2016 and 2017, authorities acted aggressively to tighten existing capital controls, impose new ones and increase their control over the renminbi to prevent capital flight and avert a much sharper currency depreciation (McCowage 2018). Over the past year or so, the government has strengthened regulatory oversight of the financial sector and taken steps to reduce shadow financing activity to reduce the risks of a future financial disruption or crisis. In light of all this, it seems most likely that a sharp slowdown in activity would occur in a scenario in which a number of these shocks coincide and authorities struggle to respond effectively to all shocks simultaneously. There are clearly many potential combinations of shocks that could lead to a notable slowdown in China; one illustrative scenario is sketched out below.

The success that authorities have had to date in preventing a collapse in property prices or a sudden stop in construction activity suggests that policy-makers may well be able to avoid a sharp slowdown originating in the property sector. However, if weakness in property markets coincided, for example, with a pick-up in defaults on shadow banking loans that triggered widespread concern about the health of the financial system, the consequences would be harder for authorities to address. The resulting confidence effect could be expected, among other things, to weigh on equity prices and spur an increase in capital outflows, placing downward pressure on the exchange rate. While the currency depreciation would act as a buffer to domestic weakness, authorities might not be willing to allow that to occur, given their stated policy of maintaining currency stability.[1] In that event, policymakers would have limited capacity to respond to the slowdown with a monetary easing, at a time when local governments would already be facing a strain on their ability to raise funds as a result of reduced revenue from land sales due to falling property (and land) prices. In other words, authorities would encounter a scenario in which the economy is facing several headwinds at once but the presence of multiple policy objectives may limit their capacity to respond, increasing the chances of a sharp slowdown.

Macroeconomic Consequences of a Chinese Economic Slowdown for Australia

Quantifying the channels of transmission

To explore how a slowdown in Chinese economic conditions could influence the Australian economy, we conduct scenario analysis using MARTIN, the RBA's macroeconometric model.[2] Using a model allows us to quantify and trace through the implications of a change in overseas activity to domestic economic activity, and then from these variables to the labour market and prices. MARTIN accounts for interactions and feedback between all of these variables. Some financial market channels are also included, although banking-related channels are limited. We are able to include many of the channels described above, although most of these are captured as linear relationships and with differing levels of detail. A limitation of such macroeconometric models is that they are based on average historical relationships, and so may not encompass large movements in variables that have not occurred in the past.

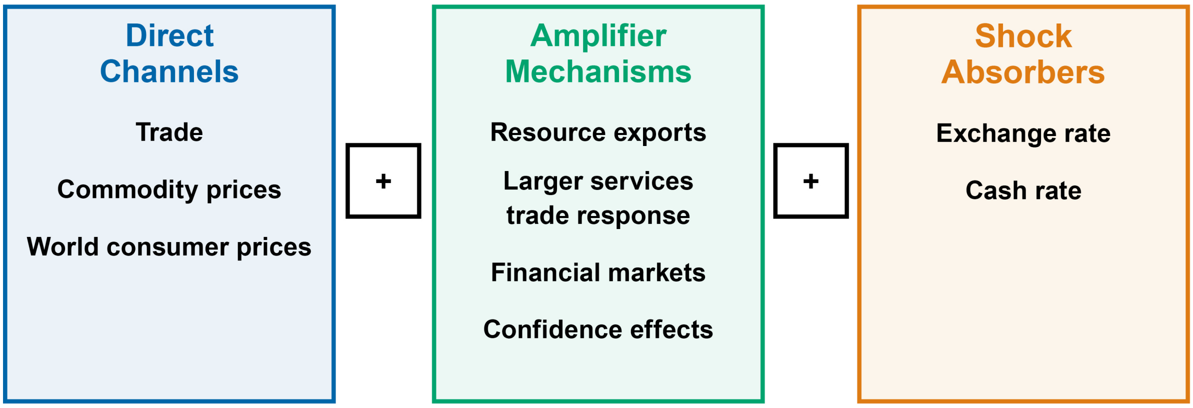
As the starting point for the scenarios, we assume a 5 per cent fall in the level of Chinese GDP relative to current forecasts. This results in a trough in year-ended growth of 2 per cent, compared with a baseline forecast of around 6 per cent after the first year (Graph 10). Note that Chinese GDP growth is already expected to decline; the scenario represents a shock to the economy that sees a much sharper decline than forecast. This number is chosen to be illustrative of a pronounced slowdown and we do not assign a specific probability to such an event occurring.

The magnitude of the slowdown is smaller than what occurred during the GFC, but lasts a similar amount of time, with growth returning to its pre-crisis trend after two years. Even so, the level of Chinese GDP in the scenario is permanently below what it would have been in absence of the slowdown. We assume that Chinese policymakers

Figure 1

Channels of Economic Transmission from China to Australia

Key scenario mechanisms



Source: RBA

respond to the slowdown with policy stimulus measures to prevent a more severe outcome. However, the resulting recovery in growth is somewhat less rapid than that observed during the GFC. This reflects the fact that, in responding to other policy objectives (such as deleveraging), Chinese policymakers may be more constrained in their ability to counteract a sharp fall in growth today than they were in the late 2000s. We do not examine how alternate triggers for a Chinese slowdown, or alternative paths for Chinese policy, would affect Australia differently. Instead, we assume a general slowdown that could arise from a combination of several shocks such as those described above.

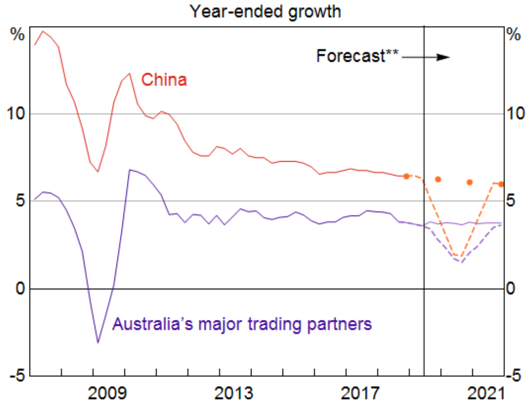
We build three scenarios to illustrate the channels through which Chinese economic conditions could affect Australia, which we discuss in detail below (Figure 1).[3] First, we examine the effects of the slowdown through the trade and commodity market linkages between the two countries. As described above, these are the most direct channels through which a slowdown in Chinese growth would affect the Australian economy. Global consumer prices also respond. Next we examine financial and other indirect linkages. This includes confidence effects, world interest rates and other factors that are likely to come into play in the case of a severe or unexpected slowdown, which could amplify the effects described in the first scenario. In these two scenarios, we hold Australia's cash rate and exchange rate fixed, which allows us to isolate the consequences of a foreign slowdown independently of other economic developments. In the third scenario, we allow the cash rate and exchange rate to respond, which mitigates some of the negative consequences of the economic slowdown.[4]

While large, the size of many of the mechanisms incorporated into the model – even in the amplifier scenario – are less than the movements experienced during the GFC (such as MTP growth and commodity price movements). As such, the outcomes of the scenarios, in terms of output and

Graph 10

China and Major Trading Partner GDP*

Year-ended growth



* Dotted lines indicate scenarios; coloured dots indicate IMF figures in year-average growth terms

** Chinese and MTP baseline forecasts are based on IMF and RBA forecasts respectively

Sources: ABS; CEIC data; IMF; RBA; Refinitiv inflation, for example, tend to be less than what was seen during the GFC period. These scenarios also do not assume a financial crisis as a result of the slowdown, as was seen during the GFC. As a result, credit availability channels are assumed to be far less important in the scenarios.

Direct-channels scenario

Given the strong trade links between Australia, China and many other Asian economies, a slowdown in Chinese growth would lead to less demand for many Australian products. In MARTIN, global demand is captured through changes in Australia's MTP growth. As MTP GDP is weighted by exports and China accounts for 40 per cent of Australia's MTP exports by destination, a 5 per cent decline in Chinese GDP mechanically lowers output of Australia's MTPs by 2 per cent. However, a slowdown in China will also affect economic activity in other economies. We assume that a shock in China would spill over to Australia's other trading partners, particularly in Asia and, in aggregate, we estimate the shock to lower output of Australia's MTPs by around 2.5 per cent.[5] The major advanced economies would experience a smaller but still notable decline in their economic output relative to what would have been the case if China did not experience an economic slowdown. Therefore, this scenario captures a decline in global demand and trade from both China and the other economies that have connections with China.

The other key standard channel we consider is commodity prices. Our scenario has commodity prices declining by 25 per cent after three quarters and global consumer price inflation declining by a peak of 1.2 percentage points after two years.[6] This reflects China's outsized role in global commodity markets and the downward pressure on world prices that would come from a slowdown in Chinese investment and spending. However, the lower aggregate demand in China and resulting commodity price falls do not necessarily lead to a decline in Australian resource export volumes. As outlined above, Australian bulk commodity producers are among the most efficient, low-cost and high-quality producers. As such, the Australian resource exporters may be well placed to withstand price and demand declines. Consequently, we leave resource export *volumes* unchanged relative to the baseline forecast (but allow *values* to respond) in the direct-channels scenario, which is broadly consistent with Australia's experience during the GFC. We revisit the response of resource exports when examining the amplifier scenario.

In the direct-channels scenario, the MARTIN model suggests that the level of Australian GDP would contract by 1.3 per cent, relative to its baseline, over the first three years (Graph 11).[7] This translates to year-ended GDP growth being up to 0.8 percentage points lower than in the baseline case of no negative shock to the Chinese economy. There would be a fairly immediate trade response, with the level of non-resource export volumes declining by up to 1.5 per cent relative to baseline after two years and lowering GDP by 0.3 percent after three years. Trade in the services and manufacturing sectors experiences the largest falls, which reflects China's significant demand for Australian tourism, education and manufactured food exports. Business investment is slower to respond, but would be expected to decline by more than 5 per cent over three years. This investment response is largely driven by resource firms responding to the lower commodity prices. The decline in world consumer prices helps support Australian imports and consumption, but its effect is small and short lived.

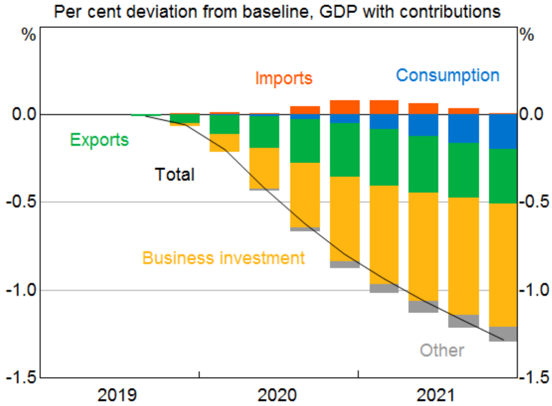
Amplifier-mechanisms scenario

The amplifier scenario includes additional factors that could be present in a large disorderly

Graph 11

Australian GDP – Direct Channels Scenario

Per cent deviation from baseline, GDP with contributions



Source: RBA

downturn in the Chinese economy. These mechanisms are expected to compound the effects of the standard trade and price channels. The amplifying channels we capture in this scenario are trade and confidence related, as follows:

- **Service exports** – In the direct-channels scenario, growth in service trade is 4 percentage points lower over two years, relative to baseline. However, given China's importance in the travel and education sector, the decline could be larger. This is because the discretionary nature of foreign travel and education make their demand highly sensitive to income. Tourists from China also tend to spend more than the average tourist (Rickards 2019). As such, we increase the effect of a slowdown in the travel and education services trade. Growth in services declines by an additional 2 percentage points to be around 2 per cent in the first year, roughly 6 percentage points below the baseline (Graph 12).
- **Resource exports** – In the MARTIN model, it is assumed that all the resources that Australia produces are sold, given the high quality and low cost of Australia's resources. As such, global demand does not directly affect resource exports volumes. However, in the event of a severe decline in Chinese demand, it is possible that some marginal resource producers will stop production. To account for this possibility, we lower resource export volumes by 2.5 per cent.[8]
- **Financial channels** – Although there are relatively few links between the Australian and Chinese banking and financial systems, developments in the Chinese economy are influential for global financial markets.[9] A deterioration in Chinese economic conditions could lead to uncertainty, greater financial market volatility, a reassessment of global growth prospects and a repricing of risk. As a result, the pricing of securities, such as equities, will change. In the model, equity prices are estimated to decrease by around 10 per cent, based on these global uncertainty channels and lower commodity prices, and corporate borrowing spreads are assumed to increase by more than 20 basis points. Global policy rates are also expected to respond to slowing growth and inflation.[10]
- **Consumer confidence** – The MARTIN model does not include measures of consumer (or business) confidence. This may be an important omission during turning points and times of stress (Wang and Berger-Thomson 2015). For example, at the onset of the GFC, the model overestimates GDP growth and much of this miss can be attributed to unexplained weakness in consumption. It is possible that household consumption reacted faster than expected to the news of the impending crisis due to changing sentiment. So, to proxy for the role of consumer confidence, we decrease consumption in the first year of the scenario by an amount roughly equal to the unexplained decline in consumption during the GFC. This amounts to an average of 0.3 percentage points per quarter less consumption growth for the first four quarters.

Putting these additional effects through the model, we find that Australian GDP would be 2.5 per cent lower after three years than it otherwise would have been, which is twice as large as the effect in the direct-effects scenario and occurs much more quickly. Household consumption and exports are the main drivers of the decline. Equity prices decline noticeably, by 10 per cent in the first year, which results in lower household wealth and consumption. This decline in economic activity translates to a rise in the unemployment rate by 0.9 percentage points, and a decline in inflation of 0.2 percentage points after three years.

An important caveat to these results is that the financial and banking sector channels in the MARTIN model are fairly limited. Factors such as bank funding costs and interbank liquidity are not captured. As such, it is plausible that greater financial stress could cause the negative effects on the economy described above to be larger.

Shock absorber scenario

In the third scenario, we allow the exchange rate and the cash rate to respond to the effects borne out in the amplifier scenario. In theory, when a negative foreign shock hits the Australian economy, the exchange rate should depreciate, particularly given a decline in the terms of trade. This lowers the relative price of Australian exports making them more internationally competitive, which could facilitate exporters' ability to find new markets at a time of soft Chinese demand. The depreciation also raises the relative price of imports, which puts upward pressure on inflation and encourages consumers and firms to switch their spending to domestic products. As such, we expect the exchange rate would act as a shock absorber, as it has done in the past (Manalo, Perera and Rees 2015). Similarly, monetary policy can respond to a slowdown in economic growth. A lower level of interest rates would support the economy through a depreciation of the exchange rate, raising asset values and by reducing required interest payments on borrowing, freeing up cash for other expenditure.[11]

While Chinese authorities have a stated policy of maintaining currency stability, as discussed earlier, it is conceivable that, in response to a notable shock to activity, policymakers may decide to allow the currency to depreciate to support activity. This would limit the depreciation of Australia's real exchange rate and, as such, some of its influence in counteracting the effects of the slowdown in China.

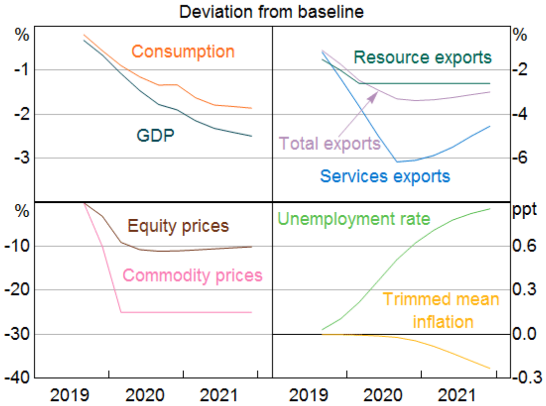
We consider a hypothetical exchange rate and cash rate profile (illustrated in Graph 13) that together, could largely offset the effects of a decline in overseas economic activity. The lower terms of trade puts downward pressure on the real exchange rate, which responds quickly and declines by around 10 per cent in the first year (Graph 13). The substantially lower exchange rate over the three years provides considerable support to the economy. The cash rate would also be expected to decline, although the pace may be gradual because the central bank makes its decision under uncertainty in relation to the severity of the overseas shock.[12] Furthermore the cash rate decline is relatively small in this scenario given the already considerable support provided by the lower exchange rate. The cash rate would decline by around 25 basis points after a year; this monetary policy accommodation would then be gradually unwound. If the exchange rate did not depreciate by as much, a larger reduction in the cash rate may be warranted. We would still see an initial slowing in growth and rise in unemployment, in line with the amplified China-slowdown scenario (Graph 14). However, the exchange rate and monetary policy movements could offset much of the negative consequences of the slowdown in China over time.

Relative to the case where the cash rate and exchange rate do not adjust, household spending, investment and exports would decline by less. However, they would remain lower for many years relative to what would have occurred without the China slowdown. Import volumes would decline substantially, because the depreciating exchange rate renders overseas goods and services relatively

Graph 12

Australian Economic Indicators – Amplifier Scenario

Deviation from baseline

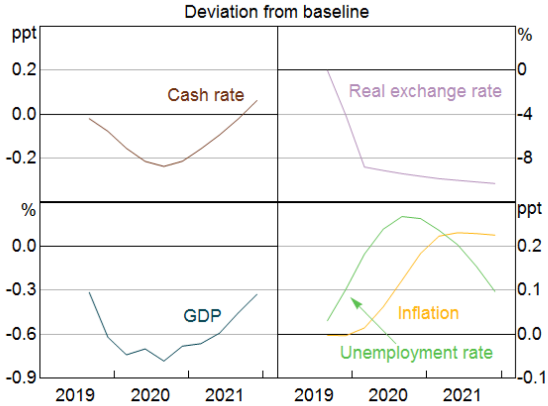


Source: RBA

Graph 13

Australian Economic Indicators – Shock Absorber Scenario

Deviation from baseline



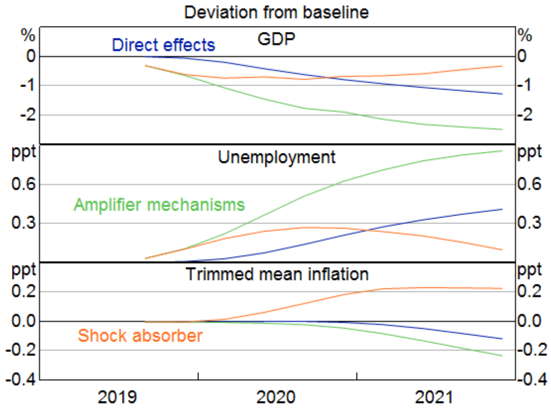
Source: RBA

more expensive; this boosts GDP growth. The lower cash rate would also stimulate dwelling investment, which adds a little growth in the latter part of the scenario period. Finally, the effect of the exchange rate depreciation on higher import prices offsets the negative effect of more labour market slack on inflation, leading to a small pick-up in underlying inflation of 0.2 percentage points.

The possibility of a slowdown in China is often highlighted as a key uncertainty for Australia's economic outlook. Overall, the scenarios demonstrate a range of plausible channels through which a foreign shock could affect the domestic economy. We show that a slowdown in Chinese economic activity of around 5 per cent could result in a decline in Australian GDP of up to 2½ per cent, depending on the nature of the scenario. There is potential for the exchange rate and monetary policy to provide some offset to these effects. Of course, additional forces could come into play, which we have not accounted for. For example, Chinese foreign investment into Australia could decline, which would affect dwelling and other investment. However, there has already been a noticeable softening in Chinese foreign investment to low levels, so a further decline may not be material. A Chinese economic downturn could have larger effects internationally – beyond the trade and equity market links we have incorporated – which would have larger negative implications for the Australian economy. On the other hand, automatic stabilisers (lower tax and higher government spending) and discretionary fiscal stimulus can also provide an additional shock absorber for the domestic economy.

Graph 14

Australian Domestic Effects – China Slowdown Scenarios



Source: RBA

Conclusion

The Chinese economy has expanded rapidly over the past few decades and cross-border linkages with Australia have increased. However, since the early 2010s, Chinese growth has eased. This slowing has been orderly and designed to move the economic trajectory onto a more sustainable footing. However, risks remain elevated, particularly in relation to increased indebtedness. There is a broad range of potential triggers for a severe slowdown in the Chinese economy, including a property market slowdown, an external demand shock or a financial system shock. Given Australia's connectedness with China, this could have important consequences for the domestic economy.

Trade linkages and China's influence on global commodity markets are likely to be the key channels through which a slowing in growth in China would spill over to Australia. A sizeable decline in economic activity in China is likely to decrease Australian economic growth, through lower exports and investment, raising unemployment and putting downward pressure on prices. Greater global uncertainty can lead to lower consumer confidence and equity prices, which would amplify the effect of an overseas shock. However, these negative effects can be offset to a degree by an exchange rate depreciation and accommodative monetary policy. While larger effects are possible, especially if the global and financial spillovers from a China-specific shock are greater than what is factored into our scenarios, the effects on the Australian economy will ultimately be contingent on whether policy is able to respond in a way that is sufficiently timely and commensurate to the size of the shock.

Footnotes

[*] The authors are from Economic Analysis Department.

[1] See Li (2019).

[2] See Cusbert and Kendall (2018) for a description of MARTIN.

[3] We take a similar approach to Gilhooly *et al* (2018) in characterising the mechanisms that underline the scenario analysis.

[4] Discretionary fiscal policy may also be used to counteract the impact of a global slowdown onto Australia. However, we do not include this channel in our analysis.

[5] This is based on estimates using the Oxford Economics Global Economic Model and world input-output tables from the OECD and European Commission.

[6] Movements in the commodity prices are based on Dieppe *et al* (2018) and are in line with other estimates in the literature. The global interest rate and price movements are based on results from the Oxford Economics model.

[7] This is roughly twice as large as estimates in Zhai and Morgan (2016). Their estimates take into account a large fall in commodity export volumes but a much smaller decline in commodity prices.

[8] This is based on Australia's resources exposure to China (about 40 per cent) and Chinese import elasticity (of around 1.3). However, it is possible that China would support Chinese domestic producers, so the decline in Australian resource export volumes could be larger.

[9] See RBA (2015) for a discussion of how concerns about the prospects for economic growth in China triggered substantial equity market volatility during the second half of 2015.

[10] In the scenario, global interest rates – defined as interest rates in the United States, euro area and Japan – are estimated to decline by around 7 basis points after six quarters, before rising again. The movements in global interest rates are modest, given interest rates in these economies are already low and some have little room to move lower.

[11] See Atkin and La Cava (2017) for a description of the mechanisms through which a lower cash rate can stimulate the economy.

[12] In the model, the cash rate responds to past data and so may seem slow to react. Alternatively, monetary policy could respond faster in anticipation of further slowing in China, which would in turn make the downturn slightly less severe.

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Competition and Profit Margins in the Retail Trade Sector

Matthew Carter[*]

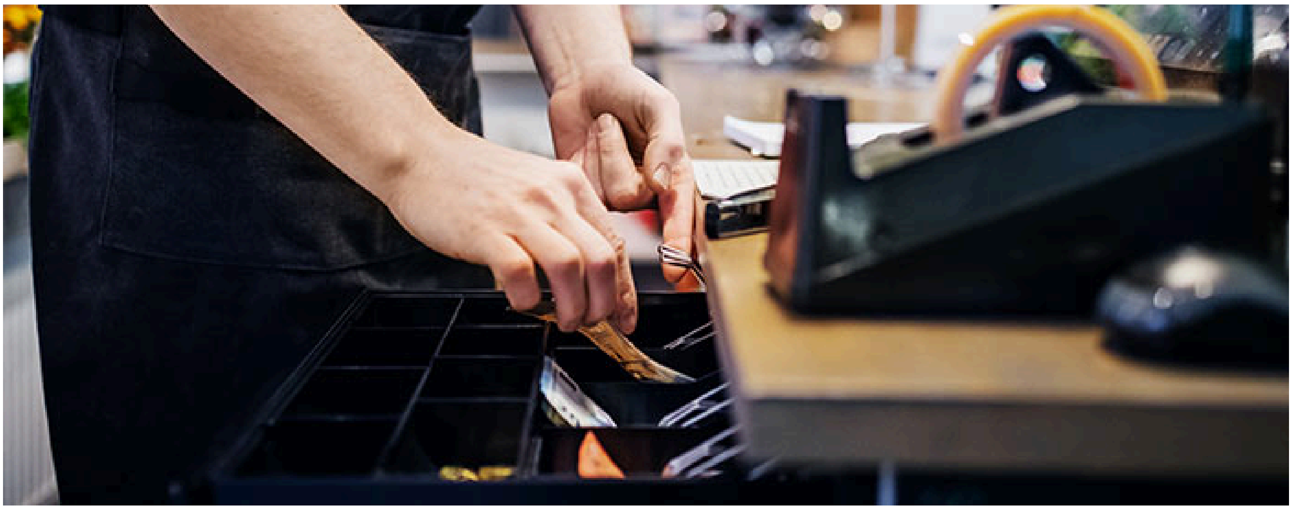


Photo: Tom Werner – Getty Images

Abstract

Net profit margins have declined for both food and non-food retailers over recent years. This has been driven by a decline in gross margins suggesting a reduction in firms' pricing power. This is consistent with information from the Reserve Bank's business liaison program about heightened competition in the retail trade sector. Liaison indicates that firms are seeking to offset the decline in margins through measures such as vertically integrating supply chains and adjusting product mixes. Retailers also report a push to reduce operating expenses such as rent and labour, though with mixed success.

Introduction

A consistent theme in discussion with firms in the Reserve Bank's business liaison program for several years has been heightened competition in the retail trade sector.[1] The retail sector has undergone significant structural change since the early 2000s, including the rise of online shopping and the entrance of new international firms into the market. Firms suggest these changes have increased competitive pressures and that, in response, they have had to adjust their pricing behaviour to compete for sales and market share. While firms in other industries also report changes in the level of competition over time due to similar factors, liaison has identified the retail sector as being particularly affected. Survey-based measures also suggest that business conditions in the retail sector have been weaker than other industries in recent years (Graph 1).

Firms suggest that consumers in the retail sector are increasingly price sensitive and that, in response, they have had to adjust their pricing behaviour, typically by increasing the size or 'depth' of discounts on their products, as well as the frequency. Retail goods, such as furniture, food, clothing and footwear, comprise around one-third of the Australian Consumer Price Index. This increase in discounting behaviour by retailers has been one of the factors contributing to low inflation outcomes in the Australian economy in recent years (Debelle 2018).

This price competition may also affect the profit margins of retailers as they seek to maintain a 'lowest price position' in the market. This could, in turn, influence other business decisions and have wider economic consequences. For example, firms may decide to defer or cancel investment plans, or they may reduce the number of staff they employ or the number of hours their staff work. Some firms are even willing to forego profits to gain market share by 'loss leading' or selling products at a loss; this is likely to increase the risk that firms become unprofitable. This could have implications for the asset quality of banks if firms are unable to repay their debt obligations, though the flow-on effect to Australian banks so far appears minimal (Araujo and de Atholia 2018).[2]

This article explores recent dynamics in retail firms' pricing behaviour and their impact on profit margins. It draws on information from firms in the Bank's business liaison program, as well as data from the Australian Bureau of Statistics (ABS).

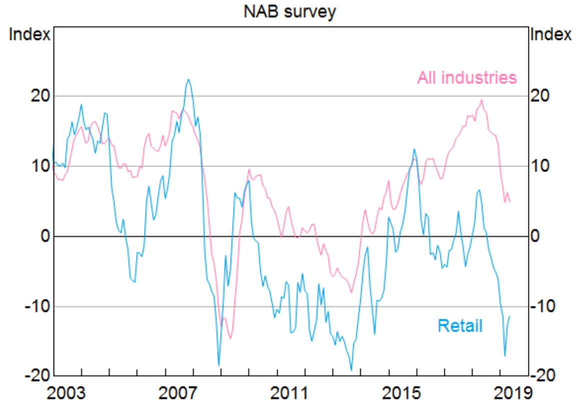
Price-setting Behaviour of Retailers

Firms often attribute the increase in competition to the actions of a perceived 'market leader' that is looking to expand their market share by lowering prices (Ballantyne and Langcake 2016). In response,

Graph 1

Business Conditions*

NAB survey



* 3-month moving average; seasonally adjusted

Sources: NAB; RBA

other retailers are forced to adjust their own pricing behaviour to compete for sales. While there is an increasing availability of detailed micro-level datasets to investigate the price-setting processes of individual firms, the use of qualitative information from surveys can also provide useful insights into how individual firm characteristics affect pricing decisions (Fabiani *et al* 2005). Firms in the Bank's business liaison program are periodically surveyed about their price-setting behaviour, including how frequently they review and change their prices, and what factors influence these decisions (Park, Rayner and D'Arcy 2010). These responses can also be compared over time to see whether firms' price-setting behaviour has changed.

Around 60 per cent of retailers in the Bank's liaison program indicate that they currently review their prices either daily or weekly (Graph 2). The data also suggest that the frequency of price reviews has increased over time, which is likely to reflect advances in technology that have reduced information costs for both consumers and firms (Debelle 2018). Consumers are able to easily compare the price of products across multiple firms and determine which is offering the lowest price. Firms are able to continually monitor the online prices of other retailers using web scraping tools to ensure their products are competitively priced, and to adapt quickly to changes in the retail environment. The data from the Bank's liaison program also indicate that the frequency of price reviews is positively related to the perceived level of competition; of the firms that review prices on a daily or weekly basis, almost all characterised the level of competition in their market as 'significant'.

An advantage of survey-based pricing studies is that they allow us to identify the factors that have caused a firm to change their prices. In regular interviews, retailers are asked to assess the importance of five factors on their decision to change prices over the preceding 12 months by ranking them on a scale of 'unimportant' (a score of 1) to 'very important' (a score of 4). An increase in costs is the most significant factor in a firm's decision to increase prices, while a decrease in demand or a change in a competitor's prices are the significant factors in a firm's decision to lower their prices (Graph 3).[3] When compared over time, these factors have become more significant in retailers' decisions to decrease prices. This may indicate competitive pressures have intensified and are having more influence on the price-setting behaviour of retailers.

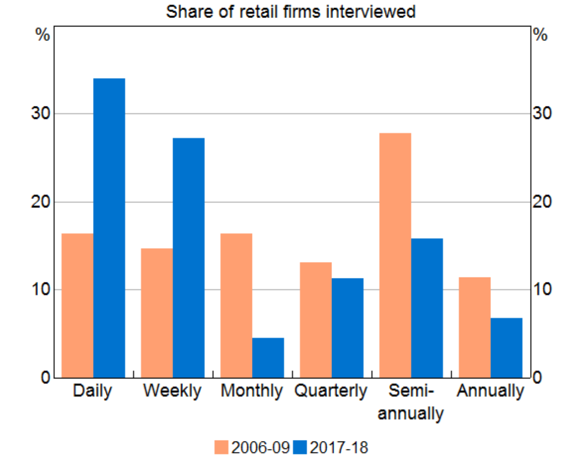
The Impact of Competition on Firms' Margins

To understand the role of margins in price setting, it is useful to work with a stylised version of the retail supply chain (D'Arcy, Norman and Shan 2012). Goods are manufactured either domestically or overseas and sold to a wholesaler, who then on-sells them to a retailer. The price paid by the retailer, along with any freight costs, comprises the retailers' 'cost of goods sold' (COGS). To cover these costs the retailer applies a gross margin or 'mark-up' to obtain the final sale price charged to consumers. The retailer also incurs expenses in its day-to-day operations, such as labour and rent, as well as marketing, packaging and administration. These operating expenses are collectively referred to as the 'cost of doing business' (CODB). The difference between the CODB and the retailers' gross margin is their profit or 'net margin'.

Graph 2

Frequency of Price Reviews

Share of retail firms interviewed

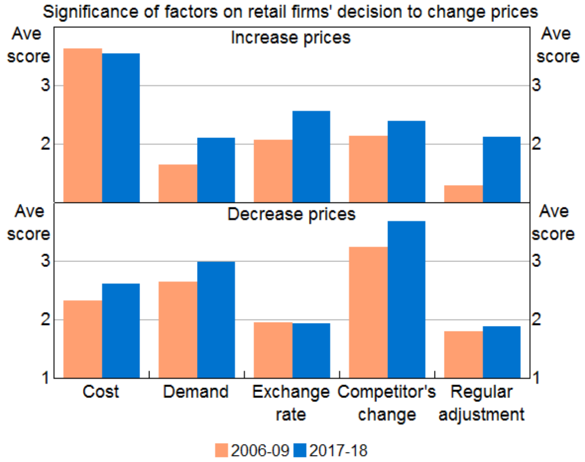


Source: RBA

Graph 3

Factors Explaining Price Changes

Significance of factors on retail firms' decision to change prices



Source: RBA

While liaison with firms suggests that competitive pressures in the retail sector have increased over recent years and that firms have had to adjust their pricing behaviour in response, competition is not directly observable. Instead, we must rely on proxy measures such as firm-level 'mark-ups'. Hambur and La Cava (2018) estimated retail mark-ups by measuring the ratio of price to marginal cost. They found mark-ups rose over the mid 2000s but have declined in recent years, which suggests the retail sector has become more competitive.

In this article, we infer the effect of competition by constructing a series of net and gross margins for Australian retail firms using the ABS 'Australian Industry' series, which is produced annually using data sourced from the Economic Activity Survey conducted by the ABS and Business Activity Statements provided by almost every Australian business to the Australian Tax Office. We analyse margins at the two-digit Australian and New Zealand Standard Industrial Classification level, and disaggregate the retail sector into the categories 'food' and 'non-food' to separately analyse the effect of competition across both.

Net margins

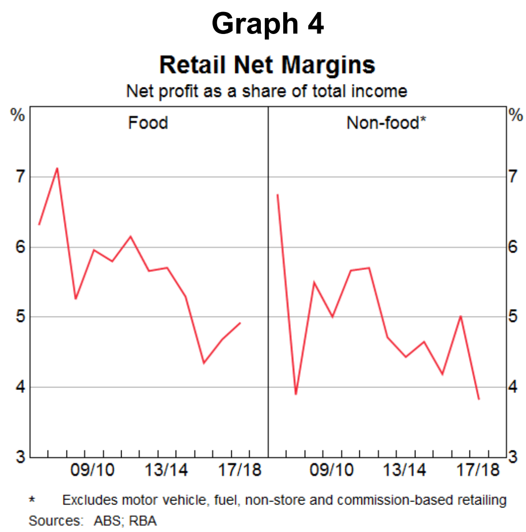
We find that net margins have declined for both food and non-food retailers over recent years (Graph 4). This is consistent with information from liaison of heightened competition. Net margins for food retailers (such as supermarkets and grocery stores) have declined by around 1¾ percentage points since 2011/12. This has occurred alongside the expansion of foreign supermarkets into the Australian market as well as a period of aggressive price competition between the major domestic supermarkets. Net margins for non-food retailers have declined by a similar amount. This finding is in line with other research: for example, Hambur and La Cava (2018) found that firm-level 'mark-ups' had declined since 2012, while Ballantyne and Langcake (2016) concluded that the relatively high level of the Australian dollar between 2010 and 2013 had led to increased competition from foreign online retailers.

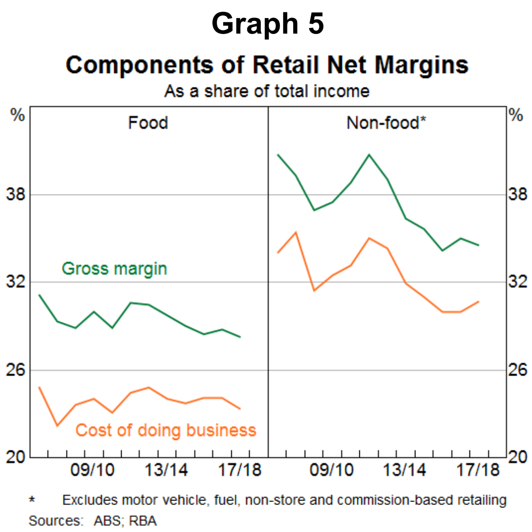
Gross margins

While the decline in retail net margins is consistent with heightened competition, a decline in net margins can be caused by one of two things: a reduction in gross margins (due to lower prices or higher COGS) or because firms' operating expenses, such as labour and rent, are increasing and they are unable to pass them through to final prices. We find that the decline in net margins for both food and non-food retailers has been driven by a decline in gross margins (Graph 5). The decline in gross margins is particularly marked for non-food retailers, falling by around 6 percentage points since 2011/12 , indicating a reduction in their pricing power.

However, a consistent theme in liaison with both food and non-food retailers over the past couple of years has been a focus on firms trying to rebuild their gross margins by adjusting their business practices, including through measures such as:

- **Adjusting product mixes to incorporate more own brand or private label products**. These products are designed and manufactured by the retailers themselves, which reduces third-party costs. Own brand products also allow the retailer to differentiate their product offering from that of their competitors, affording them a degree of pricing power. Some retailers are also incorporating more premium brands into their product mix that are of a higher quality and attract a higher price and margin.
- **Improved inventory management and stock monitoring practices** have reduced the need to discount as aggressively to clear excess stock, particularly for seasonal products such as summer apparel. Some retailers report this has also been achieved by rationalising their product range and reducing the number of individual products or 'stock keeping units' they sell.
- **Non-food retail firms are increasingly moving to an 'everyday low price' (EDLP) strategy**, where the prices of key products have been lowered permanently. This differs from the traditional 'high-low' pricing strategy which uses a cycle of discounts and promotional sales. While EDLP strategies have been used by supermarkets for a few years, they are becoming more common among discount department stores, as well as specialty apparel and homewares retailers, that have a high degree of product homogeneity. By offering a consistent and predictable low price, retailers are able to attract a constant flow of foot traffic through stores and increase their sales volumes. This growth in sales volumes enhances the firm's bargaining power with wholesalers, allowing





them to negotiate a lower average unit cost on products.[4]

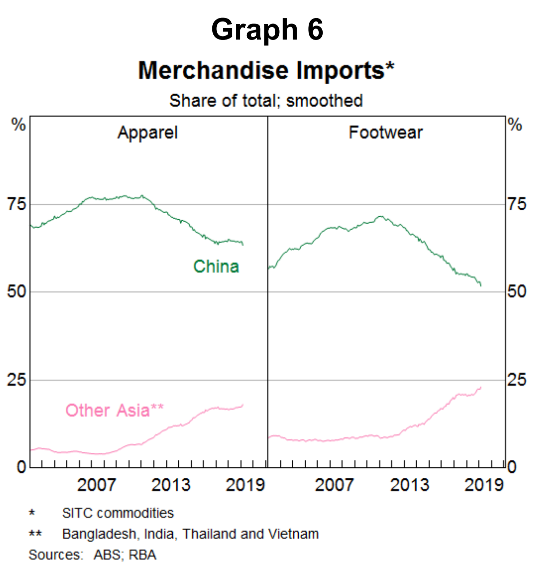
- **Vertically integrating supply chains to increase productivity**. This occurs when a retailer owns or controls each step along their supply chain, removing third-party intermediaries and reducing costs. A number of firms report that they now purchase products directly from manufacturers rather than through a wholesaler, allowing them to reduce their COGS and capture wholesalers' margins. Some firms have also transitioned from using manufacturers in China to lower-cost countries in South-East Asia such as Bangladesh, India, Thailand and Vietnam (Graph 6).

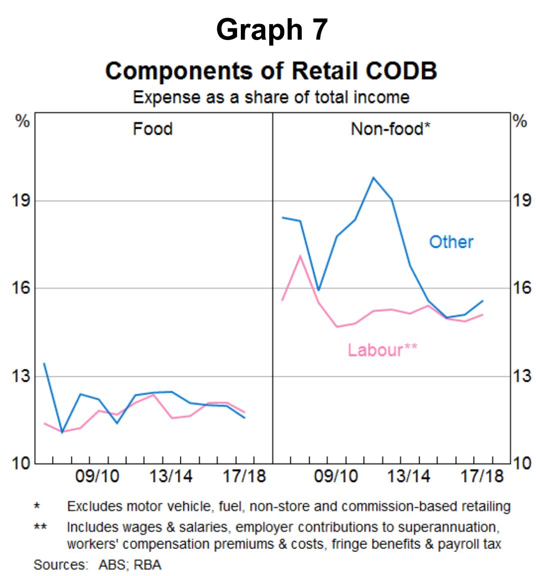
The 'cost of doing business'

The decline in gross margins has been partially offset by a reduction in firms' operating expenses. Firms often report an inability to pass cost increases through to final prices due to competitive pressures and are, instead, absorbing them into their net margins. To mitigate this, there has been a strong push by firms to reduce their CODB. The Australian Industry data disaggregate CODB broadly into 'labour expenses' (which includes wages and salaries, as well as other associated costs such as employer contributions to superannuation and payroll tax) and 'other expenses' (which captures expenditure on items such as rent, marketing and advertising).

We find that non-food retailers have had considerable success in lowering their CODB over recent years by reducing their 'other expenses' (Graph 7). While food retailers appear to have had less success in reducing their expenditure, it is worth noting they have a lower cost base to begin with. Rent is typically the second largest operating expense for a retailer and firms have been able to lower this by closing underperforming stores or by reducing the size of their physical 'bricks and mortar' stores and expanding their online presence.[5] Firms have also been able to negotiate lower rent increases with landlords. Given softer retail trading conditions, increased supply of retail space and the rise of online shopping, some landlords have been willing to offer lower rent increases or incentives such as rent-free periods to secure low-risk, long-term tenants that attract foot traffic through shopping centres (Araujo and de Atholia 2018). Firms have also been able to reduce expenditure on 'discretionary' items, such as advertising and marketing, by using more digital and social media. These are not only cheaper than traditional mediums such as TV commercials or catalogues, but reach a wider audience and can also be targeted to specific consumer demographics.

Wages are typically the largest expense for a retailer and firms appear to have been able to control growth in their labour expenses in recent years. This has partly been achieved by reducing headcount, including by introducing self-service checkouts and





consolidating back-office support roles. However, firms note that they have also been responding to increases in competition by enhancing the 'in-store experience' by improving the level of customer service and increasing the range of services offered. Retailers are unwilling to reduce headcount too much due to the negative impact it may have on service and sales.

Firms have also been able to control growth in labour expenses through more efficient rostering. A number of firms report investing in computerised rostering systems and using data analytics to track intraday sales patterns, allowing them to optimise staff numbers and minimise overtime and penalty payments. This has been complemented by an increased use of part-time labour to provide greater flexibility with rostering decisions (Graph 8).

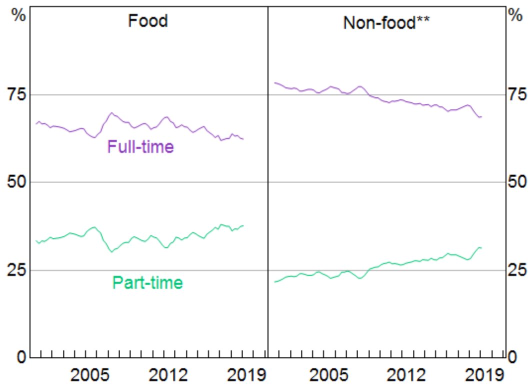
Conclusion

We find evidence to suggest that competition in the retail sector has increased in recent years, which supports messages from firms in the Bank's business liaison program and previous analytical work. Net margins have declined for both food and non-food retailers reflecting a reduction in firms' pricing power as they compete for sales and market share. Using survey-based results, we also find that competition is an important determinant in the price-setting behaviour of retailers, influencing the frequency of price reviews and the willingness of firms to lower the prices of their products. Firms have responded to these challenges by changing their business models to increase their pricing power and gross margins, through measures such as vertically integrating supply chains, or by transitioning to 'everyday low price' strategies. Liaison also indicates that firms have managed to partly offset the decline in margins through a focus on reducing operating expenses such as rent and labour, though with mixed success. ✠

Graph 8

Retail Employment*

Per cent of total; smoothed



* Hours-based measure
** Excludes motor vehicle, fuel, non-store and commission based retailing
Sources: ABS; RBA

Footnotes

[*] The author is from Economic Analysis Department and would like to thank Tom Rosewall for his comments and feedback.

[1] The Reserve Bank's business liaison team conducts around 70–80 discussions each month with firms, agencies and community groups. Liaison meetings are held nationally with firms of all sizes, though most discussions are with mid-sized and large firms where conditions are somewhat more likely to reflect economy-wide trends rather than firm-specific factors. For more information, see RBA (2014).

[2] Araujo and de Atholia (2018) find that the major banks' non-performing loan ratios for the retail business sector remain low and that banks' exposures to retail businesses are declining.

[3] These findings are in line with other international surveys. For example Greenslade and Parker (2010) found the same pattern of causal factors for the UK as Graph 3 shows for Australia.

[4] Firms often highlight the 'virtuous circle' of EDLP: lowering unit costs allows them to lower final prices further, which leads to an increase in foot traffic and sales volumes, further enhancing their bargaining power with wholesalers to negotiate even lower unit costs.

[5] The inability for food retailers to lower 'other' expenses may also reflect that the rise in online retail has largely been concentrated in the non-food sector.

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Can Structural Change Account for the Low Level of Non-mining Investment?

Jonathan Hambur and Keaton Jenner[*]

Photo: Andrew Mckenna / EyeEm – Getty Images

Abstract

No, it cannot. Non-mining firms have invested less over the past decade, relative to their output, than they did over the previous two decades, and this decline in investment intensity has been broad based across firms. This reduced investment could contribute to slower economic growth, if, for example, it is associated with decreased adoption of new technologies. This article looks into potential driving forces behind the decline in the rate of investment, finding that it cannot be explained by shifts in industry structure, or the composition of firms by age or date of formation. The size of the decline is consistent with what would be expected given slower technological progress and lower depreciation rates. But there might be other, more cyclical reasons for the observed slowdown in non-mining investment.

Introduction

The production of goods and services typically relies on the use of both capital (e.g. buildings, machinery & equipment, computer software) and labour inputs. To expand production, firms can either increase their stock of capital, hire additional workers, or find ways to use existing inputs more efficiently. Since firms' investment decisions affect their stock of capital, investment is a key channel through which the economy can grow its productive capacity.

Over the past decade, non-mining firms have tended to invest less intensively than they did in the preceding two decades. In the decade leading up to the Global Financial Crisis (GFC), firms in the non-mining sector invested, on average, between 14 and 16 cents per dollar of output. In the post-GFC period this has declined to between 10 and 12 cents of investment per dollar of output (Graph 1). To put this into context, if non-mining firms invested with a similar intensity today as they did before the GFC, non-mining investment would have been around $54 billion, or one-third, higher in 2017/18 than was actually observed. The slowdown in investment is not unique to Australia; following the GFC, many advanced economies have recorded weaker capital expenditure than expected (CEA, 2017).

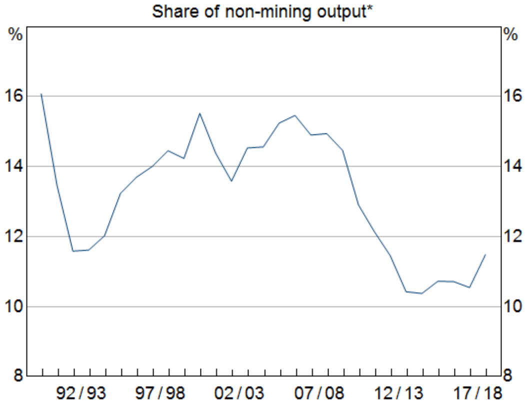
The decline in the economy's investment intensity could have wide-ranging consequences. For example, to the extent that lower investment leads to slower growth in the capital stock, growth in output per worker (also known as labour productivity) is also likely to slow unless there are offsetting technological improvements. All things being equal, this would tend to put downward pressure on wage growth. Moreover, if firms tend to invest in new and more *productive* capital, a decline in the rate of investment could contribute to a lower rate of technological advancement, and therefore slower economic growth.

Given the possible consequences, we are interested in understanding what has driven the decline in the economy's investment intensity in the past decade. In doing so, we build on past work by van der Merwe *et al* (2018), which provided an overview of, and evidence regarding, a wide range of potential explanations for the decline in investment intensity. In the first part of this article, we revisit whether changes in industry structure can explain the decline, as well as examining a potential role for changes in the age and cohort composition of firms in the economy. We do this using firm-level tax data from the Business Longitudinal Analysis Data Environment (BLADE), which is ideally suited to such an analysis.[1]

Graph 1

Non-mining Investment

Share of non-mining output*



* Calculated as private non-mining investment divided by non-mining gross value added

Sources: ABS; RBA

Having demonstrated that compositional change explains only a very small share of the decline in the economy's investment intensity since the GFC, and that the decline is apparent across most firms irrespective of their characteristics, we then consider other explanations. In particular, we present a simple theoretical model of the economy's (long-run) investment intensity. Using this model and aggregate data, we demonstrate that the combination of a slowdown in technological progress and a lower depreciation rate can potentially explain a large share of the decline in the non-mining sector's investment intensity.

Throughout this article, we focus on nominal (rather than real) investment as a share of output. Nominal data are considered more appropriate given difficulties in comparing the level of real investment over time and across industries, particularly due to the large changes in technology over recent decades and the significant shifts in the relative prices of investment goods that have accompanied these changes. However, given real investment has also been relatively subdued in recent years, this focus on nominal data is unlikely to substantially affect our conclusions.

Compositional Change

Industry structure

If economic activity shifts away from investment-intensive sectors, such as manufacturing, to sectors with lower intensities, such as services, then, in principle, this could account for a decline in the overall (non-mining) investment intensity (Adeney, 2018, van der Merwe *et al* 2018). But although economic activity has shifted in this way over the decades, the shift accounts for only a small part of the more recent decline in investment intensity; most of the decline has occurred *within* sectors. Previous research showed this for broad sectors such as manufacturing and services, using National Accounts data (van der Merwe *et al* (2018); Graph 2). We confirm that this finding is also true for more

Table 1: BLADE Non-mining Investment Intensity

Cumulative change from 2007/08 to 2014/15, percentage points

	Total	Within-industry effect	Compositional effect
Total Non-mining	–0.99	–1.21	0.22
Transport	–5.50	–7.30	1.80
Rental, hiring & real estate	–5.41	–6.12	0.71
Manufacturing	–0.84	–0.56	–0.27
Construction	–1.27	–1.31	0.03

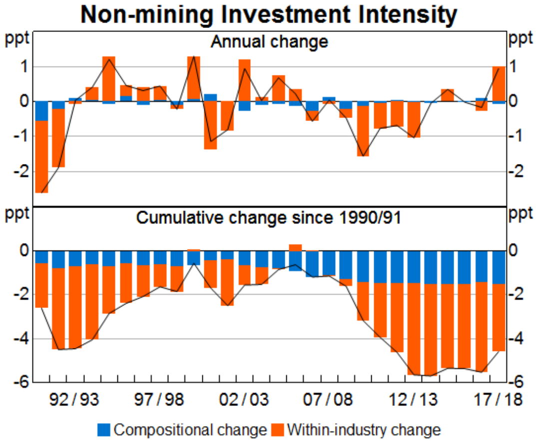
Sources: ABS; RBA

disaggregated industry groupings using firm-level data from BLADE.[2] That is, the decline in investment intensity has not occurred because activity had shifted within sectors to less investment-intensive industries in each sector.

To demonstrate this finding, we show results for four sectors that account for much of the decline in the aggregate investment intensity based on firm-level data. These sectors are: transport, 'rental, hiring and real estate' (RHRE), construction and manufacturing. We find that for three of the sectors we examine – transport, RHRE and construction – compositional change has actually contributed *positively* to investment intensity (Table 1). The manufacturing sector is an exception: around one-third of the decline in its investment intensity is explained by changes in the *type* of manufacturing done now, compared with the pre-GFC period. In particular, shifts away from 'traditional' manufacturing industries such as *non-ferrous metal manufacturing, aluminium smelting* and *motor vehicle manufacturing* appear to have played some role.

Graph 2

Non-mining Investment Intensity



Sources: ABS; RBA

Investment intensity over the firm lifecycle

At a high level, there are two potential explanations for the broad-based declines in the investment intensities of industries: either they reflect some sort of compositional shift between firms, such as an increase in the prevalence of older, less investment-intensive firms; or they reflect broad-based declines in the investment intensities of all firms. We consider two potential compositional shifts, both of which are motivated by overseas evidence.

The first is a shift in the age distribution of firms. As we will show, young firms are typically more investment intensive than mature firms. This finding is intuitive, given young firms need to buy machinery, fit out their shop or purchase other capital goods before they can ramp up production. Accordingly, any shift in economic activity away from young firms, and towards older firms, could weigh on the economy's aggregate investment intensity. Other research has noted a trend of declining firm entry rates both in Australia (Productivity Commission, 2015) and overseas (Pugsley, Sahin & Karahan 2015). Lower firm entry rates will mean fewer young firms and, all else being equal, this could potentially contribute to a decline in the economy's investment intensity.

The second compositional shift we consider is a change in the cohort composition of firms. Firms 'born' at different points in time could have inherently different investment intensities. For example, firms born during periods of weak economic growth, such as the GFC, may be inherently less investment intensive than firms born during other periods. This would be consistent with evidence from the United States, which shows that firms born during the GFC remained smaller than firms born during other periods (Moreira, 2017). As such, this could contribute to the decline in the economy's investment intensity, if firms from low-intensity cohorts start to make up an increasingly large share of the economy.

To quantify age and cohort effects, we use an age-period-cohort (APC) model with firm-level data from BLADE. APC models are useful in this context because they allow us to separately identify the effects of ageing from the effects of belonging to a particular cohort, or of being observed in a particular time period.[3]

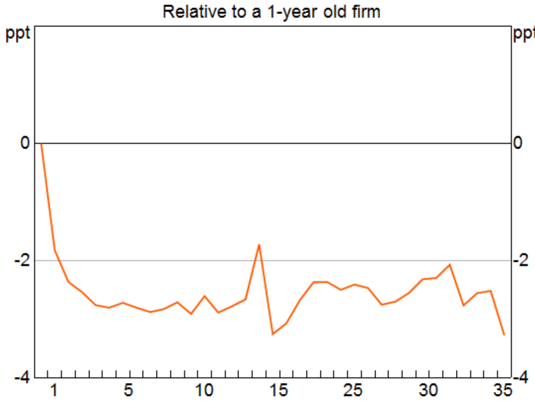
We start by considering age effects. Our results show that firms are most investment intensive in their first year of life and that the sharpest drop-off occurs as they move from their first to second year of existence (Graph 3). Firms' investment intensities continue to decline for a few years, but then flatten out from the age of five onwards.

Moreover, the share of output produced by young firms (defined here as between 1 and 5 years of age) has declined by around 4 percentage points relative to the pre-GFC period. At face value, the two observations together would suggest that age effects could be important in explaining the decline in the economy's investment intensity. However, we estimate that the reduction in the share of output accounted for by young firms explains at most 10 per cent of the total decline.[4]

Graph 3

Investment Intensity by Firm Age

Relative to a 1-year old firm



Sources: ABS; ASIC; RBA

In terms of cohort composition, we want to consider whether firms born or established during periods of low growth, such as in the GFC period, have permanently lower investment intensities. While we do find some weak evidence that firms born during periods of slower economic growth tend to be less investment intensive than other firms, this is not particularly robust to different modelling choices. Further, these 'cohort' effects are not economically significant. Firms born during the GFC are estimated to be only slightly less investment intensive than firms established during more normal economic conditions. Further, since firms born during the GFC make up only a very small portion of the economy, their effect on the aggregate non-mining investment intensity is close to zero.

Taken together, our results do not provide evidence of significant compositional effects at the firm level. Rather, they suggest that the decline in the non-mining sector's aggregate investment intensity has been broad based across all firms. To demonstrate this further, we can examine the estimated year effects from the model. Year effects capture the (weighted) average investment intensity across all firms in a given period, after we account for other relevant factors such as their age, cohort and industry. As a result, they can be thought of as capturing any aggregate factors that affect all firms equally at a given period in time.

The estimated year effects have been consistently negative since 2008/09, suggesting that, on average, all firms have tended to be less investment intensive than expected, given factors such as their age and cohort (Graph 4). Moreover, the magnitude of the effects is similar to the overall decline in the aggregate investment intensity in BLADE (see Graph A1). This is consistent with earlier findings that there is little role for compositional change in explaining the decline in the economy's investment intensity.

Long-run Determinants of Non-mining (Market Sector) Investment[5]

Because the decline in firms' investment intensity appears to be broadly based, there may be some economy-wide factors that have been depressing firms' investment intensity. One useful starting place to look for such factors is to examine the theoretical determinants of an economy's investment intensity – those factors that would be expected to determine the economy's investment intensity in the long run. In this section, we focus our analysis on the non-mining market sector, which excludes health, education and public administration. We do this to avoid complications related to measuring productivity growth in the non-market sector. The trends in investment intensity are similar to those in the overall non-mining sector, although the decline has been more pronounced in the non-mining market sector.

As discussed in Jenner *et al* (2018), using a simple theoretical model, the non-mining economy's long-run investment-to-output ratio should depend on three things: the economy's capital-to-output ratio; the growth rate of output, which in turn will be a function of productivity growth and growth in inputs; and depreciation rates.[6] This reflects the fact that additional investment will be required to both support future economic growth and to replace worn-out capital. Below we consider each of the three factors and how they have changed over time. We note here that this exercise is descriptive in nature and focuses on the long run, and that there may be other factors outside of our stylised model that can help to explain the observed decline in investment intensity.

First, we consider the capital-to-output ratio. Economic growth theory suggests that the capital-to-output ratio should be constant over time, which appears to be broadly true in the Australian data, at least over our sample period (Graph 5). This suggests that changes in the ratio cannot explain the decline in the investment-to-output ratio in the past decade. For the rest of the analysis, we assume that the capital-to-output ratio is equal to the average capital-to-output over the sample, which is about 2. A ratio of 2 indicates that, on average, firms require two dollars of capital – such as buildings, motor vehicles or computer hardware – to produce one dollar of output each year.

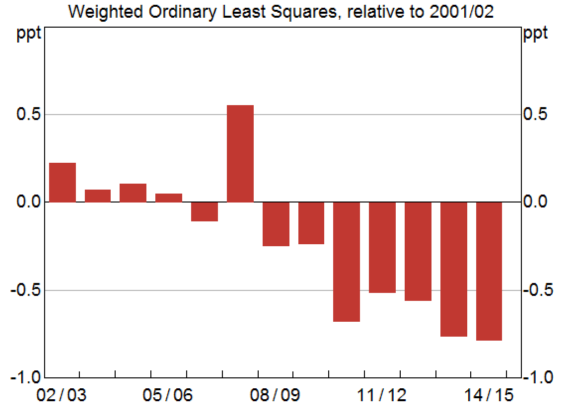
The growth rate of non-mining output is the second determinant of investment intensity in our model. The growth rate of output is important because changes in production and capital must match each other over time if the capital-to-output ratio is to remain constant. Therefore, the faster (slower) that output expands, the more (less) investment will be required to increase the stock of capital.

Economic theory suggests that, in the long run, the growth rate of output is determined by growth in productivity and growth in the supply of labour. Graphs 6 and 7 show both determinants, and provide some evidence of lower productivity

Graph 4

Year Effects

Weighted Ordinary Least Squares, relative to 2001/02

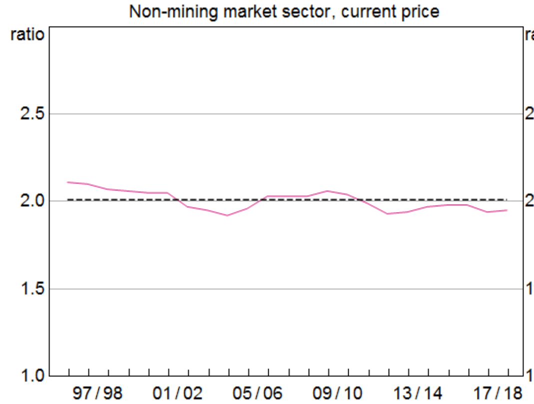


Sources: ABS; ASIC; RBA

Graph 5

Capital-to-output Ratio*

Non-mining market sector, current price



* Dashed line is estimated long-run non-mining market sector capital-to-output ratio

Sources: ABS; RBA

growth over the past decade, although the precise magnitude of the slowdown is sensitive to the reference period. More generally, a slowdown in productivity growth has been widely documented both in Australian and overseas (D'Arcy and Gustafsson, 2012; McCririck and Rees, 2016), with some overseas research also finding that the decline in productivity growth preceded the GFC (Fernald *et al*, 2017).

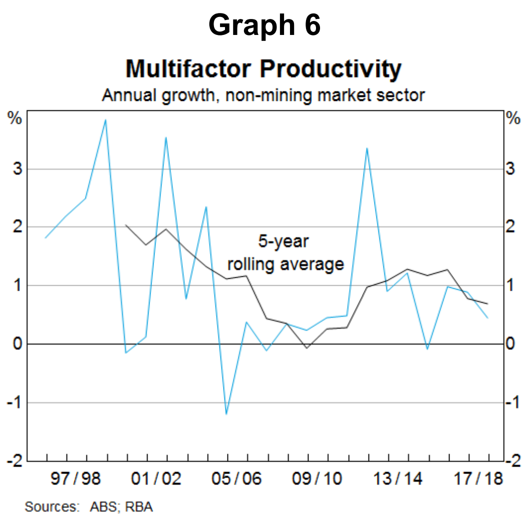
The final component of our calculation is the depreciation rate. The depreciation rate measures the amount of firms' capital that is 'consumed' or 'worn out' in a given period. In our model, some investment is required simply to offset depreciation and to maintain the value of the existing stock of capital. The ABS measure of the depreciation rate for the non-mining market sector has declined notably since the early 2000s, implying that less investment is required to maintain the existing capital stock than used to be the case (Graph 8). The decline in the depreciation rate largely reflects a compositional shift in the capital stock towards longer lived assets, such as buildings & engineering structures (i.e. office towers, roads and railways), which tend to be replaced less often than other types of capital, such as machinery & equipment.

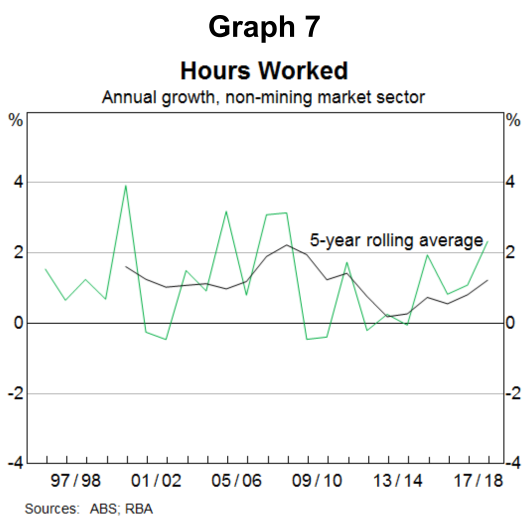
To quantify the effects of these three factors, we can use them to construct an estimate of the long-run investment intensity of the non-mining market sector that we would expect the economy to eventually reach over time.[7]

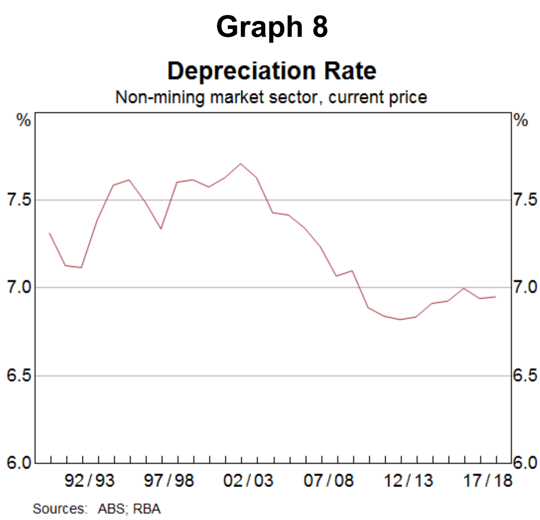
We estimate that the non-mining market sector's long-run investment intensity has decreased by about 5 percentage points over the sample, driven by weaker multifactor productivity growth and a lower depreciation rate (Graph 9). This suggests that declining rates of (long-run) output growth and depreciation could explain most of the recent decline in the economy's investment intensity. Despite this, we can't rule out the possibility that other cyclical factors may have also weighed on investment intensity in recent years. For example, an increase in risk premiums or risk aversion may have also depressed firms' investment over the post-GFC period.

Conclusion

We find that the decrease in the economy's investment intensity has been broad based across most firms and that shifts in the industry, age or







cohort composition of firms have not had a material impact. This is consistent with a lower long-run investment intensity for the entire non-mining market sector. We estimate that the economy's long-run investment intensity has declined over the past decade, reflecting weak multifactor productivity growth and a lower depreciation rate. ✠

Appendix A

For our analysis of compositional change, we use longitudinal firm-level data from BLADE.

Our measures of investment and output are both derived from firms' Business Activity Statements (BAS). We define the investment-to-output ratio as firms' capital expenditure divided by their gross output. The sample covers 2001/02 to 2014/15.

For all analysis using BLADE, we exclude firms:

- in the finance and utilities divisions due to conceptual issues with the calculation of gross output, as well as public sector organisations;
- in a handful of industries where the data appears suspect.

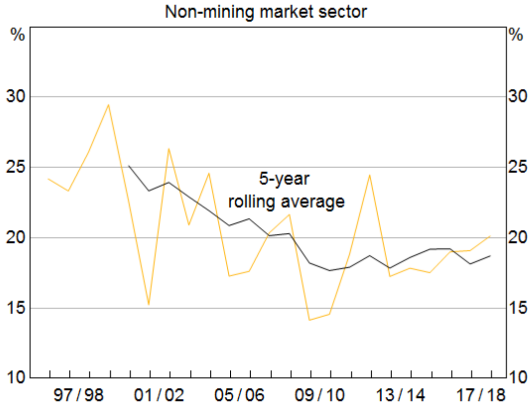
For our analysis of firm age and cohort effects, we also exclude firms:

- with an investment-to-output ratio above the 99th percentile (around 160 per cent);
- born prior to 1980 and after 2013 due to the small sample size of firms born outside of this period.

Graph 9

Long-run Investment Intensity

Non-mining market sector



Sources: ABS; RBA

Further, we combine the BAS data with data on the date of firm formation, which we use to calculate firms' ages. One feature of the data, however, is that there is a substantial increase in the coverage of firms born from 2001/02 onwards.[8] This will initially inflate the measured share of output produced by young firms in our sample. Moreover, this bias will tend to decline over time, as additional observations with improved firm coverage become available. The effect of this will be to exaggerate the decline in the share of output produced by young firms from 2001/02 onwards, likely causing us to overstate the effect of an ageing business population.

Appendix B

We want to decompose the decrease in the aggregate investment intensity into:

a. A compositional effect that is due to industries with a low investment intensity growing faster than the average division.

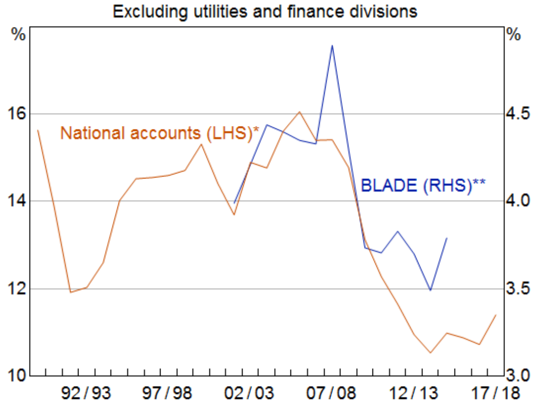
b. Within-industry effects, which are due to investment intensities within industries decreasing.

Denoting industries as x, first we note that the aggregate investment intensity, $\frac{I_t}{Y_t}$, can be expressed as the sum of the individual industries' ratios, $r_{x,t}$, weighted by their shares of total output, $w_{x,t}$:

Graph A1

Non-mining Investment-to-output

Excluding utilities and finance divisions



* Calculated as private non-mining investment divided by non-mining gross value added

** Calculated as private non-mining capital expenditure divided by non-mining gross output

Sources: ABS; RBA

$$\frac{I_t}{Y_t} = \frac{\sum_x I_{x,t}}{\sum_x Y_{x,t}}$$

$$\frac{I_t}{Y_t} = \sum_x \frac{I_{x,t}}{Y_{x,t}} * \frac{Y_{x,t}}{\sum_x Y_{x,t}}$$

$$\frac{I_t}{Y_t} = \sum_x r_{x,t} w_{x,t}$$

The change in the aggregate investment intensity over some period, *j*, is then:

$$\frac{I_t}{Y_t} - \frac{I_{t-j}}{Y_t - j} = \sum_x r_{x,t} w_{x,t} - \sum_x r_{x,t-j} w_{x,t-j}$$

The within-industry effect, *WE*, is calculated by assuming that the weights are unchanged across the two periods (at their average level):

$$WE_t = \sum_x r_{x,t} \frac{(w_{x,t} + w_{x,t-j})}{2} - \sum_x r_{x,t-j} \frac{(w_{x,t} + w_{x,t-j})}{2}$$

$$WE_t = \sum_x (r_{x,t} - r_{x,t-j}) \frac{(w_{x,t} + w_{x,t-j})}{2}$$

The compositional effect, CE_t, is calculated similarly, by assuming the industry investment intensities remain unchanged:

$$CE_t = \sum_x \frac{(r_{x,t} + r_{x,t-j})}{2} w_{x,t} - \sum_x \frac{(r_{x,t} + r_{x,t-j})}{2} w_{x,t-j}$$

$$CE_t = \sum_x \frac{(r_{x,t} + r_{x,t-j})}{2} (w_{x,t} - w_{x,t-j})$$

Appendix C

To estimate the firm-level effect of age and cohort, we estimate an Age-Period-Cohort (APC) model. In APC models, age effects capture lifecycle patterns, period effects capture aggregate shocks that affect all firms at a given point in time, and birth cohort effects capture differences in investment-intensities across generations. The APC model shows the outcome of interest for firm *i* at time *t* as the sum of age, year and cohort dummies, and an error term:

$$y_{it} = \sum_a \alpha_a * I(Age_{i,t} = a) + \sum_t \beta_t * I(Year_t = t) + \sum_c \gamma_c * I(Cohort_i = c) + \epsilon_{ict}$$

Since there is an exact linear relationship between age, time and cohort (i.e. age = year – cohort), all three components cannot be identified at the same time. We take two different approaches to address this issue:

1. Estimate a fixed effects model, which strips out firm-specific time-invariant factors such as their birth cohort.
2. Replace the cohort dummy variable with a proxy variable that captures economic conditions in the year the firm was born. Our main proxy variable is real gross national expenditure growth.

For both models, we include an additional control variable for firm size, measured as employment.[9] For the second approach, we also include a number of time-invariant controls, including firm's legal structure (i.e. company or unincorporated), industry (measured at the 4-digit ANZSIC level), and location (at the state level).

To calculate the effect of changes in composition of firms' age on the aggregate investment intensity, we need to weight the estimated age coefficients from our regression results by the share of output accounted for by firms of different ages. Doing so gives us a 'weighted average age coefficient' (WAAC). We construct this measure for pre- and post-GFC periods. The difference between the pre- and post-GFC WAAC can then be interpreted as the effect of ageing on the aggregate investment intensity, assuming that estimated age coefficients are constant across the two periods. Or more precisely,

$$Effect\ of\ ageing = WAAC_{Post-GFC} - WAAC_{Pre-GFC} = \sum_{j=1}^{N} (age\ coef_j * w_j) - \sum_{j=1}^{N} (age\ coef_j * \mu_j)$$

Where,

- *j* is firm age
- *w* is age j's share of output in the post-GFC period (2012 to 2015)
- µ is age j's share of output in the pre-GFC period (2007 to 2008)

Appendix D

We use a Cobb-Douglas production function to analyse long-run investment intensity in the private non-mining market sector:

$$Y = AK^{(1-\alpha)}L^{\alpha}$$

Where,

- Y_t is non-mining market sector output
- A_t is non-mining market sector multi-factor productivity (MFP)
- K_t is the non-mining market sector capital stock
- L_t is non-mining market sector labour inputs
- α is the labour share of income

In the steady state, the above equation becomes:[10]

$$\Delta Y^{*} = g_{\alpha} + (1-\alpha)\Delta K^{*} + \alpha \Delta L^{*}$$

Where,

- g_{α} is non-mining market sector MFP growth
- Δ indicates growth rates
- $*$ gives the steady state

Over our sample, technological progress seems to have been approximately "neutral" in the sense that it has not changed the capital-to-output ratio. This implies that the steady-state growth rate of both output and capital are equal. This implies that:

$$\Delta Y^{*} = \Delta K^{*} = \frac{g_{\alpha}}{\alpha} + g_L$$

Where,

- g_L is the exogenous growth rate of labour supply

We can now use the capital accumulation identity to relate the potential growth rate of output to the rate of investment. The capital accumulation identity is written as:

$$K_t \equiv K_{t-1} + I_t + \delta_t K_{t-1}$$

Where,

- K_t is the non-mining market sector capital stock
- I_t is non-mining market sector gross fixed capital formation
- δ_t is the depreciation rate

We can now use $\Delta K_t = \frac{I_t - \delta K_t}{K_t}$ to give the long-run investment-to-output ratio:

$$\left(\frac{I}{Y}\right)^{*} = \left(\frac{K}{Y}\right)^{*} \times \left(\frac{I}{K}\right)^{*}$$

$$\left(\frac{I}{Y}\right)^{*} = \left(\frac{K}{Y}\right)^{*} \times (\Delta K + \delta)$$

$$\left(\frac{I}{Y}\right)^{*} = \left(\frac{K}{Y}\right)^{*} \times \left(\frac{g_{\alpha}}{\alpha} + g_L + \delta\right)$$

We assume that $\alpha = 0.60$ in all periods, while all other values are taken directly from the annual national accounts.

Footnotes

[*] The authors completed this work in Economic Analysis Department. We would like to thank Leon Berkelmans, Mark Chambers, Gianni La Cava, Peter Tulip and Michelle van der Merwe for helpful comments and feedback.

[1] See Appendix A for details on the adjustments we have made to the BLADE data prior to analysis.

[2] For evidence that the BLADE data are suitably comparable to the National Accounts data, see Appendix A. We consider changes in industry structure at the 4-digit Australian and New Zealand Standard Industrial Classification (ANZSIC) level. Details of the calculation can be found in Appendix B.

[3] More details on this model and its estimation are included in Appendix C.

[4] Even this is likely to be an overstatement of the role of ageing, given data coverage issues that we discuss in more detail in Appendix A.

[5] This section of the article is an update of previous internal RBA work by Leon Berkelmans and Gareth Spence.

[6] For details see Appendix D.

[7] In our model, the economy's long-run investment intensity is calculated as the long-run (or potential) growth rate of output plus the depreciation rate, multiplied by the capital-to-output ratio. The ratio is surprisingly high, reflecting inconsistencies in the coverage of our investment, capital, and output measures. Nevertheless, this is unlikely to substantially affect the changes in the ratio, which tend to broadly track the observed non-mining investment-to-output ratio.

[8] The increase in coverage is also non-random in nature; for example, unincorporated firms make up just 5 per cent of firms born in 2000/01 but account for 51 per cent of new firms in 2001/02.

[9] Employment is measured as the number of full-time equivalent employees.

[10] As we focus on the long-run, we assume that the prices of investment goods, the capital stock, and output all grow at the same rate. Moreover, for ease of exposition we abstract from relative prices, and so the distinction between nominal and real quantities.

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Explaining Low Inflation Using Models

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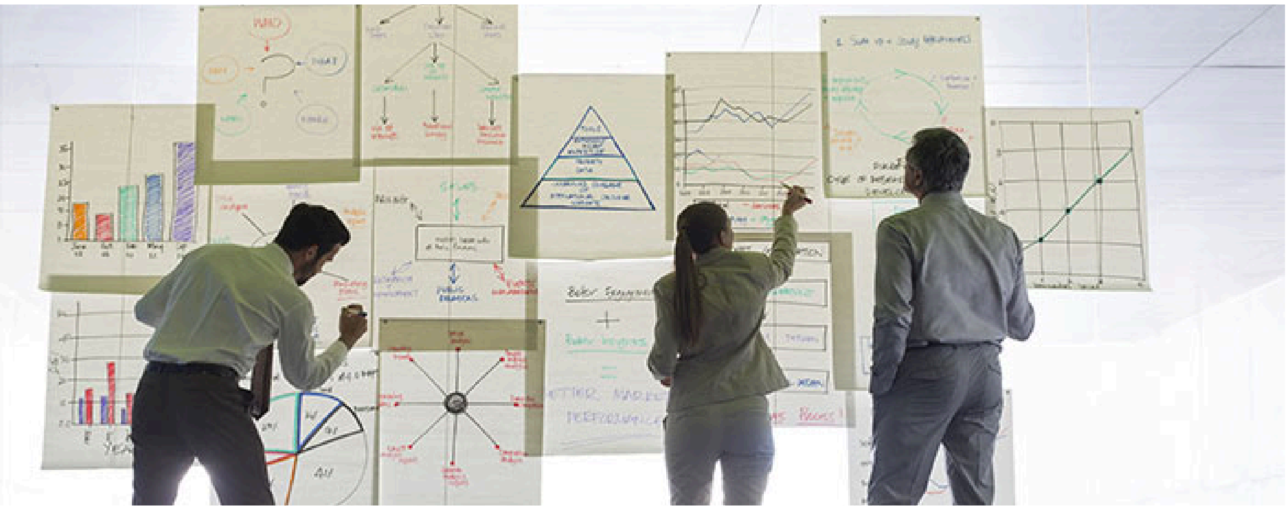


Photo: Martin Barraud – Getty Images

Abstract

The Reserve Bank's inflation forecast models can help assess which factors have contributed most to low inflation over recent years. The models find that spare capacity in the economy and the associated low wages growth can account for much of recent low inflation outcomes. This article outlines the inflation forecast models used at the Bank, and looks at the recent performance of the Bank's inflation forecasts.

Motivation

Australia's inflation target is for annual consumer price inflation (CPI) between 2 and 3 per cent, on average, over time (Graph 1). Given the long and variable lags in the transmission of changes in the stance of policy, forecasts for inflation are an important input into the Reserve Bank Board's policy deliberations. Reserve Bank staff employ a range of inflation models to assist in the forecasting process. In recent years, we have made a number of changes to our main inflation models and developed a number of new models. This article explains the choice of variables used to model inflation.

The other motivation for the article is that the inflation models can provide a lens through which to interpret the low inflation outcomes over recent years. The models suggest that spare capacity in the economy is the major reason for these outcomes, while lower inflation expectations have also played a role. More disaggregated models confirm that there has been a broad-based decline in inflationary pressure. Finally, the Reserve Bank's recent inflation forecast performance is discussed.

Inflation Modelling at the Reserve Bank

RBA forecasts reflect our best estimate of future economic outcomes (Kent 2016). This provides a useful starting point to guide policy deliberations and communicate those decisions to the public. The forecasts are published every quarter in the *Statement on Monetary Policy*.

We employ a suite of single-equation inflation models to provide guidance to the forecasts. We have also recently developed a full-system economic model, known as MARTIN (Cusbert and

Kendall 2018) and maintain a dynamic stochastic general equilibrium model (Hambur, Nodari and Gibbs 2018). The difference between single-equation and full-system models is that the former focus on a particular variable (say, inflation) and the variables that explain variations in that variable, such as the unemployment rate, are taken as given. In contrast, full-system models are a system of equations for economic variables that are solved at the same time. The focus of this article is on discussing the set of single-equation inflation models used in forecasting.[1]

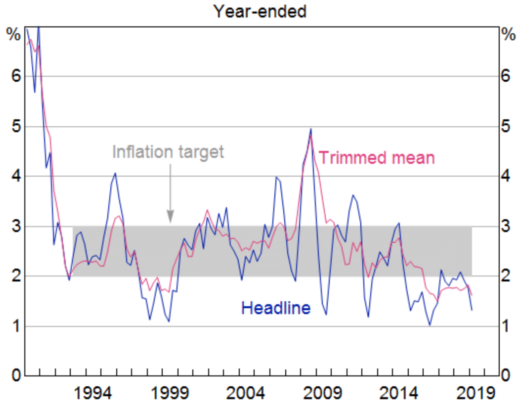
We use a range of inflation models rather than rely upon a single model so that we can incorporate more information into the forecasting process by drawing on a larger set of determinants. It also enables a consistency check across the model forecasts, and may also reduce any bias in the forecasting process. The weight forecasters apply to each of the models in deriving the final forecast for inflation can vary over time.

While the inflation target is defined in terms of headline CPI inflation, the current set of models is designed to explain trimmed mean inflation rather than headline inflation because it is less influenced by volatile and temporary factors. Forecasts for headline CPI inflation tend to be derived by adding on forecasts of volatile items to the trimmed mean forecast. The next section discusses the variables used in the Phillips Curve and Mark-up models of inflation, which are used to forecast aggregate trimmed mean inflation. Following sections discuss

Graph 1

Inflation*

Year-ended



* Excludes interest charges; adjusted for the tax changes of 1999–2000

Sources: ABS; RBA

a disaggregated model recently developed to explain major components of the CPI basket, known as the Component-level model, and separate models of both tradable and non-tradable inflation.

Aggregate Inflation Models

The two single-equation models that we use to model aggregate inflation are described internally as the Phillips Curve model and the Mark-up model. Earlier versions of these models were detailed in a RBA Research Discussion Paper (Norman and Richards 2010). The structure of both models is guided by theoretical economic relationships, combined with selecting variables based on their statistical performance in the model. Various changes have been made to these models over recent years as more is learnt about the relationships between variables, and as those relationships themselves evolve. The changes to the models over recent years were especially motivated by a desire to improve their forecast performance, and by changes to the way that the Reserve Bank measures some of the input variables used in the models.

The Phillips Curve model estimates a relationship between inflation, a measure of labour market spare capacity and inflation expectations. The following variables are included in the model (and discussed in more detail below):

- The 'unemployment gap' – that is, the difference between the unemployment rate and an estimated measure of the non-accelerating inflation rate of unemployment (NAIRU).
- Inflation expectations, because theory suggests that inflation expectations play a role in price-setting behaviour.
- Changes in the prices of imported goods are included, recognising Australia's relatively open economy. Australian consumers and businesses use imported goods and imported goods compete with many domestically produced goods.
- Inflation in the previous quarter, which can be interpreted as representing the component of inflation expectations that is backward looking.

The Mark-up model is based on the theory that firms set their prices as a mark-up over costs. As such, the model includes the following variables:

- Unit labour costs. This is measured as labour costs adjusted for labour productivity gains.
- Changes in the prices of imported goods, motivated in this context by the impact of intermediate imported goods on firm costs.
- Capacity utilisation in the economy. In this model, we use the output gap, which provides a guide to whether economic activity is above or below its (estimated) potential level.[2]
- Inflation expectations.
- Inflation in the previous quarter.

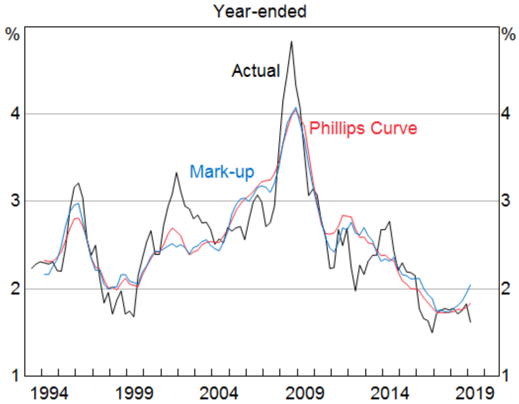
The coefficients of the models are estimated over the period since inflation targeting was introduced. These models fit many of the trend movements of trimmed mean inflation (Graph 2). For instance, both models capture the increase in inflation in the mid 2000s and the decline in inflation since the mid 2010s. The appendix provides the most recent estimated coefficients of the models and their recent performance is discussed in a separate section below.

A model decomposition shows the estimated contribution that different variables have made to inflation outcomes since 1993. The stacked bars in Graph 3 and Graph 4 show the contribution each model's input variables makes to the deviation of trimmed mean inflation from its average since 1993.

Graph 2

Trimmed Mean Inflation*

Year-ended



* Excludes interest charges and indirect deposit & loan facilities; adjusted for the tax changes of 1999-2000

Sources: ABS; RBA

The portion of inflation variance that cannot be explained by the explanatory variables – the model 'residuals' – are shown in the gold bars. Some key takeaways from the graphs are:

- The level of spare capacity in the economy (measured as the unemployment gap in the Phillips Curve model and the output gap in the Mark-up model) is an important determinant of inflation outcomes. In both models, variation in the amount of spare capacity can account for around half the variation in trimmed mean inflation when second round effects (via the lagged inflation variable included in the model) are taken into account.[3]
- During the 2000s, a sustained period of labour market tightness and a positive output gap stoked higher labour cost growth and broader inflationary pressures. However, the models were surprised by the extent of the increase in inflation in 2008, which can be seen in the series of positive residuals during this time.
- Over the past five years, the spare capacity in the economy and associated low wages growth has put downward pressure on inflation. Another source of downward pressure on inflation in recent years has been the decline in inflation expectations. A challenge of quantifying the relative contributions of spare capacity and inflation expectations is that neither are directly observed, and so these explanatory variables must themselves be estimated from the indicators available. Changes in imported prices have had only a small effect recently. While the models were a little surprised by the decline in inflation in 2016, there has been no consistent positive or negative residual more recently.

Spare capacity in the economy

Measures of spare capacity in the economy are important inputs into the inflation forecasts. In the Phillips Curve model, spare capacity is measured as the gap between the unemployment rate and the RBA's central estimate of the NAIRU. The NAIRU is the unemployment rate consistent with stable inflation over the medium term. It is not observable and has to be estimated. Our current approach is to update our NAIRU estimate as we get new data on unemployment, labour costs and inflation based on a Philips Curve framework that treats the NAIRU as an unobserved variable (Cusbert 2017).[4] The NAIRU is slow moving most of the time and, as such, most of the change in the unemployment gap comes about through changes in the unemployment rate.

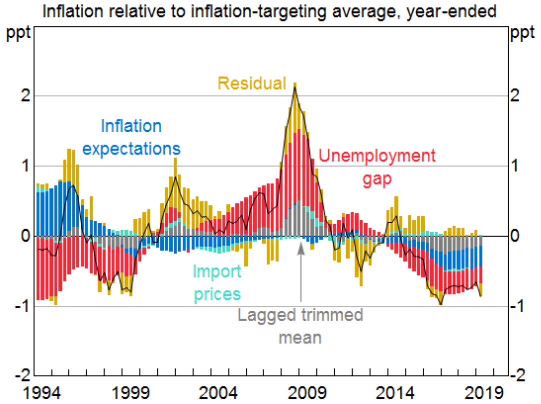
There is always considerable uncertainty around the estimate of the NAIRU. The 95 per cent confidence interval around the NAIRU estimate is around ±1 percentage point (Graph 5). The central estimate is also sensitive to the methodology chosen to estimate the NAIRU. There are many alternative ways to estimate the NAIRU, such as using a Hodrick-Prescott filter to extract the trend component in the unemployment rate or modelling the NAIRU as a function of the variables that affect the structure of the labour market. Notwithstanding these caveats, the Reserve Bank's preferred estimate of the NAIRU has declined a little over recent years to be around 4½ per cent.[5]

A number of commentators have suggested that the link between inflation and labour market developments has weakened over time.[6] That is, there is evidence across advanced economies that the coefficient on the unemployment gap in the Phillips Curve has declined, so that inflation would not rise as much as previously when labour markets tighten. The reasons put forward for this 'flatter' Phillips Curve include the anchoring of inflation expectations around inflation objectives during the 1990s, increased globalisation of labour and product markets, and changes in the relative bargaining power of labour. At face value, the fact that core measures of inflation in other advanced economies have remained low despite the unemployment rate declining below estimates of the NAIRU, provides some support to this hypothesis. In Australia, the current combination of low inflation and unemployment above the NAIRU is not obviously outside the bounds of historical experience since the mid 1990s (Graph 6). That said, there is some tentative evidence that the slope of the Phillips Curve has declined since the early

Graph 3

Phillips Curve Model Estimated Contributions

Inflation relative to inflation-targeting average, year-ended



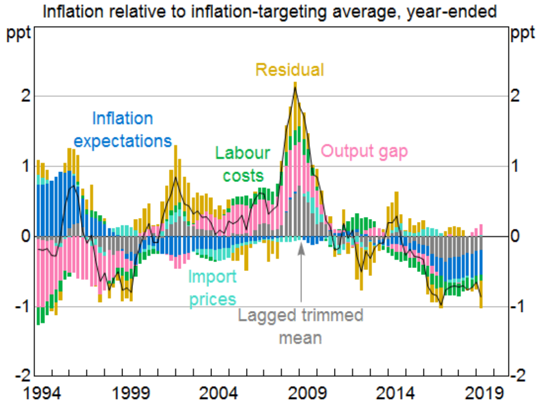
* Excludes tobacco and interest charges; adjusted for the tax changes of 1999-2000

Sources: ABS; RBA

Graph 4

Mark-up Model Estimated Contributions

Inflation relative to inflation-targeting average, year-ended



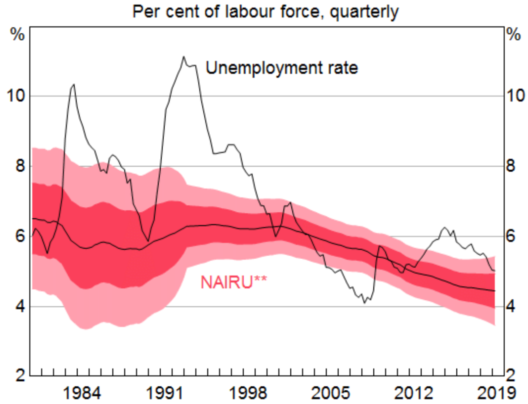
* Excludes tobacco and interest charges; adjusted for the tax changes of 1999-2000

Sources: ABS; RBA

Graph 5

NAIRU Estimate*

Per cent of labour force, quarterly



* The central estimate and the standard error bands are generated using the full data history of the input variables. It is also possible to generate a 'real-time' estimate of the NAIRU, but this is less useful for modelling purposes.

** Shaded areas represent one and two standard error bands around central estimates

Sources: ABS; RBA

1990s, though it is difficult to be certain about the extent of this. There is stronger evidence that inflation has become more stable because inflation expectations have become more strongly anchored (Gillitzer and Simon 2015).

The Mark-up model's measure of spare capacity is the output gap, which measures the deviation of GDP from its potential level. Its influence in the Mark-up model is somewhat smaller than the role of the unemployment gap in the Phillips Curve model. Like the NAIRU, potential output is not observable and has to be estimated. Our primary current method for estimating potential output is based on a 'production function approach'. This calculates potential output as the weighted average of smoothed growth in the capital stock and labour inputs plus growth in multifactor productivity. There are many techniques for estimating potential output and each method has its strengths and weaknesses.[7] Notwithstanding this, our output gap estimate suggests the decline in inflation over recent years is consistent with there being spare capacity in the economy (although this spare capacity has gradually declined over recent years).

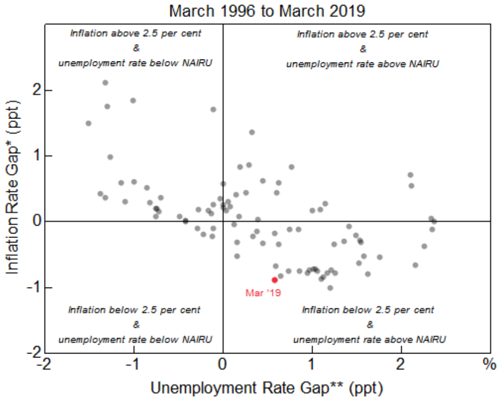
Inflation expectations

Inflation expectations are understood to play an important role in price-setting and, as such, should contain information about future inflation. Longer-run expectations are also linked to the inflation target, if it is credible. The Reserve Bank monitors a

Graph 6

Unemployment and Inflation Gaps

March 1996 to March 2019



* Year-ended trimmed mean inflation minus 2.5; excludes interest charges and indirect deposit & loan facilities; adjusted for the tax changes of 1999–2000

** Unemployment rate minus NAIRU

Sources: ABS; RBA

range of survey-based and financial market-based measures of inflation expectations. Each measure has its advantages and disadvantages (Moore 2016). For example, financial market measures such as inflation swaps and inflation-indexed government bonds are useful because market participants have strong financial incentives to estimate future inflation. However, movements in these measures are difficult to interpret because these markets are not particularly liquid in Australia. This means these measures have an embedded, time-varying liquidity premium, and can also contain an inflation risk premium that varies over time to compensate investors for bearing inflation risk. It is also not clear that market participants' expectations affect pricing decisions elsewhere in the economy. Consumer expectations of inflation should also be relevant for inflation dynamics, however, in practice, consumer survey measures do not line up very well with actual future inflation outcomes. Firms set prices but their inflation expectations are not generally surveyed.

To get around some of these issues, we combine a range of measures of inflation expectations into a single 'trend' measure. Specifically, we extract a common signal of expectations from the various measures after controlling for each measure's co-movement with recent inflation (Graph 7). This trend expectations measure is smoother than other series and is a little lower on average because it adjusts for the typical upward bias in many of those individual measures. This is done by adjusting the average of the trend measure to match the average level of the least-biased measures. We treat this measure as a proxy for the inflation expectations of those involved in price-setting in the economy.

Our 'trend' measure of inflation expectations, which has an important role in our inflation models, has declined in recent years as a result of fairly broad-based declines in survey and financial market measures of expectations. These declines have been concentrated in the short end of expectations. Gillitzer and Simon (2015) observed that long-term inflation expectations have been firmly anchored since the Reserve Bank adopted an inflation-targeting framework in the 1990s. Consistent with this, long-run survey-based measures of inflation expectations remain around 2.5 per cent.

Labour costs

The inclusion of labour costs in the Mark-up model is based on a view that increases in labour costs in excess of productivity growth (unit labour costs) should put upward pressure on prices because labour costs are the largest component of business costs.[8] However, in our model, we find that labour costs have only a small role to play in explaining inflation dynamics over the past 25 years. This may be because the measure of unit labour costs in our model is too volatile or mismeasured.[9] Or it might be because it is difficult to discern an independent effect of changes in labour costs on inflation once spare capacity in the economy (picked up in the output gap) is accounted for.

While we find little evidence of a significant relationship between labour costs and inflation, the fact that price and wage inflation have been low at the same time in Australia and in a range of other advanced economies, provides evidence of some sort of relationship. An ongoing puzzle in Australia is that, in contrast to inflation models, standard Phillips Curve models of wages growth cannot fully explain the weakness in wages growth over recent years.

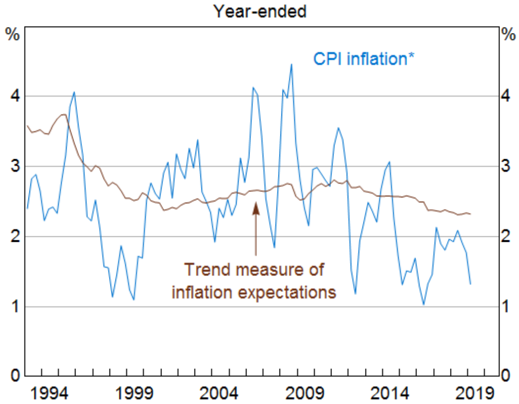
Import prices

Import prices for consumer goods are included in both the Phillips Curve and Mark-up models because imports account for around one-fifth of the cost structure of final consumer prices in Australia, and many domestically produced goods compete with imported goods. It is also the case that movements in the exchange rate flow through to import prices almost one-for-one. But according to our model, the flow-through from import prices to consumer prices is small. One possible reason is that the models are for trimmed mean inflation, and it may be that CPI components that are heavily influenced by changes in import prices, such as retail goods or fuel, tend to be trimmed out. This provides additional motivation for the development of the tradables model described in the next section.

Graph 7

Inflation Expectations

Year-ended



* Excludes interest charges and indirect deposit & loan facilities; adjusted for the tax changes of 1999–2000

Sources: ABS; RBA

Disaggregated Inflation Models

While the aggregate models help explain inflation outcomes using only a few variables, there is often a wide range of other factors influencing inflation. Over the years, various disaggregated models of inflation have been constructed by Reserve Bank staff. The models allow us to incorporate idiosyncratic movements in components into the aggregate profile and are also useful for scenario analysis.

We have developed separate Non-tradable and Tradable inflation models because there have been large differences in inflation outcomes for non-tradable and tradable items over the past two decades. Non-tradable items, which are around two-thirds of the CPI basket, are exposed to a low degree of international competition (such as services that can only be provided locally), and have prices that are influenced more heavily by domestic factors, such as spare capacity in the labour market (Jacobs and Williams 2014). In contrast, tradable items are much more affected by prices set on world markets and fluctuations in the exchange rate, and less influenced by domestic conditions.

The Non-tradable model is similar to the aggregate Phillips Curve model in that it includes the unemployment gap, a trend inflation expectations measure and its own lag (the appendix provides the details). It also includes a handful of adjustments for government policy changes that have had large one-off effects on non-tradable inflation, such as the introduction of the private health insurance rebate in 1999. Like our aggregate models, the Non-tradable model is unable to fully explain the weakness in inflation in 2015 and 2016 (Graph 8). The Tradable model contains many of the same variables as the Non-tradable model, with the addition of four lags of quarterly import price growth. The coefficients on the import price growth lags suggest that a 1 percentage point increase in import prices leads to year-ended tradable inflation being close to 0.2 percentage point higher over the subsequent year. The model also includes an adjustment to account for the recent period of structural change in the retail industry (see Box).

At a finer level of disaggregation, Reserve Bank staff have also constructed a Component-level model that seeks to explain and forecast a number of expenditure group classifications separately and then aggregates these to construct both headline and trimmed mean inflation forecasts. The groups that are modelled separately include rents, new dwelling costs, tobacco, administered prices, utilities, market services, volatile items, retail items and travel. Some of these groups, such as retail items, are further disaggregated and modelled.[10] The Component-level models are unable to fully explain the weakness in inflation over 2016 as well as over the past year (Graph 9). The residuals during these periods are predominantly related to prices for administered items and travel.

As has been previously noted, slower growth in some administered prices, low increases in rents and competition in the retail sector have all been important contributors to recent low inflation outcomes (Debelle 2018). In the Box below, we single out retail prices to demonstrate the benefits of including disaggregated models in the suite of inflation models monitored.

Forecasting Performance

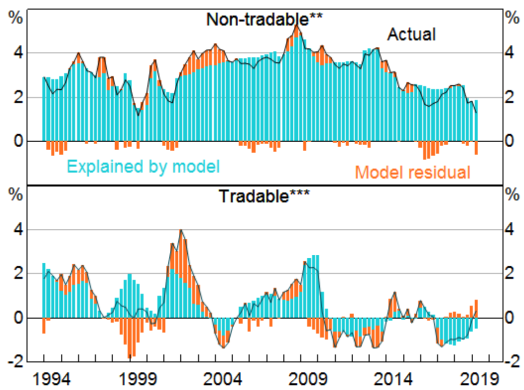
The decomposition of aggregate inflation in Graphs 3 and 4 demonstrates that a small number of macroeconomic determinants can largely account for the low inflation outcomes over recent years. The bars showing the residuals (or unexplained component) in these graphs indicate that, after the fact, low inflation has not been that surprising given the factors described above (perhaps with the exception of 2016).

We are also interested in the performance of the RBA's externally published inflation forecasts, which reflect only information available at the time. These forecasts are heavily informed by the models but can also embody a layer of judgement imposed by Reserve Bank staff. Graph 11 shows the forecast errors at the one-year (or four-quarter) horizon; that is, the deviation of actual inflation compared to the forecast one year earlier. The RBA significantly under-predicted inflation outcomes for 2008 and over-predicted future inflation for 2012 and 2015–16. Our forecasts for headline inflation have

Graph 8

Non-tradable and Tradable Inflation Models*

Year-ended

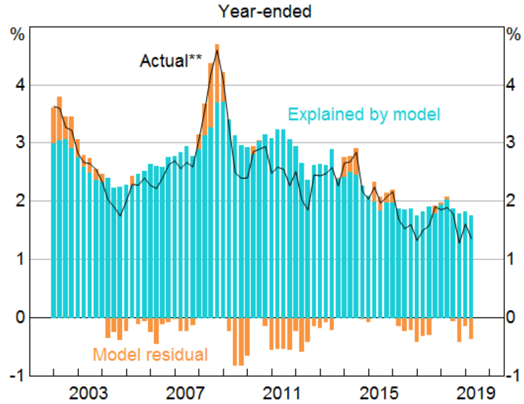


* Adjusted for the tax changes of 1999–2000
** Excludes interest charges, indirect deposit & loan facilities, and tobacco
*** Excludes volatiles and tobacco
Sources: ABS; RBA

Graph 9

Component-level Inflation Model*

Year-ended



* Weighted aggregation of the Component-level model fits and residuals
** Headline inflation excluding volatiles
Sources: ABS; RBA

Box: Low retail prices

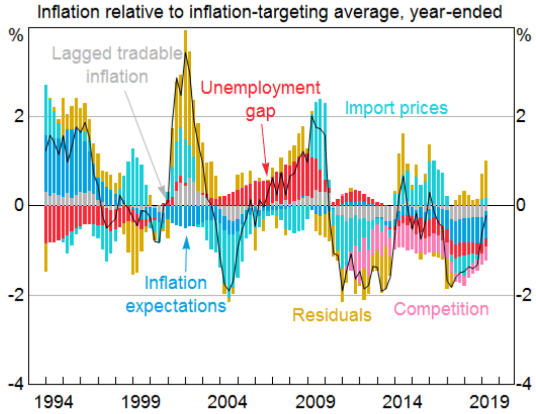
Prices of many retail items have been steady or falling over recent years. Ballantyne and Langcake (2016) found evidence that that there had been a large downward shift in the average rate of retail inflation that could not be explained by typical macroeconomic variables, such as import prices, from around 2010. They attributed this to an intensification of competition in the retail sector and firms' efforts to reduce costs along their supply chains. Firm-level data indicate that mark-ups and margins in the retail sector have been flat or in decline in recent years after increasing over the 2000s (Carter 2019). An environment of stronger price competition may reflect the entrance of new large international firms into the Australian retail market, a period of more moderate growth in demand and technological changes that have enhanced consumers' ability to search for cheaper prices.

Competition can manifest in many ways and it is difficult to quantify the effect on prices. The approach in the Tradable model is to include a simple adjustment from 2010 onwards, which crudely assumes that retail competition has had the same consistent impact on tradable price inflation each year since late 2010 (Graph 10). In the absence of any new shocks to the retail sector that would motivate a further decline in margins, it is reasonable to assume tradable inflation would eventually start to increase (or deflation start to lessen). As such, the challenge of including this kind of constant adjustment in the model is to identify what should happen over the forecast period. An alternative approach taken in the retail models in the Component-level framework is to include a time-varying intercept that adjusts based on the residuals of the model. If the price effect of retail competition does abate then the time-varying constant will gradually capture this change.

Graph 10

Tradable Inflation Model Estimated Contributions*

Inflation relative to inflation-targeting average, year-ended



* Excludes volatiles and tobacco; adjusted for the tax changes of 1999–2000

Sources: ABS; RBA

The example of retail competition also neatly illustrates the caveats in relying on disaggregated inflation models. If the decline in retail prices in recent years solely reflects increased competition in the retail sector, then this causes prices in that sector to decline *relative* to other prices in the economy. Consumers have benefitted from these lower prices and this may have boosted aggregate demand and had implications for inflation in other sectors.

tended to be less accurate than for underlying inflation. This reflects misses on volatile items which, inherently, are difficult to forecast.

The inflation forecasts that have been published over the past decade do not reflect a consistent set of model forecasts. This is because the updated models outlined in this article have only been in place since late 2016.[11] Nevertheless, in an assessment of forecast errors, it is helpful to assess the portion of the forecast miss that can be accounted for by errors in the inputs to the models. For instance, it is useful to know whether an inflation forecast error was because of an error in the unemployment rate forecast or other reasons. In 2006 and 2007, the Bank was forecasting the unemployment rate to pick up gradually over the period to 2008. However, the unemployment rate actually declined over this period, contributing to stronger than expected inflation outcomes. The forecast errors in 2015 and 2016 are most likely due to a combination of factors; inflation expectations and wages growth declined by more than expected, while it is also likely that an unanticipated decline in administered prices during this period contributed to the error.

Since the beginning of 2017, the trimmed mean inflation forecasts at a one-year horizon have been relatively accurate. This may be because inflation has been relatively stable over this period. It is too early to judge whether it reflects the impact of improvements made to our modelling framework in 2016. In recent years, the pattern of RBA forecast misses has been broadly similar to the pattern of forecast misses of other professional forecasters (Graph 12).

Conclusion

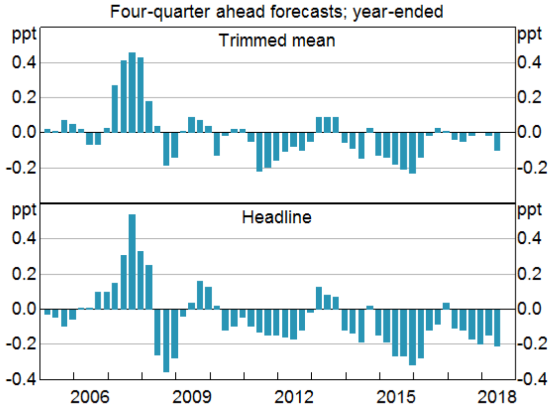
Year-ended underlying inflation has been around 1½–1¾ per cent for three years, and the RBA's inflation models attribute much of this to a period of spare capacity and low labour cost growth in the economy. The same models underpin a forecast that underlying inflation is expected to rise gradually over the next two years as spare capacity diminishes a little and labour cost growth increases gradually.

Development and refinement of the RBA's inflation models is an ongoing process, as it should be. As new data are released, more is learnt about the behaviour of the Australian economy and how it is changing over time. Several areas of potential improvement are front of mind. While the decline in labour cost growth can explain a sizeable portion of recent low price inflation, labour cost growth has been surprisingly low and hard to fully explain; investigation continues into the relationship between wage and price determination. There is also a stream of research underway looking for a better explanation of the weakness in retail price inflation over the past decade. Work is also ongoing to improve the way we estimate and use 'unobserved variables' such as potential output

Graph 11

Inflation Forecast Errors*

Four-quarter ahead forecasts; year-ended



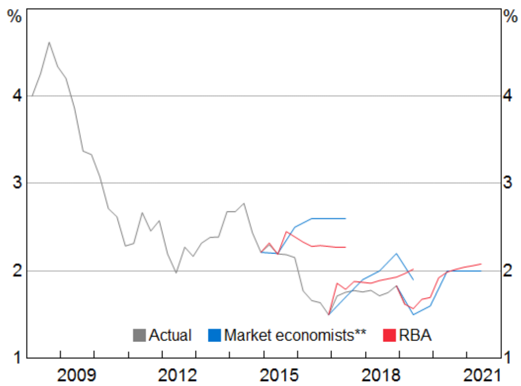
* For example, the final bar evaluates our May 2018 Statement forecasts relative to the March quarter 2019 inflation outcomes

Sources: ABS; RBA

Graph 12

Trimmed Mean Inflation Forecasts*

Year-ended



* Forecasts shown as at May SMP 2015, 2017 and 2019

** Average forecast from a quarterly RBA survey of market economists

Sources: ABS; RBA

growth, the NAIRU and inflation expectations in our forecasting process. ✠

Appendix: Model Specifications and Coefficients

Table A1: Phillips Curve Model

Estimated on Mar 1993 – Dec 2018[(a)]

	Estimate	Standard Error
Intercept	–0.001	(0.126)
π_{t-1}	0.211*	(0.094)
$\frac{trend_t}{4}$ (b)	0.808***	(0.206)
$\left(\frac{u_{t-2} - u^*_{t-2}}{u_{t-2}}\right)$ (b)	–0.643***	(0.113)
$\frac{\%\Delta^{ye}(consumerIPI_{t-1})}{4}$	0.011	(0.001)
Adjusted R2	0.45	

(a) * = 0.05, ** = 0.01, *** = 0.001

(b) The standard errors on these variables are incorrect due to the generated regressors problem.

Table A2: Mark-up Model

Estimated on Mar 1993 – Dec 2018[(a)]

	Estimate	Standard Error
Intercept	–0.230	(0.154)
π_{t-1}	0.292**	(0.091)
$\frac{trend_t}{4}$ (b)	0.961***	(0.248)
$\left(y_{t-2} - y^*_{t-2}\right)$ (b)	0.054***	(0.014)
$\frac{\%\Delta^{ye}(consumerIPI_{t-1})}{4}$	0.021	(0.011)
PDL coefficients on: $\%\Delta(NULC_t)$		
Constant term	0.010	(0.006)
Adjusted R2	0.43	

(a) * = 0.05, ** = 0.01, *** = 0.001

(b) The standard errors on these variables are incorrect due to the generated regressors problem.

Table A3: Tradable and Non-tradable Models

Estimated on Mar 1993 – Dec 2018[(a)]

	Non-tradable Model		Tradable Model	
	Estimate	Standard Error	Estimate	Standard Error
Intercept	0.157	(0.217)	–0.498	(0.317)
π^{nt}_{t-1}	0.157	(0.096)		
π^{tr}_{t-1}			0.059	(0.097)
$\frac{trend_t}{4}$ (b)	0.920**	(0.371)	1.050*	(0.467)
$\left(\frac{u_{t-1} - u^*_{t-1}}{u_{t-1}}\right)$ (b)	–0.890***	(0.215)	–0.368	(0.215)
$\sum_{j=1}^{4} \%\Delta^{qtr} consumerIPI_{t-j}$ (c)			0.154***	(0.025)
$CompDum_t$			–0.274***	(0.081)
Policy dummies				
Health (Sep 1997)	–0.725***	(0.199)		
Health (Dec 1997)	0.404	(0.205)		
Health (Mar 1999)	–1.081***	(0.199)		
GST (Sep 2000)[(d)]	–0.791***	(0.198)	0.428	(0.313)
Child care (Sep 2007)	–0.286	(0.204)		
Child care (Sep 2008)	0.102	(0.204)		
Health; Energy (Sep 2012)	0.743***	(0.198)		
Energy (Sep 2014)	–0.387	(0.199)		
Child care (Sep 2018)	–0.552**	(0.201)		
Adjusted R2	0.587	0.471		

(a) * = 0.05, ** = 0.01, *** = 0.001

(b) The standard errors on these variables are incorrect due to the generated regressors problem.

(c) The estimate provided is the sum of the coefficients on the four lags; joint significance and standard error are determined by a Wald test.

(d) There are residual tax-effects in some of the RBA's tax-adjusted CPI data.

Where:

• π_t	Quarterly trimmed mean inflation (seasonally adjusted), excluding interest charges and indirect deposit & loan facilities; adjusted for the tax changes of 1999-2000.
• π_t^{nt}	Quarterly non-tradable inflation excluding interest charges and tobacco (seasonally adjusted); adjusted for the tax changes of 1999-2000.
• π_t^{tr}	Quarterly tradable inflation excluding volatile items and tobacco (seasonally adjusted); adjusted for the tax changes of 1999-2000.
• $trend_t$	A measure of trend inflation expectations estimated using a Kalman filter.
• u_t	The quarterly-average unemployment rate (seasonally adjusted).
• u_t^*	Non-accelerating inflation rate of unemployment (NAIRU); two-sided smoothed estimate.
• $\%\Delta^{ye}(consumerIPI_t)$	Year-ended growth in the import price index for consumption goods.
• $\%\Delta^{qtr}(consumerIPI_t)$	Quarterly growth in the import price index for consumption goods (seasonally adjusted).
• y_t	Log non-farm GDP.
• y_t^*	Log non-farm potential output, estimated using PWL's production function approach.
• $\%\Delta(NULC_t)$	Quarterly growth in nominal unit labour costs. The coefficients $\phi_1, \ldots, \phi_{12}$ are assumed to be equal.
• $CompDum_t$	A dummy variable with value one from Dec 2010 to present. This accounts for an apparent structural break in the relationship between tradable inflation and the model's explanatory variables, most likely reflecting an intensification in competitive pressures in the retail industry.

Footnotes

[*] The authors are from Economic Analysis Department. The authors would also like to thank Alexander Ballantyne and Martin McCarthy for their valuable contribution in model development over recent years, as well as Angus Moore for his assistance in the forecast performance assessment.

[1] The approach to modelling and forecasting inflation at the RBA has many similarities to the approaches taken at other central banks. For instance, at the Bank of England, a larger 'structural central organising model' named COMPASS is run alongside a suite of models with different frameworks including some focused on firm input prices and a 'bottom-up' model which projects individual CPI components (Burgess *et al* 2013). At the Reserve Bank of New Zealand, tradable and non-tradable inflation are modelled separately taking consideration of spare capacity in the economy and movements in the exchange rate (Kergozou and Ranchhod 2013); a structural macroeconomic model named NZSIM models prices as a mark-up over firm's costs (Austin and Reid 2017).

[2] The Reserve Bank has a number of methods for estimating potential output and the output gap, most of which are statistical approaches to filtering out the trend and cyclical components of GDP growth. The output gap is included in addition to unit labour costs in this model to account for the cyclicality of non-wage business costs and mark-ups.

[3] Note that there is negative covariance between the contributions of spare capacity and the contributions of some other explanatory variables in both models. As a result, when this method of variance decomposition is used for each of the explanatory variables individually and these results are aggregated, the total proportion of variance in trimmed mean inflation that the model explains can be overstated. This does not impact the contributions shown in Graphs 3 and 4.

[4] The NAIRU can move in response to persistent shocks to wage and price-setting or variables that are not included in the model. For example, structural change in the retail industry may be causing inflation to be lower than expected. Since we do not account for this in the NAIRU model, the model will ascribe the lower-than-expected inflation to a lower NAIRU. Note that the Bank's NAIRU model has been modified to some degree since Cusbert (2017).

[5] Graph 5 shows the 'two-sided' smoothed estimates of the NAIRU. Real-time estimates of the NAIRU, which are also referred to as 'one-sided' estimates, are much more

volatile and had been higher in recent years than the most recent two-sided estimates.

[6] See for example Borio (2017), International Monetary Fund (2013), and Jordà *et al*. (2019).

[7] See Schembri (2018) for an overview of the definition and measurement options of potential output. Estimation techniques include either simple statistical models that filter out short-term fluctuations in output growth, or through structural models that rely on theoretical relationships between variables.

[8] There is also likely to be an influence of inflation outcomes on labour costs, which is not explicitly captured in these inflation models. Other multi-equation models maintained by the Reserve Bank can account for these feedback loops.

[9] An alternative approach would be to use growth in the Wage Price Index (WPI); either in addition to unit labour costs or as an alternative variable. Despite being a less volatile series, the WPI is less theoretically appropriate than unit labour costs for inclusion in an inflation equation since the WPI data are only partially adjusted for changes in productivity. Furthermore, the WPI series commences in 1997, whereas we prefer to condition our inflation models over the whole inflation-targeting period.

[10] This classification can differ from the expenditure group classification that the Australian Bureau of Statistics uses, because it is motivated by grouping items that have similar drivers of inflation.

[11] The Reserve Bank regularly reviews and updates its inflation models. In doing so, we recognise that the reduced-form relationships we estimate are not necessarily stable over time, either because the forces impacting the economy can be persistently different at times or because there are structural changes in the way that the economy functions.

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The Australian Equity Market over the Past Century

Thomas Mathews[*]

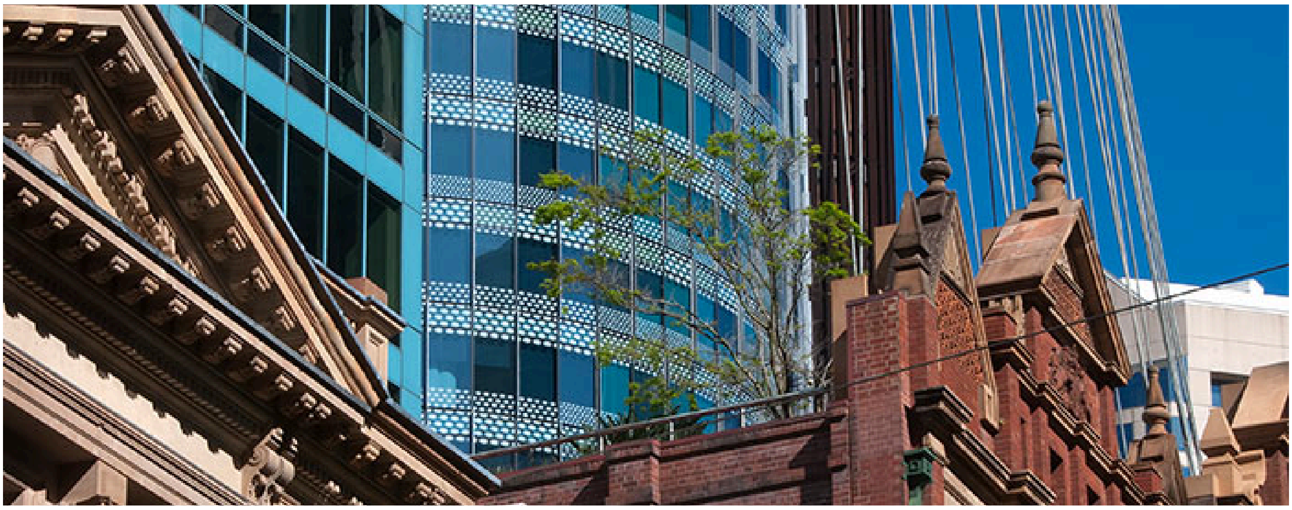


Photo: Karin de Mamiel – Getty Images

Abstract

This article describes developments in the Australian equity market over the past century, drawing in part from a newly compiled historical dataset which begins in 1917. Over the past one hundred years, the market has increased in size relative to the economy, while its composition by industry also changed substantially. The data also provide new evidence that historical returns on Australian equities – and therefore the equity risk premium – are lower than previously thought.

The equity market is one of Australia's most important and high profile financial markets. It is an important source of funding for Australian companies and a destination for a large share of households' retirement savings. The total capitalisation of listed companies in Australia at the end of 2018 was just under $2 trillion, or around 100 per cent of GDP (Graph 1). Around $5 billion in shares are traded every day. Most large, well-known companies in Australia, such as the major banks and resources firms, are listed on the Australian Securities Exchange. They account for a large share of Australian output and employment, meaning there is an important relationship between the market and real economic activity.

Historical data are important for placing equity market developments in context. An example is share price valuation metrics, such as price-to-earnings and price-to-book ratios. These are often compared to their own long-run averages by investors and market commentators to determine whether at a particular point in time they could be considered high or low. Alternatively, understanding how historical economic developments, such as mining booms or recessions, have affected the share market can help us interpret both how the market might react in future should similar events occur and the importance of current developments in light of historical experience.

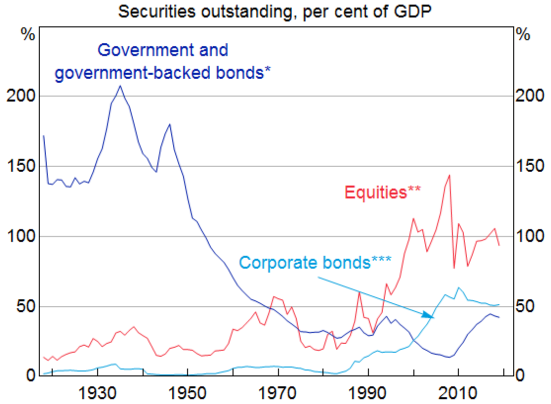
Despite the importance of the equity market, historical data for Australia are somewhat limited. Many time series begin in the 1980s or 1990s, a period during which, among other things, interest rates were very high relative to historical averages and the financial sector was expanding rapidly. This might affect their use as benchmarks for interpreting modern data. Additionally, several existing equity market time series do not extend far enough back to cover a period of economic recession, limiting our ability to interpret how they might react if one happened in the future. In contrast, in countries where comprehensive data do exist, long-run comparisons can be informative. In the United States, for example, the Shiller price-to-earnings ratio (a measure of market valuation) in recent years reached levels comparable to the period just before the Great Depression. This led to some commentary that US equities were overvalued, or that there was excessive investor exuberance (Shiller 2017). Such comparisons are more difficult to make in the context of Australia primarily due to limited data.

Other data gaps have also made recent Australian developments difficult to place in historical context. For example, reliable data on the relative sizes of different sectors of the market mostly start in the 1990s or early 2000s (depending on the source). This period does not include the deregulation and expansion of the financial sector, the decline of the manufacturing sector, nor the late 1960s/early 1970s mining boom. Therefore, it has been difficult to say how remarkable more recent shifts – such as the most recent mining boom – have been in a historical context.

Graph 1

Australian Financial Markets

Securities outstanding, per cent of GDP



* Includes central and state government bonds, as well as those issued by government-owned corporations

** Includes only companies listed on the Sydney Stock Exchange prior to 1964, so may understate the size of the market for this period

*** Data on bonds issued offshore are not available prior to 1983

Sources: ABS; ASX Limited ABN 98 008 624 691 (ASX); Black et al (2012); Foster (1996); RBA

This article presents some extended time series on the Australian equity market, filling some of these data gaps by drawing from a newly compiled dataset on the equity market which begins in 1917. The data were constructed primarily from stock gazettes published by the Sydney Stock Exchange, one of the predecessors of the modern Australian Securities Exchange. They cover quarterly company-level data from 1917 on a range of variables of interest. Further discussion of the data collection process, and its limitations, can be found in the Research Discussion Paper Mathews (2019).

As with all datasets, particularly historical ones, some caveats should be made about interpretation. The data were largely hand-entered, and market reporting conventions have changed over time, which introduces the possibility of errors. Nonetheless, the data have been carefully collected and checked, and we judge them to be of sufficient quality for research purposes. The remainder of this article highlights some interesting findings based on this dataset.

Shareholder Returns

The average return on equities – particularly when compared with the return on other assets – is a useful statistic for retirement planning and portfolio allocation, as well as some regulatory purposes. Since equity markets are quite volatile, however, it is appropriate to look at realised returns over very long periods of time. The length of the new dataset allows us to calculate average returns on Australian stocks over the past 100 years, providing a more accurate representation of returns.

Share Prices

Australian share prices have increased by a geometric average of around 6 per cent per year over the past 100 years, or by around 2 per cent after accounting for inflation.[1] Over the long run the different industrial sectors have generally performed quite similarly, although there have been periods of over and underperformance (Graph 2). For instance, banking stocks underperformed for several decades following the Great Depression, while resources stocks outperformed the rest of the market in the late 1960s and then did quite poorly afterward, during the so-called 'Poseidon Bubble'.[2]

Dividends: Payout ratios and yields

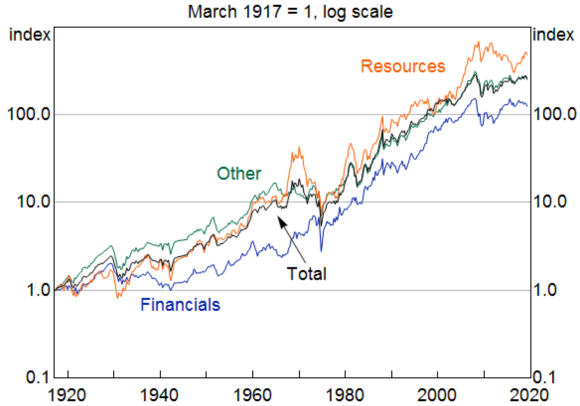
When measuring the returns on Australian equities, it is important to take dividend payments by companies into account. This is because dividends on Australian equities are higher than in many other countries due in part to their tax treatment (Bergmann 2016). This can be observed through changes in dividend payout ratios (the share of profits paid out as dividends in any given year). Before the introduction of franking credits (where shareholders receive a rebate for the tax already paid by the company on the profits being distributed as dividends) in 1987, Australian dividend payout ratios used to track those in the United States very closely (Graph 3). Since companies have to decide between using profits to pay dividends or invest in productive assets, the similarity in Australian and United States payout ratios before 1987 is likely to reflect broadly similar economic conditions. Following the introduction of franking credits, the ratios diverge; dividend payments in Australia have remained very high even as they have declined in the United States, likely reflecting their tax treatment here. In contrast, US companies have increasingly chosen to return capital to shareholders by buying back shares instead, which in Australia would not generally receive the same tax treatment as dividends.

An arguably more important statistic from the point of view of an equity investor, however, is the dividend yield: the ratio of dividends per share to share price. This shows the return on investment generated by the payment of dividends, which accounts for around half of the total return on holding Australian equities over the past century (Kohler 2018).[3] Existing data on historical Australian dividend yields, originally published in Lamberton (1958a&b) (and continued by the Sydney Stock Exchange) tend to overstate the actual dividends shareholders would have received, particularly for the first half of the 20th century.[4] This is because, historically, they were calculated as a simple average of all companies' dividend yields, giving undue weight to smaller companies which tend to have higher dividend payout ratios. Hence, historical dividend yields based on this simple average tend to be higher than on a market capitalisation-weighted portfolio.[5] The Lamberton data also excluded companies paying zero dividends. The company-level data used here allow us to calculate a dividend yield based on a market capitalisation-weighted portfolio, to more accurately reflect the yield earned by a typical investor. The result is that dividends are about 200 basis points per year lower than implied by existing data. Nonetheless, the changes over time are very similar to those shown in the Lamberton

Graph 2

Equity Price Indices

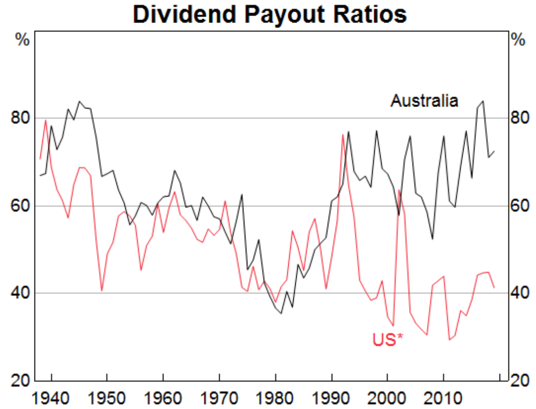
March 1917 = 1, log scale



Sources: ASX; RBA; Refinitiv Datastream

Graph 3

Dividend Payout Ratios



* Excluding 2008

Sources: ASX; http://www.econ.yale.edu/~shiller/data.htm; RBA; Refinitiv Datastream

Table 1: Total Returns 1917Q1–2019Q1

Annualised per cent, geometric average

Total market	10.2
– Resources	10.2
– Financials	10.3
– Other	10.4
10-year government bonds	6.2
Consumer price inflation	3.9

Sources: ABS; ASX; Foster (1996); Hunter (1958); Lamberton (1958a&b); League of Nations Yearbooks; RBA; Refinitiv Datastream

data (Graph 4). The RBA series also lines up quite closely with modern data where they overlap.

Total return and the equity risk premium

Using the updated dividends data, the new historical series (extended with available data for more recent time periods) imply that the total nominal return on equities (i.e. the sum of capital gains and dividends) has been around 10 per cent per year over the past 100 years (based on a geometric average which allows for compounding over time) (Table 1). In real terms – i.e. after accounting for inflation – the average annual return was about 6 per cent. There have not been material differences in returns across sectors over this time, although of course there have been periods in which sectors have performed differently. Over the same period, the total nominal return on long-term government bonds has been around 6 per cent, implying an average equity risk premium (excess return of equities over safe assets) of around 4 per cent.[6]

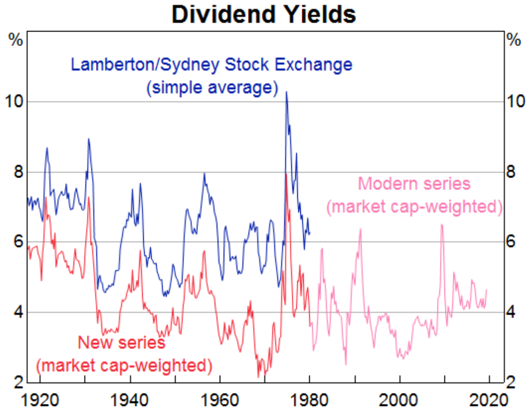
Due to the lower dividend yields, this estimate of the equity risk premium is a bit lower than using the Lamberton data implies (Graph 5). It also suggests that the realised risk premium in Australia was materially lower than that in the United States for the period 1955–80, while similar at other times. It does bring historical estimates of the premium closer to more recent realised values in Australia, however.

Composition of the Listed Equities Market

The composition of the stock market – in terms of the types of companies listed – is very similar to its composition of 100 years ago. Financial corporations (particularly banks) and resources companies (particularly miners) account for about half of the market by market capitalisation, which was also true in 1917 (Graph 6). Indeed, it is often the very same companies (albeit following several mergers and acquisitions) that comprise most of

Graph 4

Dividend Yields

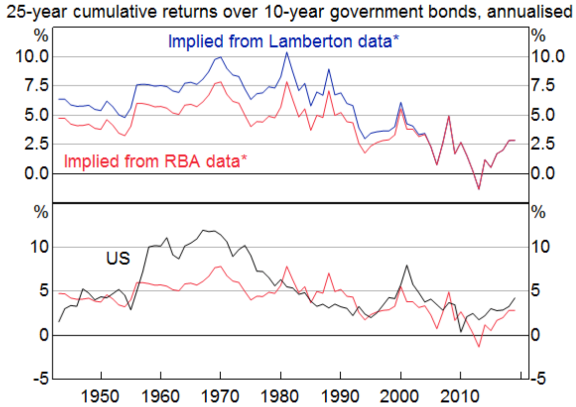


Sources: ASX; Lamberton (1958a, 1958b); RBA; Refinitiv Datastream

Graph 5

Realised Equity Risk Premium

25-year cumulative returns over 10-year government bonds, annualised



* Uses Lamberton/RBA data to 1979, extended using Refinitiv/Datastream series subsequently

Sources: ASX; http://www.econ.yale.edu/~shiller/data.htm; Hunter (1958); Lamberton (1958a&b); League of Nations yearbooks; RBA; Refinitiv Datastream the stock market. This reflects the historical importance of colonial-era banks and of mining companies founded during the resources booms of the 19th century. Nonetheless, the similarity in composition masks substantial changes that have taken place in the interim, due in part to changes in the structure of the Australian economy.

Resources

The resources sector, which includes mining and energy companies, is currently about 20 per cent of the stock market by market capitalisation. During the mining boom of the 2000s, it more than doubled in size (relative to the other sectors). However, the sector expanded much more rapidly during the mining boom of the late 1960s/early 1970s, where it reached a peak of over 65 per cent of the market.[7] Even so, mining has never accounted for more than 10 per cent of employment (Connolly and Lewis, 2010) or gross domestic product (ABS 2005) so it has always accounted for a larger share of the stock market than of the real economy.

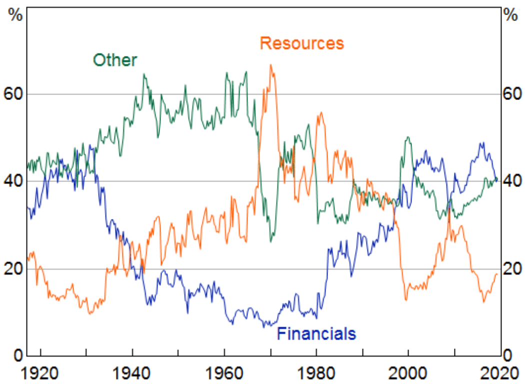
Financials

Financial stocks were among the first traded in the Australian colonies in the 1800s, and by the early 20th century they still accounted for over a third of the stock market by market capitalisation. These companies were the predecessors of today's large banks (excluding Commonwealth Bank, which was set up by the government in 1911 and publicly

Graph 6

Market Capitalisation by Sector*

Share of total index



* Largest 100 companies by market capitalisation prior to 1979; Refinitiv Datastream calculated series for whole exchange from 1980

Sources: ASX; RBA; Refinitiv Datastream

owned until the 1990s). These banks underwent many mergers in the interim, which has reduced their number. The financial sector shrank substantially in relative terms in the mid 20th century, in substantial part owing to stricter regulation following the Great Depression. As a result, for most of the past 100 years, financial corporations were a much smaller part of the stock market than is the case now. As the role of the financial sector in the economy has expanded in recent decades, however, it has accounted for an increasingly large share of the stock market. The modern listed financial sector is also much more diversified than it was 100 years ago, as insurance companies and diversified financial corporations have grown in size relative to banks.

Other

The 'other' sector – everything except financials and resources – has historically been dominated by manufacturing, consumer goods and infrastructure companies. The sector reached its peak share of about 65 per cent of the index around 1960, but declined over the next two decades and has been around 40 per cent since then. The timing of these changes aligns fairly closely with the peak and decline of Australia's manufacturing sector relative to broader measures of economic activity (ABS 2005). Large manufacturing companies such as Tooth and Co. (a brewery) and British Tobacco had been either the second or third largest companies on the market (the largest being BHP) for around 20 years, ending in the 1950s. Moreover, before the 1960s large manufacturing conglomerates like Australian Consolidated Industries (glassware and plastics), ICI (chemicals) and Australasian Paper and Pulp were among the largest listed companies as well. The value of all of these companies declined in relative terms through the mid 1960s and 1970s, and many have since ceased trading or been acquired by other enterprises.

Consumer stocks have also historically made up a large share of the market. This reflects a high number of listed department stores in the early part of the century, but newspaper companies also featured prominently. Agricultural and forestry companies, which historically accounted for quite large shares of Australian output, have never been particularly important in the stock market. This may reflect the prevalence of small-to-medium enterprises (such as farms) which would not have been big enough to list publicly.

Infrastructure companies have also been prominent on the stock market since its inception but, over time, railway and steamship companies have mostly been replaced by those focusing on roads and airports. Shipping, in particular, was still a very large industry on the stock market at the start of the 20th century. This reflects its important role in the economy through the 1800s when the value of listed shipping companies rivalled that of the banks and miners. Companies like the Union Steam Ship Company of New Zealand (the 'Southern Octopus') and Sydney Ferries were among the largest companies on the market at various times and, at its peak, the Southern Octopus was the largest private sector employer in New Zealand. Shipping overall is only a minor share of the market now, although transport companies like Transurban, Qantas and Sydney Airport remain large and significant companies.

Valuations

Market participants and observers calculate equity price valuations for a range of reasons. For instance, for market participants, knowing when a company's share price is high or low relative to some metric (for example, compared with its realised profits) might be taken as a sign to buy or sell its stock.

One simple measure of the valuation of equities is the price-to-earnings ratio. A share price should, in theory, be the discounted present value of expected future payments to shareholders. A price-to-earnings ratio above average implies that investors anticipate above-average growth in company earnings, or are discounting those earnings at a below-average rate, or both. For these reasons, the ratio is commonly used as a measure of investor optimism regarding the prospects of listed companies and their willingness to bear risk associated with investing in them. The new data suggest that in Australia, price-to-earnings ratios are very close to their long-run average (Graph 7). This is true for the index as a whole, and for the three main subsectors. This is quite striking, since price-to-earnings ratios overseas – particularly in the United States – have been above their long-run averages of late (when considered over this horizon).[8] And given that interest rates are quite low, we might expect price-to-earnings ratios to be above average all else being equal, since the present value of discounted future earnings will be higher with lower discount rates.

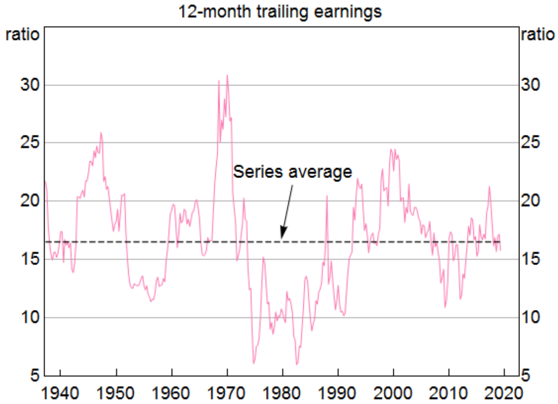
Conclusion

The Australian equity market has grown over the past century to be an important part of the financial system. Understanding it in historical context is important, and the new data presented here provide insight into a range of topics on the market and on listed companies more broadly. Readers with further interest are encouraged to read the Research Discussion Paper (Mathews, 2019) this article summarises, which covers many other topics over the same long-term perspective. ✠

Graph 7

ASX Price-to-earnings Ratio

12-month trailing earnings



* Top 100 companies by market capitalisation prior to 1979; Datastream/Refinitiv-calculated series for total exchange from 1980

Sources: ASX; RBA; Refinitiv Datastream

Footnotes

[*] The author is from Domestic Markets Department. This article summarises a recently released Research Discussion Paper, and interested readers should refer to Mathews (2019) for further detail. Some of these data were also presented in Kohler (2018).

[1] This is calculated from an index which includes the top 100 companies by market capitalisation for 1917–1979, and for the total market from 1980. See Mathews (2019) for further information.

[2] See Simon (2003) for further discussion of this period.

[3] The other half is attributable to increases in share prices.

[4] The data referred to here are from Lamberton (1958), who calculated historical dividend yields and share prices on behalf of the Sydney Stock Exchange, and continued to produce measures using his methodologies for some years following. This is the most widely used dataset on historical equity prices in Australia.

[5] Brailsford, Handley and Maheswaran (2008) discuss this issue in depth, and some adjustments that can be made to existing data.

[6] Different choices such as the safe asset series (i.e. long-term bonds or short-term bills), the time period, and whether to use geometric or arithmetic averages, will affect the estimate of the premium. Mathews (2019) discusses some of these issues in further detail.

[7] Battellino (2010) discusses this mining boom – and others – in more depth.

[8] See Graph 9 in Kohler (2018).

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China's Local Government Bond Market

Alex Holmes and David Lancaster[*]

Photo: owngarden – Getty Images

Abstract

China's local government bond market is a key source of financing for local governments, particularly to fund infrastructure investment. The market has grown rapidly in recent years but is still relatively illiquid and has a narrow investor base. It also shows little difference in pricing of credit risk across different bond types and issuers, partly due to the perception that local governments enjoy an implicit guarantee from the central authorities. The Chinese Government has implemented measures to foster the development of these features of the market, bearing in mind risks to financial stability.

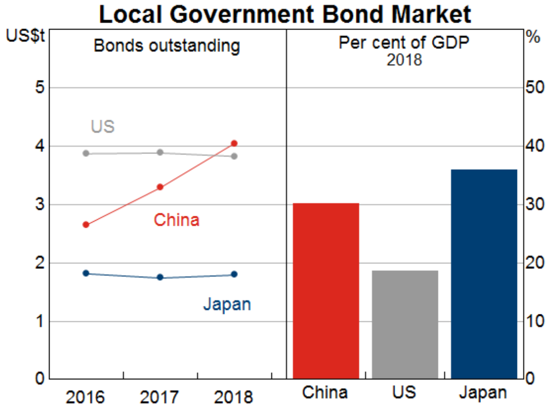
Introduction

China's local government bond market has grown rapidly in recent years and is now the largest municipal bond market in the world (Graph 1).[1] It is now also the largest bond market in China (Graph 2). The market is an important source of financing for local governments in China, which are responsible for a large share of total government expenditure (around 85 per cent) and which undertake the bulk of public infrastructure investment (Wilkins and Zurawski 2014). Bonds made up around 90 per cent of local government debt in 2017, compared with 7 per cent in 2014 when debt mainly comprised of off balance sheet borrowing from banks (Lam and Wang 2018).

This article discusses the growth in the size and importance of the local government bond market

Graph 1

Local Government Bond Market



Sources: IMF; MIC; RBA; SIFMA; WIND Information in China. It describes the emergence of the market, which has been heavily influenced by regulatory changes and other policies of the central government. It then examines the market's investor base, liquidity and pricing, and discusses recent reforms that aim to further develop the market.

The Emergence of the Market

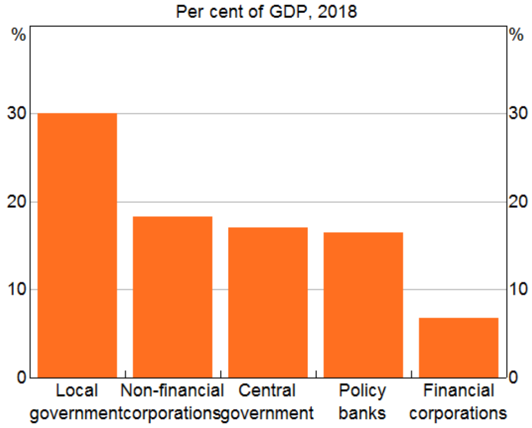
Before 2015, the size of the local government bond market was limited by China's *Budget Law 1994*, which prohibited borrowing by most local governments. As a result, local governments raised funds by forming off-balance sheet entities known as local government financing vehicles (LGFVs). These LGFVs sourced credit, in large part, from outside the regular banking system. Such funding is known as 'shadow financing' and is subject to limited prudential oversight. Local government borrowing through LGFVs increased sharply from 2009, when China's central government announced a stimulus package to support economic growth, which included approximately CNY3 trillion of infrastructure investment that was mostly undertaken by local governments (McKissack and Xu 2011).

In 2014, to increase the transparency of local government borrowing and reduce financial stability risks, China's central government adopted a strategy of 'opening the front door and closing the back door' for local government borrowing. The authorities revised the Budget Law to allow local governments to raise debt directly from bond markets, while increasing regulatory scrutiny of borrowing by LGFVs. The authorities also introduced a three year 'debt swap' program in 2015, under which local governments were able to convert the debt of LGFVs (including bank debt, debt owed to non-bank entities, and LGFV bonds) into local government bonds. Around CNY15 trillion of debt-swap bonds were issued under the program, and these bonds currently comprise around half of the outstanding stock of local government bonds. As well as increasing transparency, the debt-swap program enabled local governments to extend the average maturity of debt and reduce interest costs (Lam and Wang 2018).

Graph 2

Chinese Bond Markets

Per cent of GDP, 2018



Sources: RBA; WIND Information

The market has also grown as the authorities have approved significant increases in issuance in recent years. Issuance of local government bonds is subject to strict quotas, which are approved by the National People's Congress (NPC), China's national legislature, when it meets in March each year.[2] Quotas are set based on the funding needs of local governments, their capacity to service their debts and the economic priorities of the central government. Recently, a key priority has been to increase infrastructure investment by local governments, which had slowed over the past year or so. Accordingly, most issuance recently has been of 'special bonds', which are issued to finance specific infrastructure investments, and most of which have their repayments tied explicitly to project revenues, rather than repaid from general local government revenue. A smaller share of issuance has been of 'general bonds', which finance broader government spending.

At the NPC's most recent meeting, the Chinese authorities significantly increased the quota for local government bond issuance in 2019. The authorities set the quota at CNY3.1 trillion (3 per cent of GDP), almost one-third larger than for 2018 (Graph 3). This reflected a sharp increase in the quota for special bonds and a small increase in the quota for general bonds. The authorities have instructed local governments to complete their issuance of special bonds this year by September, to encourage local governments to bring forward their infrastructure investment (Xinhua 2019).

Features of the Market

Despite the recent rapid growth in issuance, the local government bond market in China is still developing in some key respects.

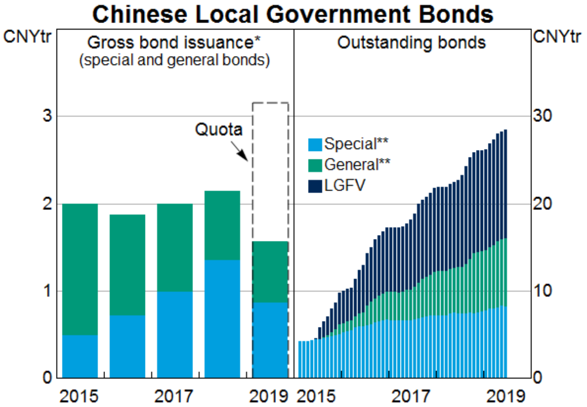
Narrow investor base

The Chinese local government bond market has a narrow investor base, with Chinese commercial banks holding almost 80 per cent of outstanding bonds (Graph 4). These holdings account for around 7 per cent of total commercial banking assets in China. China's national commercial banks, which make up over half of China's banking system, are the primary purchasers of local government bonds (Graph 5). In contrast, a diverse range of institutional and non-institutional investors hold municipal bonds in the United States and Japan, and municipal bonds make up only around 2 per cent of total banking assets in the United States. The narrow investor base of Chinese local government bonds in large part reflects the authorities' local government debt-swap program. Banks had been a key provider of credit to LGFVs, and were the primary purchasers of bonds issued in exchange for LGFV debt.

This year, China's Ministry of Finance launched a pilot program that allows retail investors to purchase local government bonds from commercial banks in order to expand the investor base. The pilot program includes bonds issued by local governments in four provinces (Shaanxi, Shandong, Sichuan and Zhejiang) and two cities (Beijing and Ningbo), which together accounted for 20 per cent of total local government bond issuance in 2018. Project-based special bonds have been selected as the first to be sold to retail investors, in part because they are explicitly linked to local infrastructure projects that residents can recognise and therefore may be more willing to purchase. In addition, any reduction in implicit guarantees on other investment products, especially wealth management products – a preferred investment product for retail investors – could make local government bonds a relatively attractive investment option in the coming years.[3]

Graph 3

Chinese Local Government Bonds



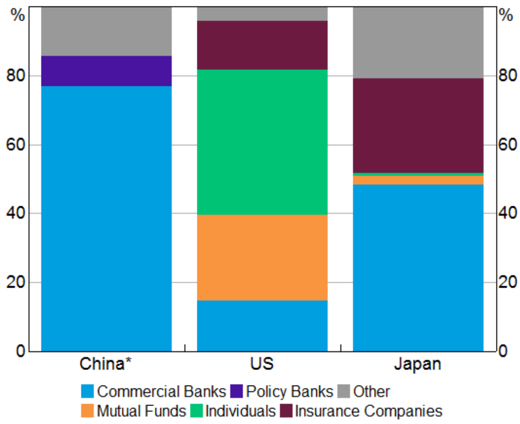
* Excludes debt-swap and LGFV bonds

** Includes new and debt-swap bonds

Sources: RBA; WIND Information

Graph 4

Local Government Bond Investors



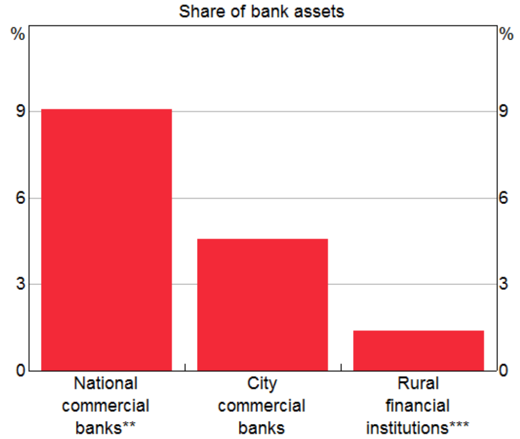
* Excludes LGFV bonds

Sources: Bank of Japan; CEIC Data; RBA; SIFMA

Graph 5

Bank Holdings of Local Government Bonds*

Share of bank assets



* Excludes LGFV bonds

** Includes large and joint-stock commercial banks

*** Includes rural commercial banks, credit cooperatives and village/township banks

Sources: CEIC Data; RBA

Low liquidity

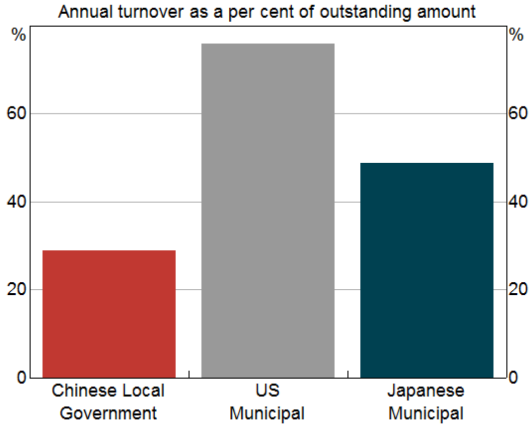
Local government bonds also tend to be relatively illiquid. In 2018, the value of secondary market transactions involving local government bonds was equivalent to only 29 per cent of the value of the outstanding stock of local government bonds. This compares with around 75 per cent for US municipal bonds and 50 per cent for Japanese municipal bonds (Graph 6). Bid-ask spreads, another indicator of market liquidity, also tend to be much wider for Chinese local government bonds relative to municipal bond markets in the United States and Japan. That being said, turnover in China's local government bond market has risen recently, perhaps reflecting policy changes intended to support market liquidity (discussed further below; Graph 7).

The narrow investor base of local government bonds may explain the illiquid nature of the secondary market. China's commercial banks tend to buy local government bonds with the intention of holding the securities to maturity. In part, this reflects the perceived low risk of default by local governments, as well as the low risk weights assigned to local government bonds under China's capital regulations. It may also reflect changes in 2015 that added local government bonds to the list of eligible collateral for various People's Bank of China lending facilities.

Graph 6

Bond Market Liquidity

Annual turnover as a per cent of outstanding amount



Sources: ABO; Japan Securities Dealers Association; RBA; SIFMA; WIND Information

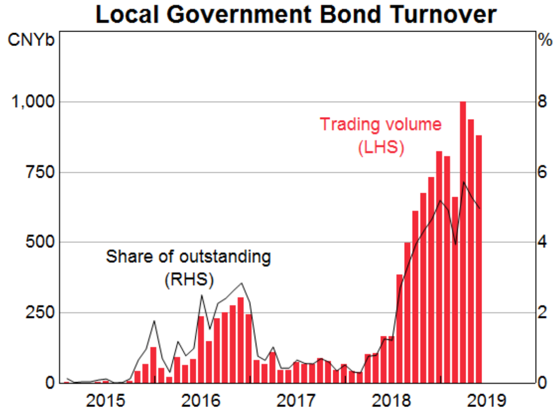
Lack of pricing discrimination

There has tended to be little difference in market pricing of credit risk, both across types of bonds (special and general bonds) and across issuers. Spreads of local government bonds to Chinese government bonds (CGBs) have been similar across Chinese local governments, despite significant variation in risk profiles and debt burdens (Graph 8). Available data indicate that almost all local government bonds are rated AAA – the highest rating – by domestic ratings agencies. There has also tended to be little difference in the market pricing of general and project-based special bonds. In part, this reflects that, while repayments of project-based bonds are linked explicitly to project revenues, final legal recourse still lies with the issuing local government (though this is untested), unlike revenue bonds in the United States and other countries.

The lack of discrimination in pricing for different levels of credit risk probably reflects the widely held expectation that the central government would intervene to prevent local governments from missing bond payments. This perception has been reinforced by China's fiscal structure, under which many local governments have limited control over revenue raising and, therefore, rely to a large extent on central government transfers to help finance their activities. In addition, the central government, through the Ministry of Finance, approves the amount and minimum pricing of local government bond issuances, which can reinforce the perception of support by the central authorities. These implicit guarantees could lead local governments to borrow

Graph 7

Local Government Bond Turnover



Sources: RBA; WIND Information

more than market-based pricing would encourage. This moral hazard might have increased medium-term financial stability risks, to the extent that bond proceeds have been used to finance projects with low marginal returns (Schipke, Rodlauer and Zhang 2019).

Regulatory changes to remove perceptions of implicit local government guarantees for off-balance sheet debt have contributed to some repricing of credit risk in the local government bond market. The efforts contributed to a considerable widening in spreads on low-rated LGFV bonds in 2018 to a level comparable with those of corporate bonds with similar ratings (Graph 9). However, spreads have narrowed more recently following the relaxation of rules at China's largest securities exchanges that allow some refinancing of LGFV debt to ease financing pressures for local governments.[4]

Recent Reforms to Develop the Market

In recent years, the Chinese authorities have sought to enhance the functioning of the local government bond market. Their efforts to date have sought to meet two key, and at times competing, objectives: supporting local government finances, including by ensuring that the market can digest increasing issuance; and fostering the development of a liquid market with a diverse investor base in which pricing incorporates credit risk. In response, the authorities have had to prioritise and carefully sequence reforms.

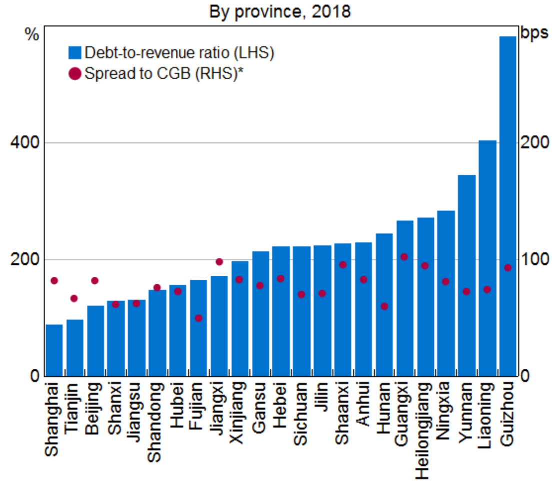
To support local government bond financing, the authorities have encouraged purchases of bonds by banks and reduced the cost of issuance by local governments. They have removed the 20 per cent limit on the share of a local government bond issuance that an underwriting bank may purchase (Hongyuran, Kan and Cheng 2018). The authorities have also reduced the minimum spread to CGBs at which local governments can issue bonds, from 40 to 25 basis points (Yuzhe, Qingin and Jia 2019).[5] In addition, the authorities have announced that local governments may use the proceeds of special bond issuance to satisfy minimum equity requirements for certain projects (Xinhua 2019).

The authorities have also implemented measures to improve the pricing of credit risk. They have prohibited local governments from guaranteeing LGFV debt and required disclosure of more information to investors and the central government, including about the financial position of issuers and the projects that bond proceeds will fund (Ministry of Finance 2018a). In addition, the Ministry of Finance has encouraged the issuance of project based special bonds, which have their repayments linked explicitly to project revenues, rather than being repaid from local government revenues (though, as noted, final legal recourse remains with the issuing local government). This includes significantly expanding the range of

Graph 8

Local Government Bond Pricing

By province, 2018



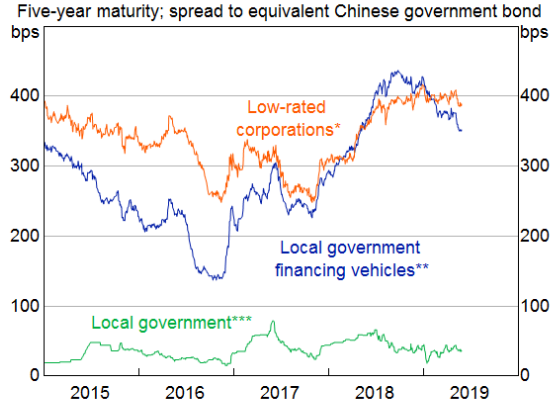
* Based on a 5-year new local government bond

Sources: CEIC Data; RBA; WIND Information

Graph 9

Local Government Bond Spreads

Five-year maturity; spread to equivalent Chinese government bond



* Based on AA- domestically rated corporate bonds

** Based on AA- domestically rated urban infrastructure bonds

*** Based on AAA domestically rated municipal bonds

Sources: Bloomberg; RBA; WIND Information investments that project-based special bonds may fund.[6]

Finally, the authorities have sought to diversify the investor base for local government bonds. They have permitted issuance at longer maturities of up to 20 years to encourage participation by long-term institutional investors, such as mutual funds and life insurance companies (Ministry of Finance 2018b). The authorities have also introduced channels for non-financial corporations and retail investors to purchase a limited selection of local government bonds through China's banks (Ministry of Finance 2019).

While seeking to enhance market functioning in these various ways, the authorities also have been conscious of the need to minimise the risk of significant market disruptions. Given their significant holdings of local government bonds, China's commercial banks could be adversely affected by abrupt changes in policy (however unlikely) that allow defaults by local governments. Also, if a reassessment of implicit guarantees reduces local government bond prices, banks may need to revalue the securities held on their books. This could put pressure on their profitability and balance sheets. An upward repricing of risk could also increase the cost of financing infrastructure investment for local governments, particularly those with relatively large debt burdens. This might undermine efforts to increase infrastructure spending by local governments.

Conclusion

China's local government bond market has grown rapidly in recent years and is now the largest municipal bond market in the world. Its size and importance is likely to grow further, in line with the authorities' goals of increasing infrastructure investment by local governments and improving the transparency of local government borrowing. However, the local government bond market in China is relatively illiquid and the investor base narrow, and there has been little difference in market pricing of credit risk, reflecting the prevalence of implicit guarantees. Efforts to reduce the perception of government guarantees might help to reduce moral hazard, but could also increase the funding costs of local governments. This is likely to remain a challenge for policymakers as they seek to foster the ongoing development of the local government bond market. ✠

Footnotes

[*] Alex Holmes completed this work in International Department, and David Lancaster is from International Department. The authors would like to thank Adam Cagliarini, Christian Vallence, Christopher Kent, Ivan Roberts and Mark Hack for their comments and suggestions.

[1] In China, local governments comprise a wide range of sub-national bodies at provincial, prefectural, county and township levels.

[2] Historically, local governments have used their full quota for bond issuance. Between 2019 and 2022, China's State Council will have scope to approve an initial quota of up to 60 per cent of the previous year's quota before the final quota is approved by the NPC in March, allowing local governments to issue bonds in the first quarter of the year (Xinhua 2018).

[3] By 2021, changes to asset management regulations will remove implicit guarantees by financial institutions on all outstanding wealth management products. For more information about wealth management products, please see Perry and Weltewitz (2015).

[4] The Shanghai and Shenzhen Stock Exchanges relaxed rules that had prevented LGFVs issuing refinancing bonds (with terms less than 6 months) if the issuer sourced more than 50 per cent of their overall revenue from local governments.

[5] The Ministry of Finance regulates the spread that local government bonds can be issued over the five-day average yield of central government bonds of the same maturity.

[6] While initially created to fund social housing and transport infrastructure, project-based special bonds may now finance over 20 types of projects, including in the education, water and real estate sectors.

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Cryptocurrency: Ten Years On

Cameron Dark, David Emery, June Ma and Clare Noone[*]

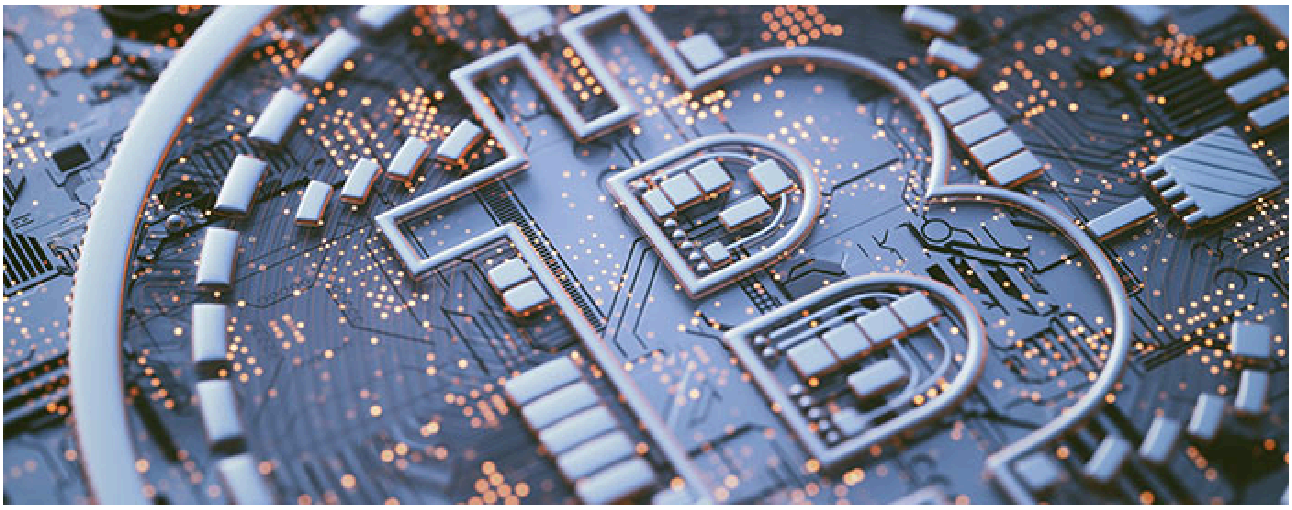


Photo: KTSDesign/Science Photo Library – Getty Images

Abstract

Ten years on from the creation of Bitcoin, the term 'cryptocurrency' has entered the public consciousness. Despite achieving some name recognition, cryptocurrencies are not widely used for payments. This article examines why Bitcoin is unlikely to become a ubiquitous payment method in Australia, and summarises how subsequent cryptocurrencies have sought to address some of the shortcomings of Bitcoin – such as its volatility and scalability problems. It also examines the proliferation of new 'coins' and concludes that, despite the developments in cryptocurrencies, none are currently functioning as money in the economy.

Introduction

On 3 January 2009, the first bitcoins were created.[1] Ten years on the terms 'bitcoin' and 'cryptocurrency' are widely known. 'How to buy bitcoin' was the third-ranked 'How to …' search term in Google in 2017 (Google 2018), alongside significant growth in fraudulent and phishing spam mail related to cryptocurrencies (Kaspersky Lab 2018). However, neither Bitcoin nor the many thousands of cryptocurrencies that have followed have become widely used for payments. People are more likely to view cryptocurrencies as a speculative high-risk investment class than a payment system. In this article, we look back over the decade since the launch of Bitcoin. We examine how cryptocurrencies have changed over that period in an attempt to address some of the shortcomings of Bitcoin as a payment system – such as its volatility and scalability problems.[2] We also describe the development of 'programmable' cryptocurrencies. Despite these changes, we see little likelihood of a material take-up of cryptocurrencies for retail payments in Australia in the foreseeable future.[3]

What is Cryptocurrency?

One definition of cryptocurrency is that it is a digital representation of value that is neither issued by a central bank or a public authority, nor necessarily attached to a national currency, but is designed to be accepted by some parties as a means of payment and can be transferred, stored or traded electronically.[4] Cryptocurrencies use computer software running across a network and rely on various established cryptographic techniques (hashing, digital signatures or one-way cryptographic functions) to control access and verify transactions. They use some form of 'consensus mechanism' to validate transactions; that is, a mechanism to achieve agreement across the network on whether a transaction is valid or not.

The technology underlying cryptocurrencies is often referred to as distributed ledger technology (DLT).[5] Given this, cryptocurrency is sometimes described as a 'digital token' on a distributed ledger that can be used to exchange value and thereby facilitate payments. DLT platforms vary in many ways, including: who can see and/or keep a copy of the ledger, who can update the ledger, what information is required to verify a transaction on the ledger, and how tokens are created and distributed. Another way in which DLT platforms can differ is in how the data on the platform is structured; blockchain refers to one way of structuring the data. Blockchain and alternative methods are discussed later in the article.

In recent years, other types of DLT-based digital tokens have been designed and launched. Some have characteristics that are similar in some respects to securities (such as shares or bonds) and others are tokens that can be redeemed for access to a specific product or service (that is often to be provided using DLT). These are often referred to as 'security tokens' and 'utility tokens', respectively. Together cryptocurrency, security tokens and utility tokens are commonly referred to as 'crypto-assets'. It should be noted that, while commonly used, these terms can be misleading. For example, 'currency' is often thought as being synonymous with money. However, no cryptocurrencies currently have the key attributes of money; and similarly, many crypto-assets have been found to fall well short of the definition of an asset as 'a useful thing or quality' (Macquarie Dictionary 2019).[6]

Cryptocurrencies (and crypto-assets more broadly) can enter circulation in a variety of ways. As described more fully below, in the case of Bitcoin, new bitcoins are created and paid out as a reward for participants of the system validating transactions. In other cases, new cryptocurrency units may be simply (and potentially arbitrarily) created by the controller of the protocol and sold (potentially via an initial coin offering) or given away for free (typically as a marketing exercise to broaden awareness of their coin). Cryptocurrency exchanges facilitate the buying and selling of cryptocurrencies in the secondary market. However, not all cryptocurrencies are listed on exchanges, or indeed have any market value.

The First Generation of Cryptocurrencies

Proposals for electronic versions of cash had been made and trialled at various points in the late 20th century, without success in practice.[7] Bitcoin, which launched in 2009 following the publication of a paper by an unknown author or authors in 2008, combined a series of existing technologies to provide a peer-to-peer version of electronic cash (Nakamoto 2008). Box A provides a high-level description of some of the basics of Bitcoin.

Bitcoin demonstrated that, under certain assumptions, information about transactions could be verified and relied upon without the need for a trusted central party. The possibility of transactions being recorded securely on a distributed basis led to considerable interest in Bitcoin and other potential implementations of DLT.

While Bitcoin remains the most prominent cryptocurrency, a large number of alternative cryptocurrencies and digital tokens have been created in recent years. Some are essentially replicas of Bitcoin, while others seek to introduce additional functionality or have different design features. For example, Litecoin adopts most of the features of Bitcoin but has a shorter block confirmation time of around 2½ minutes and uses an alternative hashing algorithm. Dogecoin, initially created as a novelty currency, gained use for various crowd-sourced fundraising efforts.

As identified by Nakamoto, the purpose of Bitcoin was to act as a peer-to-peer payment mechanism. In practice, its use for this function has been limited. However, it has seen significant use as a vehicle for speculation. This was particularly the case in late 2017 when there was a very considerable increase in the price of bitcoin, along with most other

Box A
Bitcoin Basics[8]

Bitcoin has a 'blockchain' of transactions. The 'ledger', or record of changes in ownership, consists of 'blocks' of information linked together in chronological order (a 'chain'). Every 10 minutes on average, the Bitcoin blockchain is updated to include a new block of transactions. Addresses (or ownership) on the ledger are in terms of alphanumeric pseudonyms rather than legal names.

Most conventional payment methods – cash is the obvious exception – rely on some central party to keep and update the ledger or record of holdings. For example, the Reserve Bank maintains the ledger of commercial banks' Exchange Settlement Account holdings. And commercial banks maintain records of their customers' deposits. By contrast, Bitcoin and other cryptocurrencies rely on a distributed ledger. The Bitcoin ledger (the blockchain) is replicated across the 'nodes' (i.e. computers) connected to the network. The idea is that each of the nodes ends up with an identical copy of the latest version of the ledger.

If a ledger is open to participation by any party, and any party can propose changes to the ledger, it is known as a public (or 'unpermissioned' or 'trustless') ledger. Bitcoin and many other cryptocurrencies are examples of trustless distributed ledgers. The user does not need to know or trust any party on the network but, in effect, needs to trust the algorithm and the cryptography used. This allows parties who do not necessarily trust each other to transact without the need for an intermediary.

The security of the Bitcoin system relies on public/private-key cryptography. The transaction verification methodology is referred to as 'proof of work'. Participants in the system (or 'miners' as they are known) compete to successfully verify (by solving computationally intensive calculations for) a new block of transactions, with each block consisting of around 2,500 transactions at the time of writing. The first miner to do so earns a reward of newly 'mined' coins, currently set at 12½ bitcoins (currently, worth around US$100,000). The successful miner also earns any transaction fees offered by the people initiating the transactions contained in that block.

cryptocurrencies. Media reports of these price increases generated further speculative interest, with many buyers unlikely to have had familiarity with cryptocurrencies other than what they had heard or seen in the media or from acquaintances. Following this speculative episode, prices fell dramatically from their peaks, leaving many purchasers of cryptocurrencies with capital losses.

Economic definitions of money typically reference three key features: a means of payment, unit of account, and store of value. Assessments of whether Bitcoin and other cryptocurrencies meet this definition usually conclude that they do not (Ali *et al* 2014; RBA 2014). Bitcoin's very significant fluctuations in price mean that it is a poor store of value (Graph 1). In part reflecting this price volatility, it is not used as a unit of account: goods and services sold for bitcoin are nearly always priced in some national currency, with the amount of bitcoin required to be delivered varying as its price changes. While Bitcoin and other cryptocurrencies can act as a means of payment, they are not widely used or accepted due to a number of shortcomings.

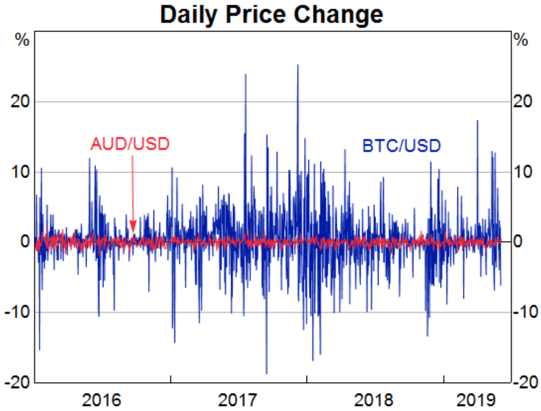
There are strong network effects in payments: use and acceptance of payment methods are generally self-reinforcing – as can be seen from the rapid adoption of contactless card payment by both merchants and cardholders. A failure to generate network effects can mean that payment methods become, or remain, niche. In this context, Bitcoin has a number of shortcomings that appear to have limited its suitability for widespread household and business payment use – price volatility (discussed above), lack of scalability and uncertainty around settlement finality.

The lack of scalability (see Box B) stems from the fact that Bitcoin blocks have a limit on the amount of information they can contain. This limits the number of transactions that can be validated in any individual block and restricts the system to fewer than 10 transactions per second. By contrast, the Fast Settlement Service that serves Australia's New Payments Platform is designed with the capacity of settling around 1,000 transactions per second.

Another issue with Bitcoin is that a transaction cannot be assumed to be final until sometime after it is confirmed in a block. A block is validated by the network roughly every 10 minutes. Since miners compete to nominate new transaction blocks, a transaction may be included in one miner's block but not another's. Sometimes two competing blocks are mined at approximately the same time: eventually one of these will become part of the longest chain while the other becomes an 'orphan' block. Bitcoin transactions recorded in an orphan block are likely to eventually be picked up and included in a later block in the (main) chain but, before this occurs, transactions in the orphan block cannot be treated as settled. Even after a few subsequent blocks are mined, a given block may still be part of an orphan chain: an oft-cited guide is for parties to a transaction to wait until five subsequent blocks are mined (i.e. a total of 60 minutes) before treating a transaction as final. This lack of prompt settlement finality can be a problem for users where, say, goods or services are being delivered in exchange for bitcoins.

Graph 1

Daily Price Change



Sources: Coinmarketcap.com; RBA

Because Bitcoin and other first-generation cryptocurrencies rely on 'proof of work' to establish consensus on the state of the ledger, they consume considerable amounts of energy. Miners compete to solve a computationally intensive cryptographic puzzle that, when solved, verifies a new block of transactions. The successful miner earns a reward of new coins plus any transaction fees associated with a block. The chances of successfully mining a block are roughly proportional to the amount of processing power devoted to solving the cryptographic puzzle. This leads to an arms race in mining technology, as miners invest in more processing power to increase their chances of success. However, since the incentives for this additional investment apply to all miners, if all parties individually invest in faster computing power, then there is no change to their chances of successfully mining a block (Ma, Gans and Tourky 2018). At time of writing, it is estimated that the amount of energy used to power the Bitcoin consensus process is estimated to be equivalent to the energy consumption of Switzerland (Digiconomist 2019). This sizeable energy consumption is a key element of ensuring the validity of cryptocurrency ledgers, but generates large negative environmental externalities. This is likely to become an issue for policymakers, particularly in the context of increasing concerns about climate change.[9]

While it is possible for an end user to transact in and manage their holdings of bitcoin without using a third party, most end users of cryptocurrency rely on some sort of intermediary to facilitate transactions. These include providers of cryptocurrency exchange services and cryptocurrency wallets. The roles undertaken by intermediaries effectively reinserts the need for some form of trust in a central party for most users. The central party provides services that are valuable to the end user, but also exposes the end user to risks of fraud.[10]

One perceived benefit of Bitcoin and other cryptocurrencies appears to be censorship resistance. There are two main elements to this. Once a transaction is recorded on a widely distributed blockchain, the record cannot be easily erased or altered. In addition, a user who controls their own private key can undertake transactions without a central authority (be it a government, an intermediary or any other party) preventing that user from doing so. The inability of other parties to prevent, modify or censor transactions is, for some of its adherents, a key advantage of cryptocurrency.

In contrast, the decentralised nature of cryptocurrencies and a lack of clarity around jurisdictional issues raises challenges for regulatory authorities, who have tended to focus not on the central protocol but rather on intermediaries providing services relating to cryptocurrencies, and on those using crypto-tokens for fundraising purposes. For example, the Australian Transaction Reports and Analysis Centre (AUSTRAC) obliges digital currency exchange providers in Australia to: register and enrol with AUSTRAC; adopt and maintain an Anti-money Laundering and Counter Terrorism Financing program that mitigates and manages the provider's money laundering and terrorism financing risks; and report suspicious matters and transactions above certain thresholds to AUSTRAC.

How Have Cryptocurrencies Changed?

Ten years on from its first transaction, Bitcoin remains one of the most prominent cryptocurrencies, and first generation-style coins continue to be created today (though they may not necessarily be used or traded). But there has also been innovation to address the key shortcomings of the first-generation coins and provide increased functionality. In the last two years in particular, there has been a substantial increase in the number of new crypto-assets created, some of which embody novel features or capabilities relevant for their potential use for payments. In this section we set out some prominent examples of newer coins that attempt to address the shortcomings of earlier cryptocurrencies for use in payments.

Of note, while a great many crypto-assets have been created, most are small and many do not exist for long. For example, of the more than 2,000 crypto assets included on CoinMarketCap, a crypto-asset information service with the most comprehensive publicly available list of crypto-assets, the top 50 account for more than 95 per cent of the market capitalisation of all crypto assets.[12] In addition, only around half of all crypto-assets currently included on CoinMarketCap have existed for more than one year (Graph 2), and of all the crypto assets removed from CoinMarketCap in the past four years around 40 per cent were less than a year old.

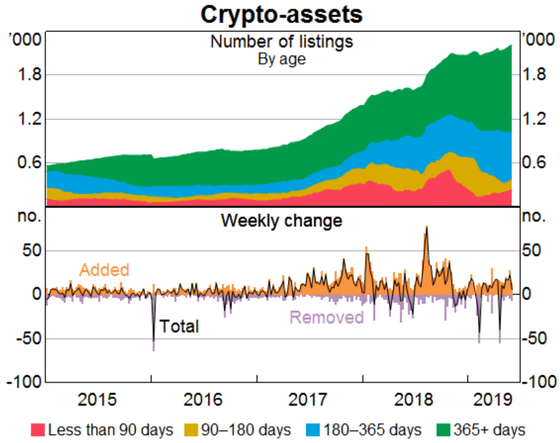
This short lifecycle of crypto-assets is not surprising. There are very few technical barriers to creating a crypto asset – as noted earlier, many are created through minor changes to the code of another crypto asset. Also, many exchanges will list new cryptocurrencies and other crypto-assets on a fee-for-service basis, without regard to their legitimacy. The short lifecycle may also partly reflect a rapid pace of technological development; with 'coins' potentially being discarded as they become 'old-tech'.

Iterations to address price volatility

As discussed above, the price volatility of cryptocurrencies such as Bitcoin is likely to have inhibited their use as a payment method (that is, a means of exchange). If it is difficult or impossible for merchants and consumers to know what a cryptocurrency will be worth from one moment to the next, then it will be unattractive for most parties to price, or buy, goods and services in that cryptocurrency and accept payment in the cryptocurrency. Similarly, high price volatility makes cryptocurrencies a poor store of value.

Graph 2

Crypto-assets



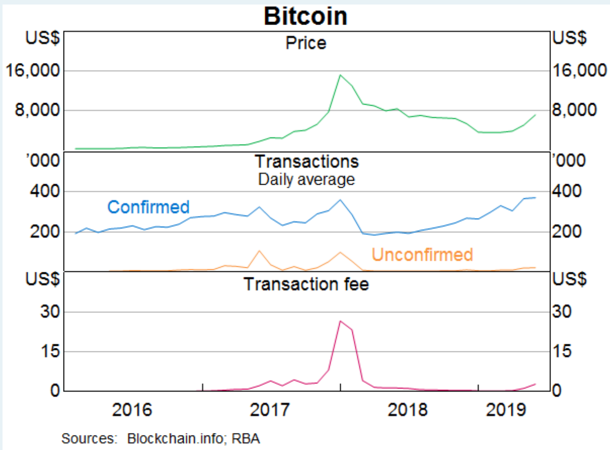
Sources: Coinmarketcap.com; RBA

Box B
Bitcoin Scalability Problem

As described above, Bitcoin transactions are confirmed when miners – participants in the Bitcoin system who compete to verify transactions – include those transactions in a new block that is added to the Bitcoin blockchain. This set-up limits the number of transactions in two ways: (1) each block, which records transactions, is by construction limited in size to one megabyte; and (2) a new block is added to the blockchain approximately every 10 minutes. Thus there is a hard limit on the capacity of the Bitcoin network, and fewer than 10 transactions per second can be processed. In contrast, and as noted earlier, Australia's new Fast Settlement Service has been designed with the capacity to settle around 1,000 transactions per second. The processing capacity of the international cards schemes is even greater, being in the region of tens of thousands of transactions per second.[11]

Initially, this transaction limit was not binding, but this changed through 2017 and 2018 when bitcoin speculation became more popular and the number of transactions increased (Graph B1). In December 2017, to incentivise miners to prioritise their transaction, Bitcoin users had to pay, on average, almost US$30 per transaction (and more than US$50 on certain days).

Graph B1



Two categories of solutions have been proposed to address this scalability problem. The first, 'on-chain', seeks to change the Bitcoin protocol to allow more transactions. The second, 'off-chain', seeks to net offsetting transactions in a separate system, before settling the net flows on the main Bitcoin system.

Two main on-chain proposals have emerged: use blocks more efficiently; and/or to increase block size. In late 2017, an update to the Bitcoin code was released that, by changing the way blocks are structured, roughly doubled the transaction capacity of each block. This update was designed to be backward-compatible with the existing Bitcoin system, and gained wide adoption by Bitcoin miners. At roughly the same time, a group of miners started using new code that allowed for 8 megabyte blocks. Most Bitcoin users, however, remained with the original Bitcoin and the new system (dubbed 'Bitcoin Cash') effectively became a new, less popular, cryptocurrency. The example of Bitcoin Cash demonstrates the challenge faced by all on-chain solutions. Proposals to change the Bitcoin code must gain widespread support across the Bitcoin community (and specifically miners) to be adopted, otherwise any modifications to the code will result in a new cryptocurrency rather than an update to Bitcoin itself.

The main off-chain solution to have emerged is the so-called Lightning Network, where Bitcoin users establish bilateral 'payment channels' by transferring bitcoins to a jointly controlled address. This solution is discussed further in the section 'Iterations to address scalability'.

In an attempt to address this, a number of so-called 'stablecoins' have emerged. Stablecoins are a type of cryptocurrency designed to minimise price volatility against some widely used unit of account (often the US dollar) or a common store of value (such as gold). Two broad approaches to achieve this currently exist: asset-backed stablecoins, and algorithmic stablecoins, with some offerings being a hybrid of the two.

Asset-backed stablecoins are cryptocurrencies that seek to gain and maintain a stable value through being – or purporting to be – a claim on real or financial assets. For stablecoins that are fully backed by assets, this means that new coins are, in theory, only issued against an inflow of assets of the same value, and that the coins can be redeemed at a fixed price by selling these assets. Stablecoins that are fully backed by assets that match the peg they are trying to maintain (e.g. money in a US dollar bank account for a USD-pegged stable coin) will, in general, be less susceptible to price volatility, while stablecoins that are not fully backed, or that are backed by more volatile assets (e.g. other cryptocurrencies) tend to be more susceptible to price volatility. Asset-backed stablecoin issuers may seek to cover costs and/or derive profit via seigniorage; that is, they earn interest on the backing assets but do not pay interest on their stablecoin liabilities.[13] These assets are typically controlled by the issuer of the cryptocurrency. However, the underlying details regarding legal recourse of stablecoin holders to those assets, and even whether the assets actually exist, is often unclear. The existence of a central entity that controls the asset backing the stablecoin runs somewhat counter to the original idea behind cryptocurrencies, which was to be a decentralised form of money not reliant on any central body.[14]

Algorithmic stablecoins attempt to gain and maintain value through a software protocol that manages the supply of the cryptocurrency to match demand, such that the market-clearing price tracks the underlying unit of account closely. Two broad approaches exist to achieving this. The first simply adds or removes coins from circulation (either directly or by changing their status to 'inactive') in order to match supply to demand. While this may succeed in maintaining the quoted stablecoin price, it does this by changing the number of active coins that users hold, such that the total value of users' holdings, being the price multiplied by the number, will still be volatile. The second approach seeks to use incentives and expectations to maintain a stable price. If supply exceeds demand, the stablecoin algorithm issues 'bonds' at a discount to face value, and uses the proceeds to purchase and destroy the surplus stablecoins. If demand exceeds supply, new stablecoins are issued to 'bondholders' to redeem the liability. If the price of the stablecoin falls but some users expect it to rise again in future, then there is an incentive for them to buy 'bonds' and profit from the temporary deviation. If, on the other hand, there are not enough such optimistic users, then the mechanism will fail and the stablecoin price may not recover.

Tether, which is one of the earliest and most prominent asset-backed stablecoins, has to date maintained a relatively tight – although imperfect – peg to the US dollar (Graph 3), despite some market participants questioning the extent to which it is indeed backed by US dollars. Of note, Tether initially claimed to be fully backed by US dollars held at an undisclosed bank. However, in February 2019, it modified its terms of service indicating that its stablecoin may be backed by other US dollar-denominated assets in addition to cash and cash equivalents. Court proceedings have since indicated that only 74 per cent of Tether tokens are backed by cash and cash equivalents (Hoegner 2019). In addition, some reserves were reportedly used by the company to invest in bitcoin and 'other assets' (Cermak 2019). In contrast, other stablecoin issuers have partnered with established financial institutions and engaged with regulators. For example, funds backing the TrueUSD stablecoin are held in escrow accounts at a number of US-based fiduciary and banking partners that the TrueUSD issuer cannot access.[15] So far, TrueUSD has maintained a tight peg to the US dollar since it launched in 2018. NuBits is one of the few algorithmic stablecoins that has launched. It uses bond-like instruments to provide users with incentives to maintain a stable price. Its price fell substantially in early 2018 and has not recovered, highlighting the role of price expectations in algorithmic stablecoin models.

In Australia, the use of stablecoins as a payment method has been very limited, as has the supply of Australian dollar-linked stablecoins. AUDRamp, the first Australian dollar-linked stablecoin to launch, went live in September 2018. However, only 137 tokens were issued and the price has fallen to zero. More recently, TrueAUD was launched in April 2019 by TrustToken, the issuers of TrueUSD, though no tokens appear to have been issued. TrueAUD is expected to operate similarly to TrueUSD.

Looking ahead, the Libra Association – whose participants include Facebook, Mastercard, Visa, PayPal and others – plans to launch a 'global cryptocurrency' in 2020 that would be fully backed by a reserve comprised of a basket of bank deposits and short-term government securities denominated in a range of national currencies. The initial description of the cryptocurrency, named Libra, notes that its value may fluctuate as it is not pegged to any given currency (Libra Association Members 2019).

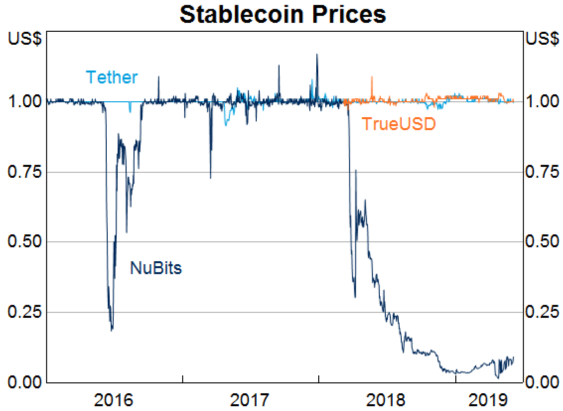
Stablecoins have, in theory at least, the benefit of a stable value while retaining elements of Bitcoin's pseudonymity. However, even if the concerns about the credibility of stablecoin issuers and their coins are resolved, it is not clear that there would be material demand (at least for legitimate purposes) to pay with, or accept, stablecoins over conventional payment methods linked to deposit accounts at commercial banks. The strongest, though still niche, demand for stablecoins appears to be from holders of cryptocurrency that want to diversify into a low-volatility asset without leaving the crypto-ecosystem. Demand may also reflect a reticence to interact with the regulated banking system more generally, perhaps because of a crypto-libertarian[16] ethos, or because the cryptocurrency held may not have arisen from legitimate activities or the holder is seeking to avoid or evade taxes. It is also not obvious that all stablecoins will necessarily be attractive to crypto-libertarians. As noted above, asset-backed stablecoins rely on a central body to buy and manage the assets that back the stablecoin, which means that users have to trust that central body. This is somewhat counter to the initial idea behind cryptocurrencies, although for users who value the technical capabilities of DLT, rather than necessarily valuing the ideological aspects of Bitcoin, this may not be a problem.

Iterations to address scalability

The Bitcoin scalability problem (see Box B) highlighted one barrier to cryptocurrencies becoming widely used. At present, blockchain technology provides for transaction throughput orders of magnitude lower than what would be required for a widely used payment system in Australia, let alone a global payment system. This is unsurprising – the trade-off between

Graph 3

Stablecoin Prices



Source: Coinmarketcap.com

decentralisation, scalability and security faced by blockchain developers often requires the throughput of the network to be a lower priority consideration. This trade off is known as the 'scalability trilemma', which claims that blockchain systems can, at most, have only two of the following three properties: (i) decentralisation, (ii) scalability and (iii) security. In practice, these trade offs are incremental; increasing the scalability of a blockchain does not require it to become entirely centralised or insecure, but *more* centralised or *less* secure. Even so, to increase throughput and not compromise on a cryptocurrency's degree of decentralisation and/or security is a difficult task. These attributes are often decided early on in a cryptocurrency's development; for a cryptocurrency to be a reliable store of value – volatility aside – security is paramount.

Increasingly, blockchain developers are implementing alternative consensus algorithms to proof of work. These algorithms include, among others, proof of stake, byzantine fault tolerance[17] and proof of authority.[18] Generally, these alternative consensus algorithms provide for a significant increase in throughput compared with computationally expensive proof-of-work mining processes. The scalability trilemma means that this is typically achieved through centralisation. For example, proof of authority requires a centrally managed *authority* node to appoint block validators; similarly, byzantine fault tolerance requires a *leader* node to propose which transactions are included in a block. Proof of stake is less centralised than these algorithms, but remains more centralised than proof of work – it concentrates the validation of blocks in nodes that hold a large volume of cryptocurrency.

Other cryptocurrencies have turned to non-blockchain solutions to address scalability. Two notable developments include off-chain 'payment channels' and non-blockchain applications of DLT. The Lightning Network is an off-chain network of bilateral payment channels that sits above a host blockchain. Users establish a payment channel by transferring cryptocurrency to a jointly controlled address on the host blockchain. Flows back and forth between any two participating users are then recorded off the blockchain ledger, and the net effect of these transactions is only settled on the blockchain ledger when the payment channel closes. This is comparable with the bilateral netting that occurs in some other payment systems. Transactions can be routed indirectly via multiple bilateral links if no direct link exists. A drawback of this system, however, is that cryptocurrency quarantined in payment channels is unable to be used elsewhere, until those channels close. Liquidity is effectively trapped in the payment channel. While the Lightning Network was first developed for Bitcoin, it has recently been implemented for Litecoin (another first-generation cryptocurrency). A similar off-chain network of payment channels is under development for the Ethereum blockchain.

One non-blockchain application of DLT used to address scalability is to replace the linear blockchain with a directed acyclic graph (DAG). Unlike a blockchain-based cryptocurrency, where transactions are bundled into blocks that form a linear chain, in a DAG-based cryptocurrency, individual transactions are linked together. Different nodes are able to confirm unrelated transactions in parallel, allowing multiple chains of transactions to co-exist and interconnect.[19] IOTA and Nano are two of the better-known cryptocurrencies using DAGs, though both have relatively low levels of activity outside of coordinated tests designed to demonstrate the capacity of each platform to process higher volumes of transactions.

Most of these solutions are not operational or are operating at a scale much smaller than intended. In May 2019, the average number of unique, active Bitcoin addresses per day was around 700,000. By contrast, the implementation of Lightning Network for Bitcoin has less than 10,000 active nodes. Alternative consensus algorithms, such as byzantine fault tolerance or proof of authority, are unlikely to be implemented in widely used public cryptocurrencies because of the centralisation needed for proposing and/or validating blocks. These algorithms may be better suited to private and permissioned blockchains where there is a degree of trust between the participants or with the entity operating the blockchain.

Iterations for functionality

One of the most pivotal innovations in cryptocurrencies since the creation of Bitcoin was the introduction of public distributed computing platforms, the most well-known of which is Ethereum. The Ethereum platform and its native cryptocurrency, ether, were launched in 2015. The platform's key innovation is the Ethereum virtual machine, which allows the execution of 'smart contracts' that, among other things, facilitate the issuing of crypto-assets or 'tokens' and the development of distributed software applications. Ethereum operates using a proof-of-work algorithm, with ether used to pay miners to process transactions, including the execution of smart contracts. Transaction fees differ by computational complexity, bandwidth use and storage needs. As new blocks are mined, ether is created as a reward for the successful miner.[20]

Smart contracts are comprised of self-executing computer code running on a blockchain or other DLT platform.[21] The creator of a smart contract on the public Ethereum blockchain sets out the conditions under which the contract will execute and its output. As smart contracts are stored on a blockchain or other DLT platform, the conditions and associated outputs are visible to all parties to the contract and immutable. This allows parties to enter into an agreement knowing that it will be enforced without the need to trust each other. For example, a crypto-asset token can be issued using a smart contract using 'if, then' or other conditional statements. Here, the smart contract may be configured as: 'if Address A receives 1 ether from Address B, then send 10 tokens from Address A to Address B'. If the token is a cryptocurrency, it is sometimes referred to as 'programmable money'. One benefit of programmable money is that both sides of a transaction are able to settle simultaneously – a so-called 'atomic' transaction. Tokens may also have a broader array of features and characteristics, facilitating the creation of security and utility tokens. Around 1,300 of the crypto-assets listed on CoinMarketCap are created using smart contracts and around 90 per cent of these were created on the Ethereum platform. Even though smart contract code on the Ethereum blockchain is typically public, and therefore can be independently verified, fraudulent activity nonetheless occurs. In 2017, researchers estimated that as many as 10 per cent of smart contracts on the Ethereum platform were related to fraudulent activity (Bartoletti *et al* 2017).

The additional functionality offered by smart contracts does not, in itself, address the fundamental barriers – such as scalability and volatility – to cryptocurrencies becoming widely used for payments. Indeed, it may be the case that additional functionality offered by smart contracts can be integrated into centralised systems, including into some of Australia's existing payment systems. Indeed, a recent Data61-CBA proof of concept to apply 'programmable money' to National Disability Insurance Scheme payments found that a system based on a centralised database could, in theory, generate the same efficiency gains as a DLT-based approach (Royal *et al* 2018).

Are Cryptocurrencies Money Today?

Some of the evolution in cryptocurrencies in recent years has been an attempt to address some of the key shortcomings that have prevented Bitcoin from functioning as money. However, it remains the case that no cryptocurrencies currently function as money in Australia, or as widely used payment methods. Proposals to improve scalability and volatility have had varied success. Many continue to be a work in progress and they generally come at the cost of making a cryptocurrency more centralised, a feature that may not be attractive to crypto-libertarians and in any case makes them more similar to established payment systems. Developments to date have also not added sufficiently to the overall reliability, functionality and credibility of cryptocurrencies to make them an attractive alternative to established payment systems for everyday payments for the population at large.

Regardless, DLT is likely to continue to evolve, including in ways that are unrelated to cryptocurrency. For example, there are several private-sector initiatives focused on 'private permissioned' DLT systems, for example, Corda and

Quorum, which – while not suitable for a widely used cryptocurrency – are being explored for use in financial market infrastructure and wholesale payments. Accordingly, the Reserve Bank will continue to study the implications of cryptocurrencies and DLT for the financial system, and the economy more broadly.

Finally, it should also be noted that innovation continues to occur in traditional centralised payment systems – the creation and launch of Australia's New Payments Platform is an example of this. As long as the Australian dollar continues to provide a reliable, low-inflation store of value, and the payments industry continues to work on the efficiency, functionality and resilience of the Australian payments system, it is difficult to envisage cryptocurrencies presenting a compelling proposition that would lead to their widespread use in Australia.

Footnotes

[*] The authors are from Payments Policy Department.

[1] We use (lower case) 'bitcoin' to refer to a unit of cryptocurrency in the Bitcoin system.

[2] In this context, scalability refers to the capacity of a system to grow to meet demand.

[3] This article focuses on privately established cryptocurrencies. It does not address issues relating to central bank digital currencies, which have been given some consideration in recent years: for a local and global perspective see Lowe (2017) and CPMI and MC (2018). Nor does this article address the potential use of distributed ledger technology in wholesale or large-value payments systems or other financial market infrastructures.

[4] This definition draws on the European Banking Authority's definition of 'virtual currencies', see European Banking Authority (2014).

[5] As described in the UK Cryptoassets Taskforce Final Report, 'DLT is a type of technology that enables the sharing and updating of records in a distributed and decentralised way. Participants can securely propose, validate, and record updates to a synchronised ledger (a form of database), that is distributed across the participants.' (HM Treasury, Financial Conduct Authority, Bank of England 2018). The term 'blockchain' is often used interchangeably with DLT, but it refers to a specific way of structuring data on a DLT platform.

[6] ASIC has issued investor warnings on both cryptocurrencies and initial coin offerings, see ASIC (2018a) and ASIC (2018b).

[7] For example, the 1990s saw trials of digicash and Mondex, early prototypes of electronic cash.

[8] This description is drawn from Richards (2018).

[9] See Debelle (2019) for a financial sector perspective on these issues.

[10] A widely known early example relates to Mt Gox, which declared bankruptcy in early 2014 following the loss of 850,000 bitcoins. More recently, customers of the Canadian exchange QuadrigaCX are reported to have lost access to crypto-assets following the death of the founder of the exchange, purportedly the only person with the cryptographic keys to access the 'cold wallets' (offline storage) of users.

[11] For example, Visa's payment network, VisaNet, processes around 1,700 transactions per second and is capable of processing more than 65,000 transactions per second.

[12] For a cryptocurrency to be included on CoinMarketCap, it must fit the definition of a cryptocurrency, be traded publicly, and actively traded on at least two exchanges. There are around 250 exchanges currently recognised by CoinMarketCap.

[13] The term seigniorage is used to describe the income earnt from the production of money. It can refer to the profit derived from the difference between the face value of the money (such as banknotes) and the cost of its production. It can also refer to the income earnt on securities acquired in exchange for the money produced, less any interest payable on the money that is outstanding (zero in the case of banknotes). Today, it is common for banknote issuing authorities, including the Bank, to derive seigniorage using the latter approach. This is because commercial banks can and do return banknotes to the central bank in exchange for fresh electronic balances at the central bank and, as such, banknotes are treated as zero-interest liabilities. See RBA (1997) for further discussion.

[14] Outside the scope of this article, there are also, in prototype form at least, commercial bank-backed stablecoins such as JPM Coin. In such a set-up, holders are likely to be exposed to the credit risk of the commercial bank, similar to a conventional deposit account (abstracting from any government deposit guarantees).

[15] TrueUSD is registered as a money services business with the Financial Crimes Enforcement Network, which administers anti-money laundering, 'know your customer' and anti-terrorism financing regulations.

[16] Crypto-libertarians are commonly characterised as mistrustful of the traditional banking system. Richards (2018) notes that 'Some of them [crypto-libertarians]

assert that the quantitative easings undertaken by major central banks in the wake of the global financial crisis have somehow debauched the value of traditional national currencies.'

[17] Byzantine fault tolerance (BFT) is a concept in distributed systems, in which the participants of a system (some of whom may be malicious) can achieve consensus on its state. Consensus algorithms such as *delegated* BFT or *practical* BFT achieve BFT by appointing a *leader* node to propose changes to the blockchain; nodes may take turns fulfilling the *leader* role. If more than a defined threshold of the other nodes agree with the *leader* node's proposed changes, the changes are committed to the blockchain.

[18] Variations on these algorithms, such as *delegated* proof-of-stake or *democratic* byzantine fault tolerance, differ mostly in how the underlying algorithm is implemented. The latter, implemented in University of Sydney and Data61's 'Red Belly Blockchain' has been shown to scale to more than thousands of transactions per second under experimental conditions.

[19] For more information, see: <https://medium.com/fantomfoundation/an-introduction-to-dags-and-how-they-differ-from-blockchains-a6f703462090>.

[20] Ethereum currently uses proof of work for mining, though it has been aiming to move to proof of stake for a long time.

[21] In this section we discuss smart contracts created on the public Ethereum blockchain. Smart contracts may also be created on private blockchain or other DLT platforms, where the intended application will inform characteristics such as privacy.

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Exploring the Supply and Demand Drivers of Commodity Prices

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Photo: Gangliu Maogg Tatomm – Getty Images

Abstract

Quantifying the relative importance of supply and demand in price movements of commodities can help inform how changes in these prices might impact the Australian economy, via exports, business investment and the exchange rate. Isolating the extent to which a change in commodity prices is driven by demand also provides a timely indicator of global economic activity. In this article, we use a dynamic factor model to help interpret changes in commodity prices as being driven by supply and/or demand developments. Results from the model are consistent with prior understanding of several notable episodes of commodity prices movements.

Why Do Commodity Prices Matter for the Australian Economy?

Commodities account for two-thirds of the value of Australia's exports. The prices of these commodities are important determinants of the terms of trade, Australian dollar, national income and aggregate demand. A better grasp of the underlying drivers of commodity price changes – supply and demand – can improve our understanding of how long a shift in commodity prices might last and how they might affect the Australian economy.

For example, the response of export volumes to a change in price can depend on whether the change is driven by demand or supply. If prices rise because external demand has increased, then Australia's export volumes are also likely to increase. In contrast, if prices rise because Australian supply is disrupted, export volumes are likely to decline, although the higher prices could more than offset the effect of this on the value of exports. Whether a price movement is driven by supply or demand can also shed light on how long it might last. A disruption to supply as a result of severe weather is likely to be temporary, and so will have little effect on the outlook for exports or investment. On the other hand, sustained demand-driven price rises can induce large-scale investment to expand capacity to meet that demand – with lasting effects, as the Australian experience of the past decade has shown (Plumb, Kent and Bishop 2013).[1]

Commodity prices (and the terms of trade more generally) are important medium-term determinants of the value of the Australian dollar. Expectations of long-term future changes in commodity prices have been found to move closely with the currency (Chapman, Jääskelä and Smith 2018). Movements in commodity prices that are expected to be short-lived, such as those driven by temporary supply disruptions, tend to have a smaller effect on the Australian dollar.

Commodities are used extensively in global industrial production, so a change in global activity could result in changes in demand for these commodities and, as a result, a change in their prices. Given the timeliness of data on commodity prices, this can provide a useful real-time indicator of global demand and can also provide a cross-check on the Reserve Bank's forecasts of economic activity.

In this article, we use an econometric technique to quantify the relative importance of changes in supply and demand for commodity price movements. In particular, we use a dynamic factor model of commodity prices that largely follows Delle Chiaie, Ferrara and Giannone (2017).[2] This technique uses information that is shared between different commodity prices and that which is commodity-specific (or idiosyncratic) to decompose price changes into the contributions from several unobserved factors, which may be loosely interpreted as supply and/or demand. This articles provides an overview of the model and its interpretation, discusses some key results and provides examples of its application to various episodes of commodity price movements.

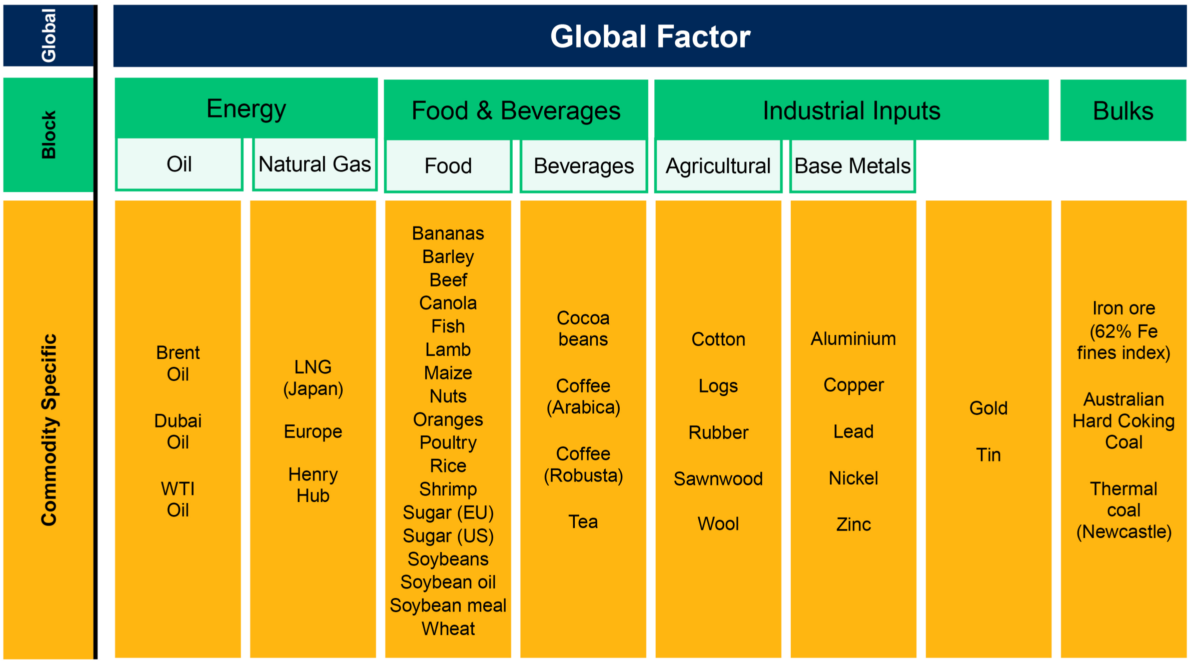
A Dynamic Factor Model of Commodity Prices

In general, factor models decompose changes in a large number of variables into a few unobserved statistically derived 'factors', which may be given economic interpretations. In our case, we take a range of commodity prices and decompose changes in these prices into factors that, as discussed below, we can generally interpret as capturing supply and/or demand developments. At the broadest level, all commodity prices are grouped together and a *global* factor that captures variation common to all commodity prices can be extracted (Figure 1). Stepping down a level, the model then groups together commodities with similar characteristics. For instance, commodities that are close substitutes (such as different types of crude oil) or those that have similar end uses (such as base metals used in industrial production) are grouped together.[3] Within each of these groups, referred to as *blocks* or *sub-blocks*, the common variation is extracted into an unobserved factor; this is the leftover common information between groups of commodities after the global component is extracted. When presenting the results from the factor model we aggregate the contribution of all block and sub-block factors under *block* factors. Finally, the remainder is the *commodity-specific*, or idiosyncratic, component, which can also be thought of as the residual; that is, the change in the price that is not explained by the global or block factors. For more details on the model see Appendix A.

The example of Brent crude oil illustrates the structure of the model:

- *Global factor*. Common variation between Brent crude oil and all commodity prices, including those in the energy block, is captured by the global factor.
- *Block factor*. Brent is one of three benchmark oil prices, which all appear in the oil sub-block because they are close substitutes and their prices tend to co-move. The unobserved 'oil block factor' captures common variation that is shared between these three prices. Because oil is one of several energy commodities, the three oil prices are then grouped with several natural gas prices under the broader 'energy block'. The unobserved factor – 'energy block factor' – captures co-movement between all oil and natural gas prices; for instance, owing to the use

Figure 1
Structure of the Dynamic Factor Model of Commodity Prices



Source: RBA

of oil-based pricing mechanisms in some natural gas contracts (Cassidy and Kosev 2015).

- *Commodity-specific factor*. Any movement in the price of Brent crude oil that is independent of all other commodities is referred to as 'Brent commodity-specific'.

The grouping of commodities into blocks and sub-blocks in our model largely follows Delle Chiaie *et al* (2017) with the exception of bulk commodities, where we establish a new block and include coking coal prices. We use month-average spot prices for 43 energy, food and beverage, industrial and bulk commodities that are important for both the global and Australian economies. Data are primarily sourced from the World Bank's Pink Sheet; we replace some series with our preferred price indices (iron ore, thermal coal, beef, lamb and wheat) and include some additional commodities that are important to Australia (coking coal, wool and canola).

While commodity prices within the same block or sub-block are correlated, the commodity-specific shocks are idiosyncratic and do not affect other commodities. For example, the commodity-specific (or idiosyncratic) component of Brent crude oil cannot spill over into the prices of food and beverages. With respect to oil prices, this assumption appears to be somewhat questionable because oil can be an input into the production process of other commodities. However, Baumeister and Kilian (2014) find that pass-through from oil price shocks to the prices of other commodities is limited. Furthermore, the model is fairly robust to misspecification of the cross-correlation among groups of commodities, in part owing to the large number of commodities in each block (Doz, Giannone and Reichlin 2012).

Interpreting the Global, Block and Commodity-specific Factors

The model outlined above is not a structural one; that is, the contributions of supply and demand developments are not directly modelled. Therefore, we should be cautious in mapping the factors to precise supply or demand developments. However, when complemented with knowledge of broader economic and commodity market developments, the model provides a framework through which to interpret price movements.

The global factor captures the co-movement between all of the commodity prices included in our model, and can be thought of as an indicator of global demand. This is because commodities are used in the production of a wide range of goods, demand for which is generally positively correlated with anticipated and realised global activity; the correlation is particularly strong during major downturns and recoveries (Graph 1).[4] For example, the global factor declined sharply during episodes such as the Asian financial crisis in the late 1990s, the United States downturn in the early 2000s, and the global financial crisis (GFC), and then rebounded strongly after each of these events.

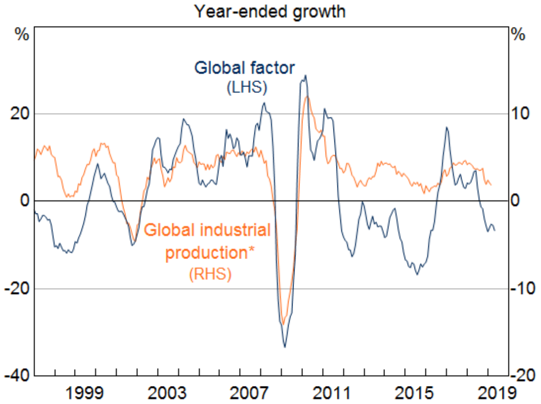
Interpreting the block factors is less straightforward. At any given time, a block factor could capture a change in demand for a specific group of commodities (e.g. Chinese demand for bulk commodities) or a change in supply that is common to that group of commodities (e.g. the largely coincident ramp-up in Australian production of iron ore, coking coal and thermal coal in response to increased demand from China).

The commodity-specific or idiosyncratic component will mainly capture supply factors, because shocks to supply tend to be isolated to one commodity (or a relatively small group of commodities). But demand factors cannot be ruled out – for example, changing regulations or technological advances in the production of a good that affects demand for a specific commodity.

Graph 1

Global Factor and Global Industrial Production

Year-ended growth



* Aggregated by share of industrial production for each country

Sources: CEIC Data; RBA; Thomson Reuters; World Bank

The relative importance of each factor in explaining individual commodity price movements varies across commodities.

- Some commodities have deeper and more liquid futures markets. This means that financial market traders can more readily express their views on the global economy through these markets. Oil and base metals have the deepest and most liquid futures market in our commodity price sample and also display the highest correlation with the global factor.
- China is by far the largest global consumer of most bulk commodities and has consequently had a disproportionate impact on global demand for these commodities. Accordingly, any changes in Chinese demand and government policies tend to have a large influence on bulk commodity prices, which will be mostly captured by the block factor in the model.
- The supply of agricultural commodities can be heavily influenced by weather patterns. Price changes for most agricultural commodities therefore tend to be less correlated with the global factor and have a larger commodity-specific factor that captures these events.
- Some commodities are not easily traded globally and their prices are largely determined in segmented regional markets. The importance of regional developments in determining prices will be captured in either the block or commodity-specific factors of the model, while the global factor will have less of an influence. For example, natural gas markets are regionally segmented and natural gas prices tend to have a low correlation with the global factor.

Applications of the Model

To illustrate the use of the factor model outlined above, we look at some examples of episodes that have been associated with large movements in commodity prices and decompose the price changes into the contributions from the global, block and commodity-specific factors.

The recovery in the price of crude oil between early 2016 and mid 2018

Higher oil prices tend to be associated with an increase in headline inflation; directly through higher automotive fuel prices, and indirectly through the effect that higher oil prices have on the cost of producing goods and services in the economy (see RBA 2015). In recent years, Australia has also shifted from being a net oil importer to a net exporter of oil-price-related products because of the large increase in LNG exports.

The price of crude oil fell sharply in 2014 and 2015, from over US$110 to a low of US$28 per barrel in January 2016 (Graph 2, left-hand side). The fall in prices followed a large increase in supply of crude oil and natural gas from the United States. This was the result of an increase in the production of 'unconventional' oil from new extraction methods (see RBA 2015). Because the growth in production exceeded growth in global crude oil consumption, inventories of crude oil – which are usually fairly stable – rose by nearly 20 per cent.

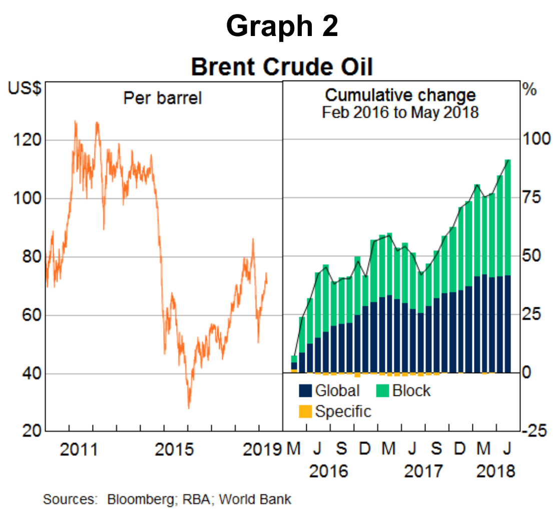
Oil prices began to recover in early 2016, and more than tripled by around mid 2018. At the time, both demand and supply factors were reported by commentators as supporting the recovery in prices. On the demand side, global economic activity was picking up (see Graph 1 above) and, consistent with this, the outlook for global oil consumption was improving. On the supply side, some oil-exporting economies experienced temporary supply disruptions in 2016, which was then followed by OPEC countries and Russia reaching an agreement to limit production from the beginning of 2017.

Although both supply and demand factors were acknowledged by market analysts as being important for the recovery in crude oil prices, the factor model can help quantify the relative contributions of these effects to the price changes. According to the model, around half of the cumulative increase in the Brent crude oil price can be attributed to the global factor and around half to block factors (Graph 2, right-hand side). The large role of the global factor suggests that the recovery in global industrial production was a significant driver of the rise in the price of Brent crude oil. The block factor is likely to capture supply developments common to oil production, and made an increasing contribution from late 2017 onwards, coinciding with the extension of OPEC-led production cuts through to the end of 2018.[5]

The increase in bulk commodity prices between mid 2009 and late 2011

The prices of iron ore, coking coal and thermal coal increased significantly between mid 2009 and late 2011. These increases helped drive Australia's terms of trade and the Australian dollar to historically high levels, and noticeably boosted Australia's national income (Graph 3). The increase in prices for iron ore and coking coal were largely driven by a rebound in global steel production, following the GFC, supported by growth in Chinese steel production (RBA 2010). Strong growth in Chinese steel production – and the associated demand for steelmaking inputs, iron ore and coking coal – was underpinned by Chinese Government stimulus policies that were targeted at infrastructure and construction investment, as well as the ongoing industrialisation and urbanisation of the Chinese economy. Meanwhile, thermal coal prices were supported by increased energy demand needed to support rising global industrial activity.

The factor model decomposition provides an additional, and broadly consistent, perspective on the drivers of the price moves between mid 2009 and late 2011. According to the model, the post-financial crisis upswing in global demand, captured by the global factor, accounted for around one-third of the increase in iron ore prices, one-



quarter of the increase in coking coal prices, and around half of the increase in thermal coal prices (Graph 4). The block factor accounts for almost half of the increase in coal prices and about one-quarter of the increase in iron ore prices, predominantly capturing the common demand shock from China. While the global and the block factors together accounted for at least half of the increase in the bulk commodities prices over this period, the importance of the commodity-specific factor varied by commodity; it accounted for almost 40 per cent of the increase in the iron ore price, while its contribution to developments in coal prices was smaller. This might reflect a larger increase in Chinese demand for seaborne iron ore compared with coal, because China was able to increase its domestic coal production by considerably more to help meet demand.

In response to the prolonged period of strong, demand-driven price growth, resource companies invested significantly to expand their productive capacity. As these large-scale investment projects have been completed, Australia's exports of bulk commodities, particularly iron ore, have increased considerably.

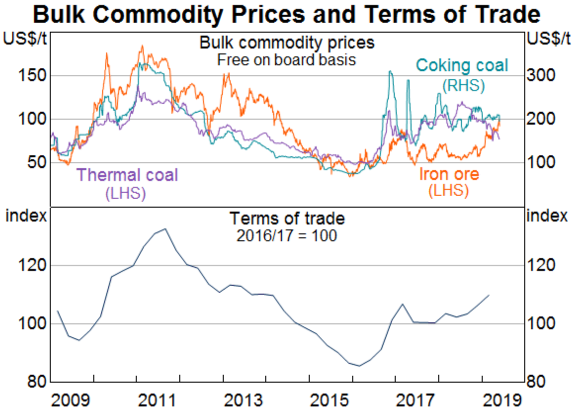
Tropical Cyclone Debbie and the spike in coking coal prices

Australia accounts for more than half of the global seaborne coking coal market following the ramp-up in coking coal exports over the past decade. About one-third of Australia's coal exports are produced in the Bowen Basin region in Queensland. Over the past couple of years, there have been some large movements in coking coal prices due to temporary supply disruptions. In April 2017, prices increased sharply after Tropical Cyclone Debbie shut down ports and damaged key rail infrastructure in the Bowen Basin region (Graph 5, left-hand side). The resulting damage to the rail network reduced coal transport capacity over the following month and Australian coking coal exports declined by around 50 per cent in April 2017 (Graph 6). Additional supply-side disruptions in Australia – including temporary mine closures, port congestion and maintenance – in the second half of 2017 also supported prices; however, coking coal prices declined over the early part of 2018 as Australian supply recovered.

These supply-side disruptions are reflected in the commodity-specific component of the factor

Graph 3

Bulk Commodity Prices and Terms of Trade

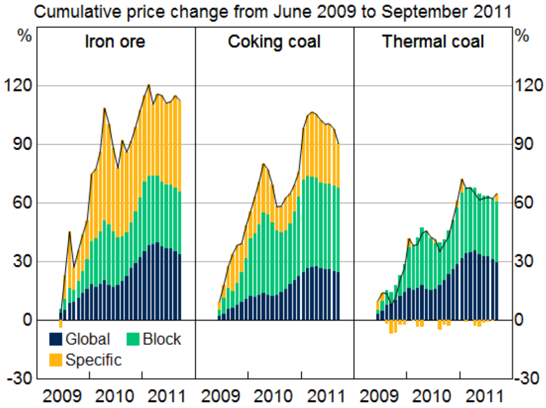


Sources: ABS; Bloomberg; IHS Markit; RBA

Graph 4

Bulk Commodity Prices

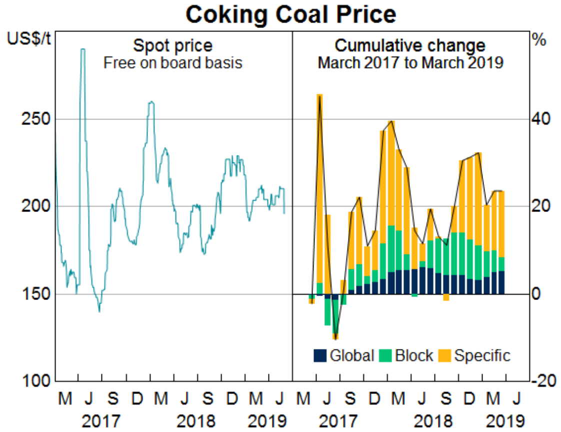
Cumulative price change from June 2009 to September 2011



Sources: Bloomberg; IHS Markit; RBA; World Bank

Graph 5

Coking Coal Price



Sources: IHS Markit; RBA; World Bank

model decomposition, which is the primary driver of coking coal price movements over this period (Graph 5, right-hand side). As the seaborne coking coal market is fairly small compared with global production, and Australia accounts for such a large share of seaborne supply, any disruptions to Australian production tends to have a large impact on prices. In contrast, the contributions from the global and block factors were fairly small during this period. Consistent with the transitory nature of the price movement associated with the supply disruption, there was little impact on investment decisions of the major coking coal miners operating Australia.

The impact of recent Australian weather disruptions on the prices of agricultural commodities

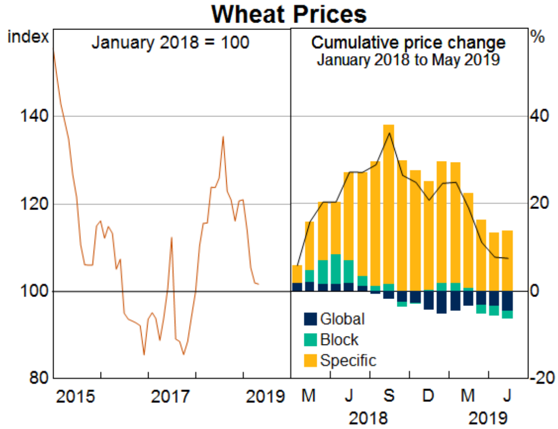
Drought conditions across eastern Australia and flooding in northern Queensland have significantly boosted prices of some of Australia's key agricultural commodities, such as wheat and beef. These price movements have also raised some domestic costs and consumer prices, although the effects are likely to be temporary if past experience is any guide.

Wheat prices were also boosted by supply disruptions in other wheat-producing economies, but more recently they have declined as the outlook for northern hemisphere supply has improved (Graph 7, left-hand side). Beef prices initially fell as Australian producers reduced herd sizes in response to the drought, thereby increasing supply (Graph 8, left-hand side). Since their October 2018 lows, however, beef prices have risen by around 35 per cent as the earlier drought-related destocking and flood-related livestock losses have reduced available supply.

Because the same weather event affects the supply of agricultural commodities in different ways, price movements tend to be driven by the commodity-specific factor (right-hand side of Graph 7 and Graph 8). For wheat, there is a relatively fast reduction in supply following the onset of dry conditions, leading to higher prices; whereas drought-induced herd destocking initially increases beef supply resulting in lower prices, which is then unwound as the impact of reduced supply becomes more of a constraint.

Graph 7

Wheat Prices

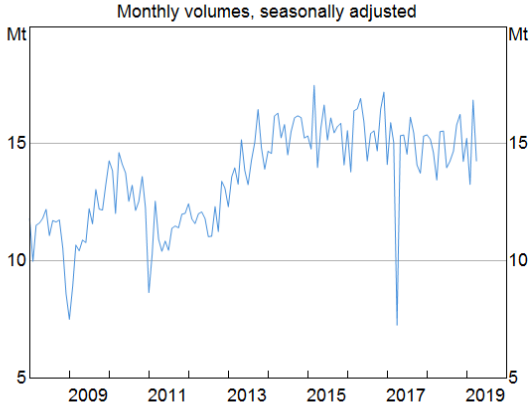


Sources: Bloomberg; RBA; World Bank

Graph 6

Australian Coking Coal Exports

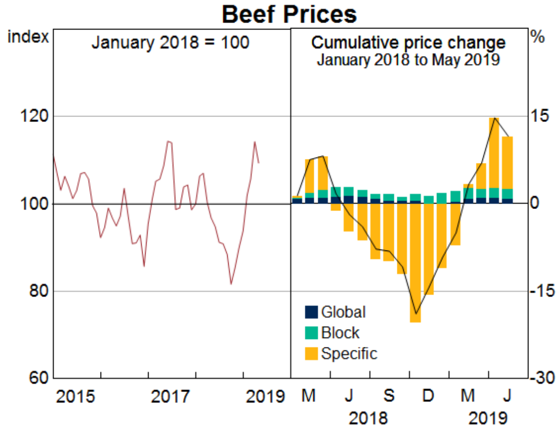
Monthly volumes, seasonally adjusted



Sources: ABS; RBA

Graph 8

Beef Prices



Sources: MLA; RBA; World Bank

Table A1: Structure of the Commodity Factor Model

Global	Blocks	Sub-blocks	Number of series
All commodities			43
	Energy		6
		Oil	3
		Natural gas	3
	Food & beverages		22
		Food	18
		Beverages	4
	Industrial inputs		12
		Agriculture	5
		Base metals	5
	Bulks		3

Source: Authors' calculations

Conclusion

This article decomposes commodity price movements by using a dynamic factor model to estimate the information that is shared between different commodity prices and that which is commodity-specific or idiosyncratic. The relative contributions of global, block and commodity-specific factors to movements in the price of an individual commodity allows us to draw clearer inferences about the relative importance of supply and demand developments to the price change. The factor model will be used to supplement our analysis of commodity price movements, such as in the *Statement on Monetary Policy*. ✠

Appendix A: A Dynamic Factor Model of Commodity Prices

The (log differenced) price of each of the 43 commodities in our model (listed in Figure 1) is modelled as the sum of k unobservable factors and an idiosyncratic component:

$$x_{it} = c_i f_t + e_{it}$$

where $f_t = (f_{1t}, \ \dots , f_{kt})'$ contains the k global and block factors (see Table A1 for detail on the structure of the blocks in the database) and $c_i = (c_{i1}, \ \dots , c_{i12})'$ contains the factor loadings where each element in c_i measures the effect of a global or block factor on commodity i. $c_{ij} = 0$ if the commodity is not in factor j.

The factors follow an autoregressive process:

$$f_t = Af_{t-1} + \delta_t \text{ where } \delta_t \sim N(0, Q)$$

The idiosyncratic or commodity-specific component e_{it} also follows an autoregressive process:

$$e_t = \alpha e_{t-1} + \varepsilon_t \text{ where } \varepsilon_t \sim N(0, R)$$

The model is estimated via maximum likelihood, using the Expectation Maximisation algorithm as in Doz *et al* (2012). First, the algorithm is initialised by computing principal components and using these as estimates of the unobservable factors to then estimate the model parameters using OLS. Second, the estimates of the factors are updated using the Kalman filter. These two steps are iterated until convergence. For more detail see Delle Chiaie *et al* (2017).

Footnotes

[*] Michelle Cunningham is from Economic Analysis Department and Emma Smith is from International Department. Alexandra Clarke also contributed to an earlier version of this work while working in Economic Analysis Department. We would like to thank Jarkko Jääskelä, Michelle van der Merwe and Mark Chambers for helpful comments and suggestions, Luke Hartigan for technical assistance, and Reinhard Ellwanger at the Bank

of Canada and Simona Delle Chiaie at the European Central Bank for sharing the code used in Delle Chiaie *et al* (2017).

[1] Other channels via which commodity prices affect the Australia economy are public demand and household expenditure (see Gorajek and Rees 2015).

[2] Similar models are used at other central banks. The model in Delle Chiaie *et al* (2017) informs commodity price analysis by the ECB, for example Álvarez and Skudelny 2017. The Bank of Canada has adapted the same model for their analysis (Bilgin and Ellwanger, 2017). West and Wong (2014) construct a static factor model of commodity prices, which has been used in research by Wadsworth and Richardson (2017) at the Reserve Bank of New Zealand.

[3] An advantage of the block structure is that by explicitly modelling the local correlation in groups of commodities we avoid over-representation of blocks or sub-blocks with a large number of individual commodities (such as food; Boivin and Ng 2006 and Luciani 2014).

[4] It is possible that the global factor is also being influenced by movements in the US dollar. Commodity prices are generally denominated in US dollars and so they tend to move inversely with changes in the US dollar, thereby keeping the price constant in other currencies. However, results from running the model with commodity prices expressed in special drawing rights (SDR) terms to try and limit the role of the US dollar exchange rate movements suggest that the global factor is not being heavily influenced by US dollar exchange rate movements.

[5] The Brent crude oil specific component, as for the other crude oil prices, makes little contribution to price changes through this period. This is because the prices of different crude oil benchmarks tend to move very closely with each other and, because of their high degree of substitutability, supply developments in different markets tend to impact the prices of all crude oil benchmarks.

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