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New Banknotes: From Concept to Circulation

Phillip Fox, Cathy Liu and Amanda Martz*

A core function of the Reserve Bank is to maintain public confidence in Australia's banknotes as a secure method of payment and store of wealth. To meet this objective, the Reserve Bank has been developing a new banknote series to upgrade the security of Australia's banknotes. The process has involved integrating artistic designs that reflect Australia's cultural identity with a range of complex technical features designed to make the banknotes very difficult to counterfeit. This article outlines the various steps of the process of 'banknotisation' for the new banknote series, whereby the design concept is developed into a finished banknote.

Introduction

Australia has a tradition of developing and introducing technologically advanced security features for banknotes. One example was the use of polymer as the production material (or substrate) for banknotes in the late 1980s. This was an innovative approach to create substantially more secure banknotes, which were much harder to replicate convincingly than the first generation of paper decimal banknotes. Australia's first polymer banknote – a commemorative $10 banknote celebrating Australia's bicentenary – was issued in 1988. It served as a trial for the new substrate and featured a clear window containing an image that moved when the banknote was tilted (an optically variable device or hologram) as a security feature. This was followed by a complete series of Australian banknotes printed on polymer – a world first – introduced between 1992 and 1996, which continue to be used today.

The security of polymer banknotes has ensured that Australia's counterfeiting levels have remained relatively low over the past 20 years, particularly compared with international experience (Kim and Turton 2014). But the increasing availability of high-quality, low-cost graphic reproduction technology has also made Australia's first series of polymer banknotes more vulnerable to counterfeiting. Mindful of this increasing threat, the Reserve Bank had been researching new anti-counterfeiting technologies for a number of years and, in 2007, formalised this work by establishing the Next Generation Banknote program. The purpose of the program was to upgrade the security of Australia's banknotes to ensure that they continue to be secure against counterfeiting. The program was announced in 2012 and the first denomination – the new $5 banknote – was issued into circulation on 1 September 2016.

The process of designing and producing a new banknote is extremely complex. Extensive research and development is required to assess potential security features and to transform design concepts into functional banknotes. Together with the selection of innovative features that ensure the new banknotes will be secure against counterfeiting, the development of the narrative elements of the overall design is particularly important given the role banknotes play in reflecting Australia's cultural identity. This article describes the process of selecting of security features, creating design concepts and testing the designs to make sure that the banknotes can be printed effectively and efficiently at the required volume, and that they will be durable when issued into circulation.

* The authors are from Note Issue Department.

Design

The primary objective of the program is to upgrade the security of Australia's banknotes to ensure that they remain very secure, while maintaining many of the familiar features of the first polymer banknote series. The design challenge has been to maximise the security of the banknote, subject to constraints of space on the banknotes and production capabilities.

There are two key elements to the design process: the selection and design of security features; and the development of design concepts for the banknote bringing together the security features and narrative elements. Much of this work is undertaken in parallel and, therefore, results in a number of iterations in the design of the layout of the security features and the narrative elements.

Security features

Since increasing security was the primary objective, the first step in the design process was the selection of suitable security features. A survey of potential features was undertaken, including features already in use around the world and those newly released or in development. This generated a list of around 200 potential features, many of which had been commonly used on paper banknotes and some of which were unique to polymer. These features were assessed by the Reserve Bank on the basis of four key criteria:

- Resilience to counterfeiting
  - (a) difficulty of creating a reproduction that effectively mimics the feature
  - (b) ease of use to validate banknotes by the public and equipment (such as vending and ticketing machines)
- Resistance to damage in circulation
- Manufacturing considerations
  - (a) ability to produce the banknote to required quality standards
  - (b) cost of production
- Ability to integrate with each other and the design to produce additional, more complex security features.

The most important factor to consider in the selection process was the extent to which a feature would meet the primary objective of increasing the banknotes' resilience to counterfeiting. This assessment had two parts: how difficult it would be to counterfeit the feature; and how easily the feature could be used to verify whether a banknote is genuine. A feature that was very easy to use for verification but equally easy to counterfeit would not provide a significant increase in the security of a banknote. Conversely, if a feature was extremely difficult to mimic but also very difficult for the public and machines to use to validate a banknote, it may be ignored by the counterfeiter and the public, thereby adding little value to a security upgrade program.

The landscape in which banknotes need to function today is very different from the environment into which the first polymer series was released in 1992, when machine-based processing, verification and dispensing was not as widespread. In developing the new series, it was necessary to ensure that a range of machine-readable security features were included that would enable efficient use of, and reliable authentication by, machines. A banknote design that could not be effectively dispensed by automated teller machines, or readily accepted in vending and ticketing machines or self-service check-outs, would not provide the functionality expected by the public.

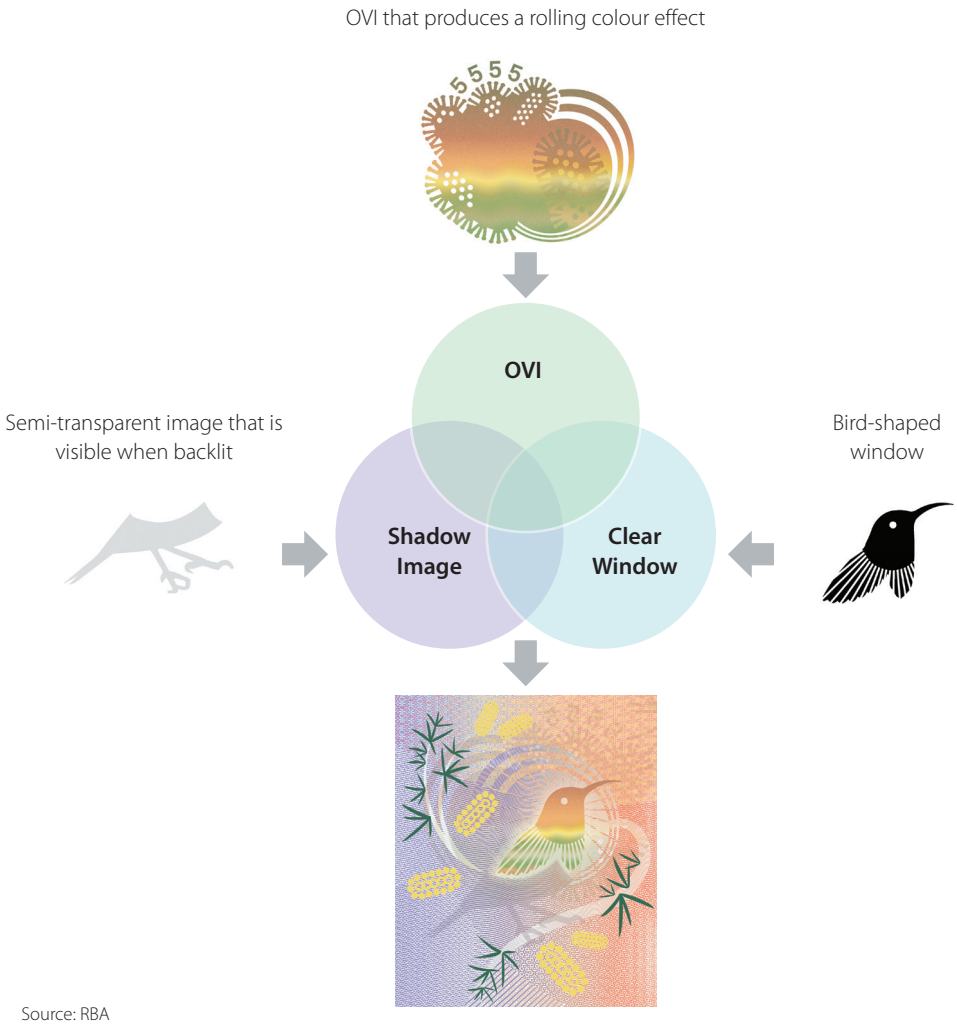
The next issue to consider was how resistant to damage each security feature would be in circulation. This is an important factor for an issuing authority because a feature with poor durability cannot be reliably used to verify a banknote and introduces additional costs associated with replacing worn and damaged banknotes.

Manufacturing considerations were also important. From a production perspective, it is important that the feature can be produced at high quality and consistency. While the cost of production also

needs to be reasonable, it is important to recognise that using readily available and low-cost materials and equipment is generally not conducive to a highly secure feature as it would also make it easier for a counterfeiter to mimic. A complex manufacturing process that uses specialist materials and techniques introduces significant barriers to a would-be counterfeiter. Importantly though, while necessary, manufacturing complexity does not, of itself, guarantee higher levels of security, since the feature still needs to be able to be used by the public and/or machines to verify banknotes and difficult for a counterfeiter to mimic by some other means.

Finally, to maximise the effectiveness of the available space on a banknote, it was desirable to be able to integrate a number of the security features to further improve counterfeit resilience. In this way, more security features could be included so as to create secondary effects, thus creating a new, more complex element. An example is the combination of three security features – a window, optically variable ink (OVI) and a shadow image – which together create another 'feature' (Figure 1).

Figure 1: Integration of Security Features on the New $5 Banknote



Source: RBA

Inevitably, any given feature involves trade-offs between the criteria so that the assessment process was not straightforward. Each of the potential security features identified by the Reserve Bank in its survey was ranked and short-listed on the basis of the factors listed above. The short-listed features were then tested for the ease of manufacturing in printing trials. This demonstrated that some of the prospective features presented significant production challenges and so were considered unsuitable. Other features were found to have durability issues, or did not integrate well with other security features or the overall design of the banknote, and were also discarded. From this process, a set of preferred features was identified and specified in an initial design brief. (Refer to 'Box A: New $5 Banknote Security Features' for a listing of the security features incorporated into the new banknote.)

Design concept

Having selected the set of security features, the next step was to develop and refine the overall designs for the new banknote series. The Reserve Bank invited a number of designers to submit proposals. The designers, all of whom had previous experience designing banknotes, were provided with a brief that detailed the elements to be incorporated into the design concepts, including the general characteristics of the banknote, the narrative elements and the security features.

The brief required that the predominant colour, size and orientation of each denomination remain the same as the first polymer series. Similarly, based on long-term engagement with the vision-impaired community, the designs were required to retain the bold, contrasting numerals and size variations (Springer, Subramanian and Turton 2015). The brief also specified the inclusion and location of other elements, including portraits, serial number, signature block, denominational numerals and words, country name and a legal tender clause. Finally, the brief asked the designers to incorporate other narrative elements representative of the contributions to Australia of the various people portrayed as well as flora and fauna that are native to Australia.

The security features that were required on the design concepts included some features used on the first polymer series, as well as new features, including multiple clear windows, OVI elements, holographic devices and motion features. Where necessary, the brief specified the location of the features, their size and complexity and any required interactions with other features.

The designer that was judged to have best met the design brief and most effectively integrated the required features – emerystudio in Melbourne – was invited to submit a final set of design concepts for all of the denominations.

Banknotisation

While the final design concepts incorporated the general design layout, features and narratives for the new series, they were essentially artworks that needed to be adapted for banknote security printing and production. Note Printing Australia Limited (NPA), a wholly owned subsidiary of the Reserve Bank, is responsible for the practical design and production of Australia's banknotes. A 'banknotisation' brief was provided to guide the designers at NPA who had to convert the design concepts into actual banknote designs.

The banknotisation process is both complex and iterative. Each individual element and layer on the design concepts was drawn and optimised to account for production constraints. The integration of various features or layers – for example the use of optically variable ink on a clear window with a connected shadow image (Figure 1) – gave rise to further printing challenges that had to be taken into account when designing the integrated element. At times, elements that initially looked attractive and appeared to integrate well with each other and the overall concept design became less so after accounting for the printing variations inherent in a large-scale manufacturing process. In these cases, the designs were refined or narrative elements replaced – a process that was often repeated a number of times before the design was finalised.

Box A
New $5 Banknote Security Features

Key security features that the public can use to determine whether or not their banknote is genuine are shown and described in Figure A1 and Table A1. There are also a number of features that are used by machines to authenticate banknotes, which are not listed below.

Figure A1: Security Features of the New $5 Banknote

Source: RBA

Table A1: Security Features of the New $5 Banknote

Polymer substrate	Australian banknotes are printed on polymer (a type of plastic) and have a distinctive feel. A genuine banknote should return back to shape after it is scrunched up.
Top-to-bottom window	There are multiple security features in the clear top-to-bottom window. The window should be an integral part of the banknote and not an addition.
3D Federation Star	Tilt the banknote to see a three-dimensional Federation Star with a colourful border. The image will appear raised or recessed.
Flying Eastern Spinebill	Tilt the banknote to see the Eastern Spinebill move its wings and change colour.
Colourful Eastern Spinebill	Tilt the banknote to see colours change within the Eastern Spinebill.
Reversing 5	Tilt the banknote to see the number '5' change direction within the Federation Pavilion. The number alternately appears forwards, disappears, then appears backwards.

Table A1: Security Features of the New $5 Banknote (continued)

Rolling colour effect	Tilt the banknote to see a rolling colour effect. On one side of the banknote it is a prominent patch near the top corner; on the other it is in a bird shape.
Federation Star	Look for a Federation Star in a small clear window. The Federation Star is embossed and has a light and dark effect. The window should be an integral part of the banknote and not an addition.
Microprint	Look for tiny, clearly defined text in multiple locations on the banknote. This includes selected lines from the Australian Constitution in the branch in the top-to-bottom window, and in front of and in the wall of Parliament House. 'FIVE DOLLARS' is also microprinted in the coloured background.
Intaglio print	Feel the distinctive texture of the dark printing. The slightly raised print can be felt by running a finger across the portrait and numerals.
Background print	Multi-coloured and multi-directional fine-line patterns appear on each side of the banknote. This background printing should be very sharp. Check for irregularities such as less clearly defined patterns, thicker or thinner lines, or colour differences.
Fluorescent ink	Look for an Eastern Spinebill, serial number and year of print that fluoresce under UV light.

Source: RBA

Furthermore, banknote designs often look different when printed using banknote printing equipment compared with how they look on a computer screen. This is particularly true where different coloured inks interact with each other, and in areas where there is a reasonable amount of fine-line artwork. For this reason, multiple print trials were conducted at different phases to assess how the designs looked when printed. Following every print cycle, each printed element, as well as the design as a whole, was assessed in detail and feedback was provided to the banknote designers at NPA (Figure 2).

An additional part of the banknotisation process is the incorporation of features that are used by machines to process and authenticate banknotes. While the public cannot see these features, they need to be well designed to ensure that the banknotes can be used in the multitude of machines that accept and dispense them. An important design consideration for these features is consistency across denominations in the series – the features should be the same and in similar positions on all the denominations. A common architecture was therefore developed that set out how the machine-readable features would be integrated across all the denominations. The Reserve Bank engaged with the banknote equipment manufacturing industry on the development of this architecture and it is now established as the roadmap by which the machine-readable features will be integrated across the series (Evans, Gallagher and Martz 2015).

Consultation

The Reserve Bank conducted extensive consultation on the banknote designs and this feedback was taken into account during the process of refining the design.

Figure 2: New Banknote Series Design Iterations

May 2011

This is a design concept from emerystudio incorporating the security features specified in the design brief.

August 2012

Following feedback that the image of Parliament House should appear more authoritative, an alternative reference image was incorporated.

April 2013

The large window, along with the OVI and several other elements, were developed further by the NPA designers.

March 2014

One of the design iterations in which the large window design was being refined with the advice of acacia SMEs. The final OVI and hologram designs were incorporated.

Source: RBA

The new series will showcase native Australian plants and birds as prominent themes, along with the existing portrait subjects from the first polymer series and their related images. A number of subject-matter experts (SMEs) were involved from an early stage to ensure that the representations were appropriate. SMEs were engaged to provide advice on ornithology, acacia and Australian history, particularly the areas and eras related to the portrait subjects.

The acacia and ornithology SMEs made recommendations on the species that could be featured. They provided information about the important characteristics of each species to the NPA banknote designers and reviewed the various design iterations. The challenge in this process was to produce a representation that fitted into the limited space on the banknote, was printable and did not impede the efficacy of any security features. The most technically accurate representation, for example, might exceed the printing capability for a banknote. The aim of the SME consultation was, therefore, to produce a design that was an appropriate representation of the species while still meeting the requirements of the banknote printing process.

SMEs on the portrait subjects and Australian history were also involved from the start of the design process. They helped to source images and artworks that shaped the stories about the subjects of the portraits. These were usually images representative of a significant aspect of the portrait subject's life or

their contribution to Australian society. The process of selecting the images was also iterative: some images, for example, did not fit the available space and others could not be printed effectively.

The Reserve Bank also established a panel to assist in the assessment of the designs as they were developed. The Design Advisory Panel (DAP) comprises people with expertise in the areas of art, design, history and banknote production. The DAP typically meets twice a year to assess the banknote designs in terms of their historical accuracy and relevance, the appropriateness of images and themes, and any potential for elements to be misinterpreted by the public.

A number of focus groups were conducted with members of the public to give general feedback on the banknotes, as well as to evaluate the banknote designs for any adverse reactions by the public. Targeted focus groups were also conducted with people who are blind or have low vision to assist in the development of the tactile feature (Springer *et al* 2015); these groups helped to determine the preferred feature as well its design and location on the banknotes.

Production

The banknote production process involves the application of a sequence of printed layers that provide functionality, security and visual content. There are 13 production processes for the new $5 banknote (see 'Box B: Production Process for the New Banknote Series' for a detailed listing of these processes). Some of these are extensions of existing production processes, sometimes updated with new materials, while others are entirely new and require new equipment.

One of the most significant changes was the incorporation of the clear top-to-bottom window. While internationally the design trend in polymer banknotes had been to use larger windows, a full-height window of the type included in the new banknote series had not been attempted before. This design presented a number of challenges, both in production and for circulation. So prior to finalising the design, a preliminary set of trials was conducted to test the production readiness of the design and the ability of banknote equipment manufacturers to develop solutions to ensure their equipment could process the new banknotes. A test note was developed based on the general design proposed for the new series featuring a large clear window with multiple security features, a second window with an embossed feature and a third window that allows part of the rolling colour effect to be seen from the other side of the banknote. This test note went through the full production process in a variety of configurations to investigate optimum production conditions and the resulting notes were assessed for durability as well as compatibility with machine-based processing.

These trials demonstrated the suitability of several key features, allowing them to be confirmed for inclusion in the design. Two of these – the rolling colour effect and the multiple security features in the clear top-to-bottom window – required new production processes (see Foil and Screen Printing in 'Box B: Production Process for the New Banknote Series'). The success of the trial enabled NPA to introduce the new equipment into the banknote production process. In later trials, NPA, working closely with the Reserve Bank, was able to develop a process for the production of a tactile feature to assist people who are blind or have low vision to identify the value of their banknote (see Tactile Emboss in 'Box B: Production Process for the New Banknote Series').

Once all production considerations had been resolved, the design finalised and the trials successfully completed, full-scale production commenced. NPA began manufacturing the first denomination of the new series – the new $5 – in 2016 and 172 million new banknotes were printed prior to their issuance on 1 September 2016. These banknotes have been made available to commercial banks to purchase at face value and issue to their customers as needed.

Box B

Production Process for the New Banknote Series

There are 13 production processes for the new banknotes. Some of these processes are also used in the production of the first polymer banknote series, while others are unique to the new banknotes.

Substrate Production

1. *Polymer*. Australian banknotes start as clear plastic beads, which are melted down and blown into a large bubble.
2. *Film production*. The walls of the bubble are pressed together and cooled to form laminated polymer film.
3. *Gravure*. Special inks are applied to make the film opaque, except for certain areas that are left free of ink to create the clear windows, before it is cut into sheets.

Printing

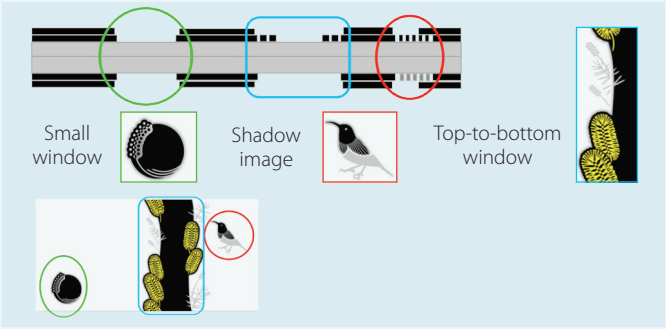
4. *Offset*. The background colours and patterns are printed onto both sides of the polymer sheets simultaneously on a 'simultan' printing machine. These machines can print up to 8 000 sheets per hour.
5. *Foil*. The multiple security features in the top-to-bottom window are applied as a continuous strip. This is the first unique process for the new banknotes.
6. *Screen printing*. The rolling colour effect is applied on a screen-printing process using an optically variable ink in a second unique process.
7. *First pass intaglio*. Major design elements, such as the portraits and narrative elements, are printed using intaglio printing machines. In this process, the ink is transferred to the sheets under great pressure using engraved metal plates.
8. *Second pass intaglio*. Separate print runs are required for each side of the sheet. The resulting raised print is one of the important security features of Australia's polymer banknotes. Some of the microprinting and embossed features are also produced during this process.
9. *Letterpress*. The serial number is added to the sheets using a letterpress printing process.
10. *Overcoating*. A protective overcoating ink is applied to the banknotes using a flexographic printing process. This overcoat contributes to the extended durability and cleanliness of polymer banknotes.
11. *Tactile emboss*. For the new series of banknotes, the tactile feature is applied in a final printing process. The tactile feature has been developed to assist the vision-impaired community to identify different denominations. It is made up of different numbers of raised bumps on the long edges of the banknote next to the clear top-to-bottom window.

Finishing

12. *Guillotining*. Printed sheets are guillotined into individual banknotes.
13. *Inspection*. Individual banknotes are inspected electronically to ensure that their quality meets the required standard. The finished banknotes are then shrink-wrapped, packed into containers and stored in a strong room prior to distribution around the country.

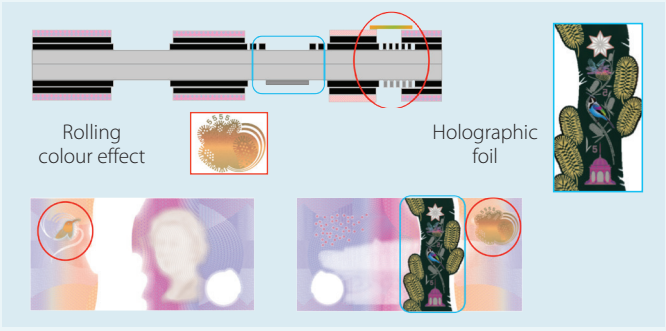
1. Polymer
2. Film production

3. Gravure



4. Offset

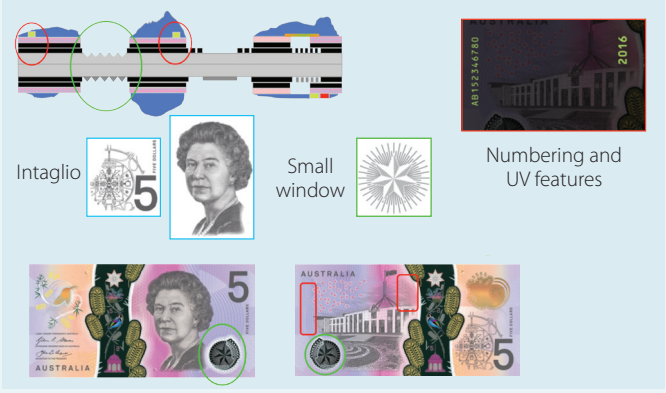
5. Foil



6. Screen printing

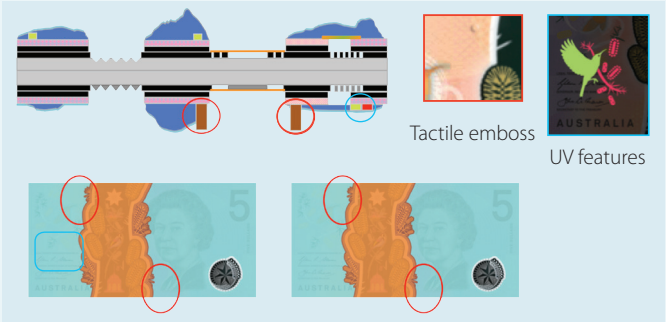
7. First pass intaglio
8. Second pass intaglio

9. Letterpress



10. Overcoating

11. Tactile emboss



12. Guillotining
13. Inspection

Conclusion

The process to develop a new banknote series from a design concept to finished banknote is extremely complex and iterative. This is particularly the case when the focus is on maximising the security benefits of the upgrade by ensuring that the most advanced technology is incorporated into the design in innovative ways. The time and effort required is an investment in the future security of Australia's banknotes thereby ensuring that the high level of confidence in Australia's banknotes is preserved.

Designs for the remaining denominations are well progressed and, over the coming years, the Reserve Bank and NPA will continue the banknotisation process until the full series is in circulation.

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Sensitivity of Australian Trade to the Exchange Rate

Duke Cole and Samual Nightingale*

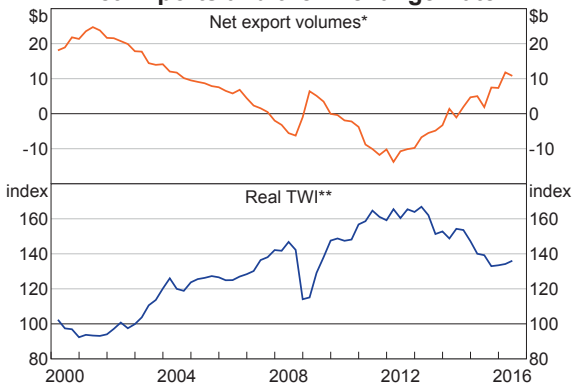
The exchange rate is an important determinant of Australian exports and imports. Movements in the exchange rate affect the relative prices of traded goods and services, and thus the competitiveness of domestic producers of exports and import-competing goods and services. This article provides estimates of the sensitivity of Australian exports and imports to changes in the exchange rate at the aggregate and component level. Other things equal, a 10 per cent depreciation in the real exchange rate is estimated to increase export volumes by around 3 per cent and decrease import volumes by about 4 per cent after two years, which implies a cumulative net exports contribution to gross domestic product (GDP) of around 1½ percentage points over this period. However, the aggregate responses of exports and imports disguise substantial variation in the responses of the components. Trade in services is generally more responsive to movements in the exchange rate than trade in goods, although it takes longer for the full effect to be seen in services trade volumes.

Introduction

The exchange rate plays an important role for Australian exports and imports. Domestically, a depreciation of the Australian dollar encourages substitution from imports to domestically produced goods and services, as imported products become relatively more expensive. A lower exchange rate also makes Australian exports more competitive in world markets, as exported goods and services become relatively cheaper in foreign currency terms.

Movements in the exchange rate assist the economy in adjusting to structural change, such as that experienced in Australia during the recent terms of trade boom (Jääskelä and Smith 2013; Gorajek and Rees 2015; Lowe 2015). Strong demand for resources from the rapidly growing Chinese economy caused commodity prices – and thus Australia's terms of trade – to rise substantially between 2001 and 2011. Associated with this, the Australian dollar appreciated by around 80 per cent in real trade-weighted terms over that period (Graph 1). The appreciation of the exchange rate raised the relative price of Australian-produced goods and services, thereby shifting demand – both domestically and internationally – away from the non-resource traded sectors of the Australian economy. By reducing the demand for labour and production inputs more generally in other parts of the economy, this gave the Australian economy more room to respond to the strong demand for resources without overheating. Over

Graph 1
Net Exports and the Exchange Rate



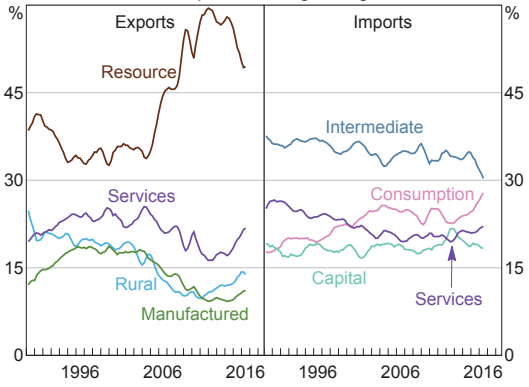
* Reference year is 2013/14
** March 1995 = 100
Sources: ABS; RBA

* The authors completed this work in Economic Analysis Department.

this period, mining investment expanded significantly, while net exports subtracted on average ¾ percentage point from annual GDP growth; although resource exports increased substantially, other exports were subdued and imports increased strongly.

As a result, the composition of Australia's exports changed dramatically. The share of resource exports in Australia's total export mix rose from around one-third in the 1990s to about half today, while the shares of other exports declined (Graph 2). In contrast, the composition of Australia's imports has been more stable; all components grew as incomes increased with the rise in the terms of trade.

Graph 2
Trade Shares*
Four-quarter moving average



* Shares do not sum to 100: 'other' goods exports are excluded from exports and non-monetary gold imports are excluded from imports

Sources: ABS; RBA

Australia's terms of trade have fallen substantially since the peak in 2011, as growth in China has moderated and the global supply of many commodities has increased. The Australian dollar has depreciated by about 20 per cent in real terms from its peak in 2013. This has contributed to a rise in demand for a range of exports and a decline in imports, notably of services. Net exports have contributed around 1½ percentage points to annual GDP growth on average during this period.[1] This has helped to sustain growth in the economy as investment in the resources sector has been wound back sharply.

In light of the important role played by the exchange rate for the Australian economy, this article provides estimates of the effects of exchange rate changes on trade volumes. These effects are estimated for exports and imports in total, as well as at the component level given the very different nature and developments of the components of trade.

Sensitivity of Trade Volumes to the Exchange Rate

We use an econometric model to quantify the historical relationship between changes in the exchange rate and their effects on exports and imports (see Appendix A).[2] The key determinants of trade volumes are demand and the real exchange rate. In the estimated models, the relevant demand variables are major trading partner growth (weighted by export shares) for exports, and domestic final demand plus exports (minus ownership transfer costs) for imports. Real exchange rate movements are captured by real trade-weighted indices, one for exports and one for imports. Weighting the indices by export and import trade shares, respectively, accounts for differences in the importance of destination and source countries for each side of the trade ledger.

The exchange rate elasticity – or sensitivity of trade volumes to changes in the exchange rate – is measured as the change in trade volumes (in per cent) that follows a 1 per cent change in the real exchange rate, all else equal. The estimates suggest that if the real exchange rate depreciates by 10 per cent, total exports will increase by around 4 per cent in the long run (Table 1). However, the responses of different components of exports vary

1 For discussion of recent developments in the trade of services, see RBA (2016). A slowdown in global trade in recent years has also contributed to the decline in imports, see Jääskelä and Mathews (2015).

2 This article focuses only on the direct effect of exchange rate changes on trade, using an error correction framework. Kohler, Manalo and Perera (2014) discuss the aggregate impact of the exchange rate on GDP and inflation and Rees, Smith and Hall (2015) provide estimates of the effects of the exchange rate in Australia using a dynamic stochastic general equilibrium model.

Table 1: Long-run Responses to a 1 per cent Depreciation in the Real Exchange Rate[a]
March 1983–December 2015, percentage points

	Response
Exports	**0.41*** **
Resource	0.22**
Rural	0.08
Manufactured	2.00***
Services	1.15***
Imports	**–0.35*** **
Consumption[b]	–0.13
Capital[b]	–0.69***
Intermediate[b]	0.10
Services	–1.13***

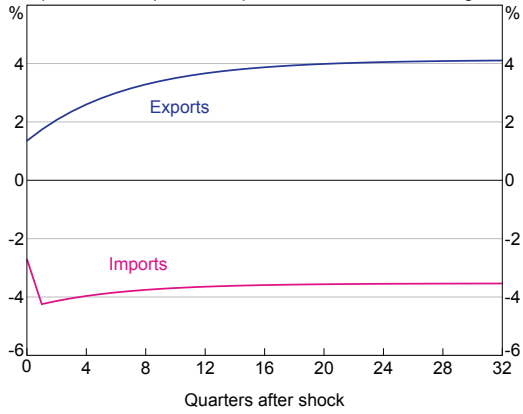
(a) *,** and *** indicate statistical significance at the 10, 5 and 1 per cent levels respectively for Wald tests
(b) Model estimated from March 1986
Sources: ABS, RBA

substantially.[3] Manufactured and service exports show a larger response than total exports to a change in the exchange rate. In contrast, resource exports appear less sensitive, while the response of rural exports is not statistically significant; that is, the estimates suggest that they do not respond to a depreciation in the long run. The models for goods exports are of generally poor fit. This suggests that they do not explain much of the variation in goods export volumes; other factors, not included in the model, may be more important. For example, rural exports are heavily impacted by weather events, such as droughts.

The estimates imply that imports decline by a little less than 4 per cent in the long run following a 10 per cent depreciation of the real exchange rate. As with exports, the responses of import components vary. Service imports move around one-to-one with the exchange rate. Goods imports are relatively less sensitive to movements in the exchange rate; the response of capital imports is moderately smaller than service imports, while consumption imports respond only modestly. Although the estimated elasticity of intermediate imports has the wrong sign, it is not statistically different from zero which suggests that intermediate imports do not respond to movements in the exchange rate.

Overall, the response to a 10 per cent depreciation of the real exchange rate implies a net exports contribution to GDP of around 1½ percentage points after two years. The full effect of an exchange rate change on trade volumes takes longer to occur. This can be illustrated with impulse response functions, which provide an estimate of the path of trade volumes following a change in the real exchange rate, assuming all other factors remain unchanged. For exports, about half of the adjustment occurs within a year of the depreciation (Graph 3). Imports respond slightly faster, with most of the response occurring in the first year. Services trade generally responds a bit more slowly than goods trade to a change in the exchange rate (Graph 4; Graph 5). In the case of service exports, it takes about two years for half of the effect of a change in the exchange rate to flow through to volumes.[4]

Graph 3
Trade Impulse Response Functions
Response to a 10 per cent depreciation of the real exchange rate

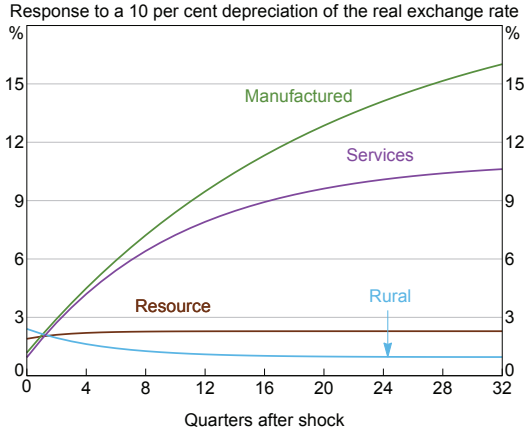


Source: RBA

3 The weighted average of the component elasticities is close to the elasticities of both total exports and total imports, despite the components being estimated separately.

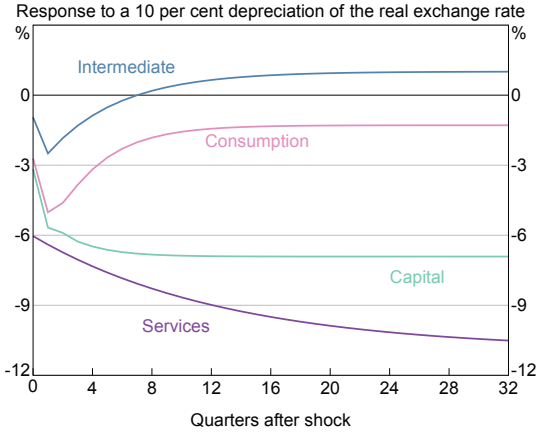
4 These estimates are for the most part in line with previous Reserve Bank of Australia work on trade elasticities: see, for example, Kohler *et al* (2014) and Dvornak, Kohler and Menzies (2003).

Graph 4
Exports Impulse Response Functions
Response to a 10 per cent depreciation of the real exchange rate



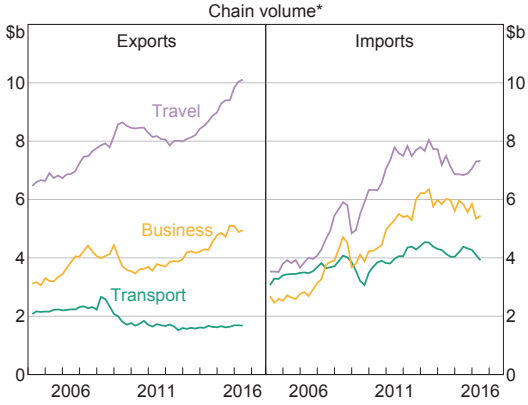
Source: RBA

Graph 5
Imports Impulse Response Functions
Response to a 10 per cent depreciation of the real exchange rate



Source: RBA

Graph 6
Services Trade Components
Chain volume*



* Reference year is 2013/14
Source: ABS

The Variation in Trade Volume Responses

Service exports and imports

Trade in services shows a relatively large response to movements in the exchange rate, although the full response only occurs with a lag of a few years. To understand this result, we consider the two major components of services trade – travel services and business services (Graph 6). Travel service exports capture spending on goods and services by foreigners in Australia, including overseas students, while travel service imports include spending by Australians overseas. Business services trade covers activities such as accounting, architecture, consulting and technical services.

The adjustment of travel services trade to an exchange rate change is likely to occur over an extended period because there is generally a lag associated with planning overseas travel or study. In the medium term, a depreciation is likely to increase the number of visitors to Australia and decrease the number of Australians travelling overseas, as it encourages both foreigners and Australians to shift some of their travel expenditure to Australia from overseas destinations (and the opposite should hold true for an appreciation). However, there is also a more immediate effect on travel services trade from exchange rate changes. Following a depreciation, the purchasing power of foreign currencies rise in Australian dollar terms; this allows foreign visitors to increase spending in real terms and thus boosts travel service exports. Similarly, Australians travelling overseas experience a fall in the purchasing power of Australian dollars in foreign currency terms and are likely to reduce their spending in real terms, which reduces travel service imports.

There are also expected to be short-term and medium-term effects of exchange rate changes on business services trade. For business services, the

initial response to the exchange rate is likely to be driven by contract-based work. Following a depreciation, Australian firms become more competitive for contracts both in Australia and abroad. This boosts exports of business services (Australian firms providing services to overseas clients) while business service imports (Australian clients purchasing services from foreign firms) are likely to be curtailed.

However, the decision by Australian firms to find a provider of services offshore – or return to an Australian provider – in response to an exchange rate change is only likely to be made if it is expected to be profitable over the medium-to-long term. Such decisions also depend on factors such as the relative availability of skilled labour, technical knowledge, production capacity and desires for longer-term cost reductions (Manalo and Orsmond 2013). If the exchange rate were to remain elevated for an extended period, some firms may be encouraged to source more services from offshore at the margin. On the other hand, a sustained depreciation of the exchange rate may encourage some firms to defer the decision to acquire services offshore, or choose to bring production of services back to Australia that had previously been moved offshore.

Resource and rural exports

Resource exports exhibit a relatively modest response to the exchange rate compared with manufactured and service exports.[5] During Australia's recent mining boom, resource exports increased strongly in the face of the large appreciation of the exchange rate. All else equal, a higher Australian dollar reduces the Australian dollar price received for commodity exports, which are typically priced in US dollars, thus discouraging these exports. However, the Australian dollar appreciated strongly because increased demand for bulk commodities drove commodity prices higher. In these circumstances, resource exporters found it profitable to invest in further capacity and export as much as they could to benefit from the commodity price increase, notwithstanding the appreciation.

Resource export volumes are likely to be relatively insensitive to exchange rate changes in the near term. There is generally a long lag between new investment and additional capacity. For a given level of capacity, the marginal cost of production is relatively low, so resource exports are not likely to respond to moderate changes in the exchange rate or commodity prices.[6] In addition, many Australian commodity producers are low cost by international standards. Indeed, declining commodity prices over recent years in large part reflect increased supply from low cost producers, including from Australia.

Rural exports also exhibit only a limited response to the exchange rate. In a similar manner to resource exports, supply decisions for rural exports – the planting of crops and breeding decisions – are generally made well in advance of the goods being exported. Additionally, weather conditions are a key driver of rural production and, in turn, export volumes.

Manufactured exports

Historically, manufactured exports have been quite responsive to movements in the exchange rate, albeit with some lag before the full effect occurs.[7] Many manufactured goods are trade exposed, and the share of production in the manufacturing industry that is exported is relatively large (Kohler *et al* 2014).

However, it appears that the relationship with the exchange rate has weakened somewhat of late.[8]

5 The Australian dollar is heavily influenced by commodity prices, which poses a challenge for disentangling the effect of the exchange rate on resource exports from the effect of commodity prices. If a commodity price variable is included and the model is run in a vector error correction model framework, the exchange rate elasticity of resource exports is not statistically different from zero.

6 This also adds to the difficulty of modelling the relationship between the exchange rate and resource exports.

7 See Menzies and Heenan (1993) for discussion of the drivers of the growth in manufactured exports from the mid 1980s to the early 1990s.

8 When the manufactured exports model is estimated with a rolling window, the magnitude of the exchange rate elasticity declines consistently over the sample, eventually turning positive in the latter parts of the sample (which counterintuitively implies that manufactured exports decline following a depreciation of the exchange rate).

Manufactured export volumes have been little changed since 2012 despite a large exchange rate depreciation. There is evidence, both via the Bank's business liaison program and in academic literature, that this is a structural phenomenon.[9] The Bank's liaison suggests that some manufacturers moved production offshore following the Australian dollar appreciation during the mining boom, but there has been limited evidence of companies moving production processes back to Australia following the depreciation of the dollar in recent years (Langcake 2016). Over the past one and a half decades, Australian manufacturers have faced intense competition from the rapid expansion of industrial capacity in lower-cost countries, in particular China after it joined the World Trade Organization in 2001. Some manufacturers have also noted significant lags between an exchange rate depreciation and their ability to change production, due to delays or lags in their supply chains.[10]

Goods imports

The response of goods imports to a change in the exchange rate is smaller than the response of service imports. This may reflect the lack of domestic substitutes for some imported products. An increase in the price of imported goods should encourage consumers to substitute away from imports to domestic goods, which become relatively cheaper. However, this 'substitution effect' is likely to be limited for goods imports if domestic alternatives are not readily available. Even if Australian-produced substitutes are available, it may not be simple or quick for firms to switch from using imported inputs in their supply chains to inputs produced in Australia.

Changes in the Australian dollar generally flow through fairly quickly to the prices of imports.[11] However, the response of goods import volumes to the exchange rate may be limited somewhat by the actions of domestic retailers and distributors, who may choose to absorb some of the changes in the cost of imported goods in their margins. Moreover, the effect of higher import prices, owing to the depreciation of the Australian dollar over the past three years, on final prices faced by consumers has been partly offset by recent developments in the retail sector, such as competition from new entrants and efficiency gains, which have placed downward pressure on retail margins (Ballantyne and Langcake 2016).

Conclusion

The exchange rate is an important determinant of Australia's exports and imports. Estimates suggest that, all else equal, a 10 per cent depreciation of the real exchange rate results in total exports increasing by around 3 per cent and total imports decreasing by just under 4 per cent over a two-year period; this would increase the level of GDP by around 1½ per cent, holding trade shares constant at current levels. However, there is substantial variation across the different components of trade. Trade in services is generally more responsive to movements in the exchange rate than trade in goods, although the full effect of the exchange rate on services takes some time. The relatively high sensitivity of services trade appears to reflect the greater availability of substitutes. In terms of goods exports, manufactured exports have historically shown the strongest response to the exchange rate, although this empirical relationship has weakened over time.

9 Gorajek and Rees (2015) note the subdued response of manufactured exports to the exchange rate depreciation in recent years. In the global context, Ahmed, Appendino and Ruta (2015) find evidence that the response of manufactured exports to an exchange rate depreciation has fallen over time due to increased 'cross-border production linkages', such as participation in global value chains (GVCs). GVCs are more likely to exist in high value-added production processes, which may be more differentiated, and less sensitive to the exchange rate. However, the Organisation for Economic Co-operation and Development (OECD) suggests that this factor may not be very important for Australian exports due to Australia's geographic isolation (OECD 2015).

10 For a broader discussion of developments in the manufacturing industry, see Langcake (2016).

11 Gillitzer and Moore (2016) discuss the role of invoice currency in the transmission of changes in the exchange rate to the Australian-dollar prices of imports. See also Chung, Kohler and Lewis (2011).

In contrast, the response of resource and rural exports to the exchange rate tends to be limited by relatively fixed supply in the short term. The response of goods imports to the exchange rate may be limited by the lack of readily available domestic substitutes, or the actions of domestic retailers and distributors.

Appendix A

The error correction model for total exports takes the form:

$$\Delta exports_t = \beta_0 + \beta_1 exports_{t-1} + \beta_2 TWI_{t-1} + \beta_3 demand_{t-1} + \phi_1 \Delta TWI_t + \phi_2 \Delta demand_t + \gamma Dummy. \quad \text{(A1)}$$

The long-run elasticities are obtained from the regression output. The exchange rate elasticity, in Table A1, is $-\beta_2/\beta_1$. The speed of adjustment, β_1, indicates how quickly exports respond to disequilibrium in the long-run equilibrium relationship. The long-run relationship is $exports_t = (-\beta_2/\beta_1)TWI_t + (-\beta_3/\beta_1)demand_t$. The imports models take the same form (Table A2).

Lags of the differences of key variables are included to capture the dynamic responses of these variables, and dummies are included in certain equations to account for large exogenous shocks. Each of the component models are formulated in the same way, though the lagged differences and dummies vary slightly.

The natural log of all variables is used. For each of the exports models, the demand variable is an index of GDP of Australia's major trading partners, weighted by export shares. For the imports models, the demand variable is domestic final demand plus exports minus ownership transfer costs.

Each of the variables in the long-run relationship is non-stationary, while the long-run relationship is stationary. This implies that the variables are cointegrated, and therefore can be modelled in an error correction framework.

Table A1: Estimation Results – Exports[(a)]
March 1983–December 2015

Model	Total exports	Services	Manufactured	Resource	Rural
Constant	0.93***	0.71***	0.42***	1.74***	1.03***
$Exports_{t-1}$	–0.14***	–0.09***	–0.05*	–0.31***	–0.16***
$Demand_{t-1}$	0.19**	0.14***	0.10	0.40***	0.14**
TWI_{t-1}	–0.06*	–0.10***	–0.09**	–0.07*	–0.02
$\Delta Demand_t$	0.55	0.17	1.63**	0.18	–0.13
ΔTWI_t	–0.14**	–0.09	–0.13	–0.19*	–0.24*
Olympic dummy[(b)]	0.04**	0.16***			
SARS dummy[(b)]		–0.08***			
9/11 dummy[(b)]		–0.09***			
R^2	0.17	0.53	0.12	0.18	0.12

(a) *, ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels respectively for standard t-tests
(b) Olympic dummy equals 1 in September 2000 (when the Olympics were held in Sydney), –1 in December 2000, 0 otherwise; SARS (Severe Acute Respiratory Syndrome) dummy equals 1 in June 2003 (when the SARS virus epidemic started), –0.5 in September and December 2003, 0 otherwise; 9/11 dummy equals 1 in December 2001 (immediately after the 11 September 2001 terrorist attacks in the United States), 0 otherwise
Sources: ABS; RBA

Table A2: Estimation Results – Imports[a]
March 1983–December 2015

Model	Total imports	Services	Consumption[b]	Capital[b]	Intermediate[b]
Constant	–1.89***	–0.64**	–3.69***	–10.69***	–1.50***
$Imports_{t-1}$	–0.15***	–0.07**	–0.21***	–0.39***	–0.19
$Demand_{t-1}$	0.26***	0.07*	0.43***	1.00***	0.27***
TWI_{t-1}	0.05***	0.08***	0.03	0.27***	–0.02
$\Delta Demand_{t}$	1.59***	0.87***	1.00***	3.71***	1.48***
ΔTWI_{t}	0.27***	0.61***	0.27***	0.32**	0.09
$\Delta Demand_{t-1}$	0.65***	0.52**	0.22		0.69***
ΔTWI_{t-1}	0.14***		0.22***	0.14	0.19***
$\Delta Imports_{t-1}$			0.17*	–0.10	
$\Delta Demand_{t-2}$			0.61**		
SARS dummy[c]		–0.07**			
R^2	0.57	0.61	0.45	0.43	0.38

(a) *, ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels respectively for standard t-tests
(b) Model estimated from March 1986
(c) SARS (Severe Acute Respiratory Syndrome) dummy equals 1 in June 2003 (when the SARS virus epidemic started), –0.5 in September and December 2003, 0 otherwise
Sources: ABS; RBA

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The Household Cash Flow Channel of Monetary Policy

Helen Hughson, Gianni La Cava, Paul Ryan and Penelope Smith*

Changes in interest rates can affect household spending by directly affecting households' interest income and payments and, in turn, the amount of cash that households have available to spend. This is typically referred to as the 'household cash flow channel of monetary policy'. Household-level data provide evidence that the cash flow channel operates both for households that are net borrowers and for those that are net lenders, though the effect on borrowers is estimated to be much stronger than the effect on lenders. Overall, changes in household cash flow appear to be an important channel through which lower interest rates can stimulate greater household spending.

Introduction

Changes in monetary policy directly affect the household sector through several channels. Lower interest rates can encourage households to save less and bring forward consumption from the future to the present (the intertemporal substitution channel). Lower interest rates can also lift asset prices, such as housing prices, and the resulting increase in household wealth may encourage households to spend more (the wealth channel). Additionally, lower interest rates reduce the required repayments of borrowing households with variable-rate debt, resulting in higher cash flows and potentially more spending, particularly for households that are constrained by the amount of cash they have available. At the same time, lower interest rates can reduce the interest earnings of lending households, which may, in turn, lead to lower cash flows and less spending for these households. These last two channels together are typically referred to as 'the household cash flow channel'.

The household cash flow channel has been described in journal articles, speeches and public commentary. But, to date, there has been little research into it, either in Australia or overseas.[1] In this article, we outline some recent research into the cash flow channel in Australia.[2]

The analysis in this article focuses on a fairly narrow definition of the cash flow channel. It examines the direct effects of interest rates on interest income and expenses, but abstracts from monetary policy changes that have an *indirect* cash flow effect by influencing other sources of income, such as labour or business income.

It is important at the outset to define some concepts that will be used throughout the article. 'Interest-earning liquid assets' are defined as assets that have income streams that are directly tied to interest rates and that are easily convertible to cash. 'Interest-bearing debt' is debt that has a payment stream that is directly linked to interest rates and that matures relatively quickly. For households, interest-earning liquid assets comprise mainly of savings deposits, while interest-bearing debt mainly includes variable-rate mortgage debt. Using this

* The authors are from Economic Group.

1 The household cash flow channel is discussed in more detail in Hughson, La Cava and Kaplan (forthcoming).

2 The article provides an Australian perspective on the new and growing literature on the distributional effects of monetary policy (see also, Doepke, Schneider and Selezneva 2015; Auclert 2016; Broer *et al* 2016).

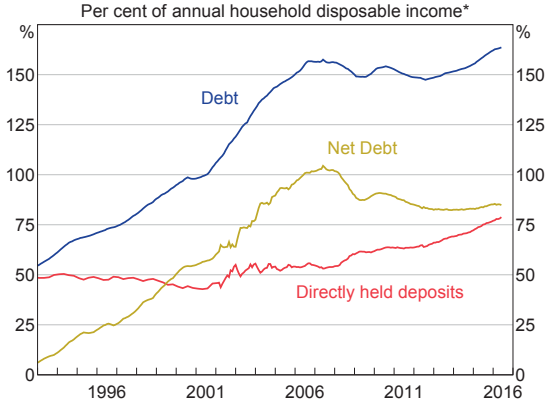
classification, a net 'borrower' is a household that holds more interest-bearing debt than interest-earning liquid assets. Similarly, a net 'lender' is a household that holds more interest-earning liquid assets than interest-bearing debt. The income flows that are associated with both interest-earning liquid assets and interest-bearing debt will be referred to as 'interest-sensitive cash flows'.

Broadly speaking, the household cash flow channel consists of three stages. First, changes in the cash rate are transmitted to changes in the lending and deposit rates faced by households. Second, changes in household lending and deposit rates flow through to changes in household disposable income by changing the required mortgage payments of borrowing households and the net interest earnings of lending households. Third, changes in cash flow potentially affect household spending, particularly for households that are constrained by the amount of available cash ('liquidity constrained'). This article focuses on the latter two stages; other recent Bank publications discuss how changes in the cash rate are transmitted to the interest rates faced by households (for example, Wilkins, Gardner and Chapman (2016)).

From Lending and Deposit Rates to Household Cash Flow

Household disposable income, or cash flow, comprises wages and salaries, property income (including interest paid on deposits) and transfers, less taxes and interest payments on debt. The household sector in Australia holds more interest-bearing debt than interest earning assets (Graph 1). Indeed, households have increased their debt holdings at a rapid pace since the early 1990s, mainly due to an increase in mortgage debt. For the household sector as a whole, the level of household debt now exceeds the level of directly held interest-earning deposits by a significant margin. However, since the mid 2000s, slower growth in household debt and increases in interest-earning deposit balances (including balances held in mortgage offset accounts) has led to a decline in net interest-

Graph 1
Interest-bearing Debt and Deposits
Per cent of annual household disposable income*



* Household sector excludes unincorporated enterprises; disposable income is before the deduction of interest payments

Sources: ABS; APRA; RBA

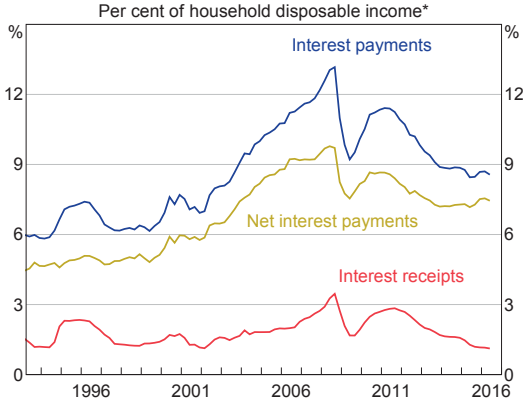
bearing debt.[3] This means that the household sector is a net payer of interest. Household net interest payments increased through the 1990s and early 2000s, mainly reflecting the rise in net household debt, but trended down from 2007 as interest rates and net debt declined (Graph 2).

The data shown above do not account for interest-earning assets held in managed superannuation accounts, which have increased substantially since the early 1990s. The majority of these assets cannot be accessed until retirement and, therefore, are likely to be of less importance for the household cash flow channel. Interest-earning deposits in retirement-phase superannuation accounts do provide an accessible cash flow; however, comprehensive data on these accounts are not available. Internal RBA estimates suggest that including these accounts would increase household interest-earning assets and interest income by 10 to 20 per cent but would otherwise not substantially affect the key results in this analysis.

Using the data on households' interest-earning deposits and interest-bearing debt, it is possible

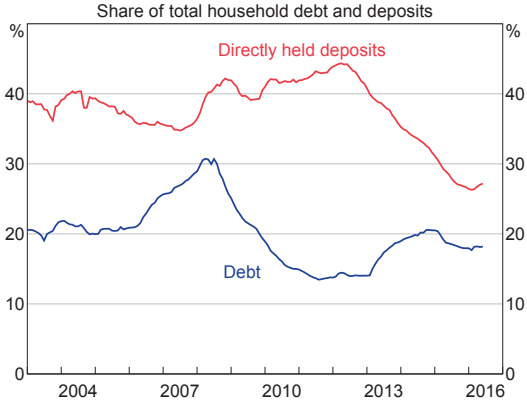
3 An offset account is a type of deposit account that is directly linked to a loan, such as a mortgage. Balances in offset accounts effectively reduce the borrower's net debt position and the interest payable on the loan. These accounts effectively 'earn' the rate of interest that otherwise would have been paid on the loan (Reserve Bank of Australia 2015).

Graph 2
Interest Payments and Receipts
Per cent of household disposable income*



* Household sector excludes unincorporated enterprises; disposable income is before the deduction of interest payments
Sources: ABS; APRA; RBA

Graph 3
Fixed-rate Share of Debt and Deposits
Share of total household debt and deposits

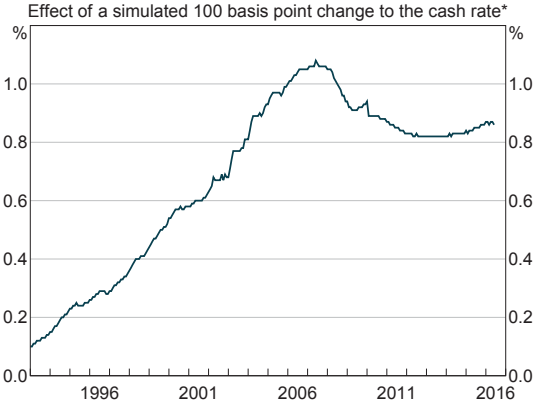


Sources: APRA; RBA

to construct an estimate of the direct effect of a cash rate change on aggregate household cash flows. For this estimate, the cash rate change is assumed to be fully reflected in the variable interest rates that households receive and pay on their deposits and debt. Such a change would usually occur within a month. However, the estimates also need to account for the time it takes for interest rate changes to pass through to fixed-rate products. Australian households have a relatively low share of fixed-rate debt compared with most other advanced economies; less than 20 per cent of mortgages are currently at fixed rates, which is around its long-run average (Graph 3).[4] On the asset side of the household balance sheet, around one-quarter of deposits are term deposits. However, more than three-quarters of the outstanding balance of these term deposits are currently estimated to mature within six months, so changes in the cash rate are passed through to interest rates on these products fairly quickly.

If changes in the cash rate are eventually fully reflected in the interest rates households receive and pay on their deposits and debt, lowering the cash rate reduces households' overall net interest expenses and raises aggregate disposable income by around 0.9 percentage points (Graph 4).[5] Compared with the early 1990s, aggregate household disposable income is estimated to have become more sensitive to cash rate changes owing to the large increase in directly held net interest-bearing debt; however, this sensitivity is estimated to have declined since the mid 2000s, reflecting the overall decline in net interest-bearing debt as a share of household disposible income.

Graph 4
Household Disposable Income
Effect of a simulated 100 basis point change to the cash rate*



* Per cent of annual household disposable income before the deduction of interest payments, excludes unincorporated enterprises; full pass-through is assumed
Sources: ABS; APRA; RBA

4 In the United Kingdom this share is close to half, and in Canada and the United States almost all mortgages have fixed interest rates.

5 Adjusting this analysis to account for an estimate of deposits held by retirees in superannuation would reduce the net cash flow effect by around 20 per cent (or about 16 basis points) in 2016.

From Household Cash Flow to Spending

As noted, for the household sector as a whole, the level of interest-bearing debt exceeds the level of interest-earning assets, so lowering the cash rate adds to household cash flow through lower net interest expenses. However, estimating the importance of the cash flow channel for overall household consumption requires disaggregate (household-level) analysis, rather than aggregate analysis, because of the relative strength of the 'borrower' and 'lender' channels. The relative strength of the two channels for household spending depends on several factors including:

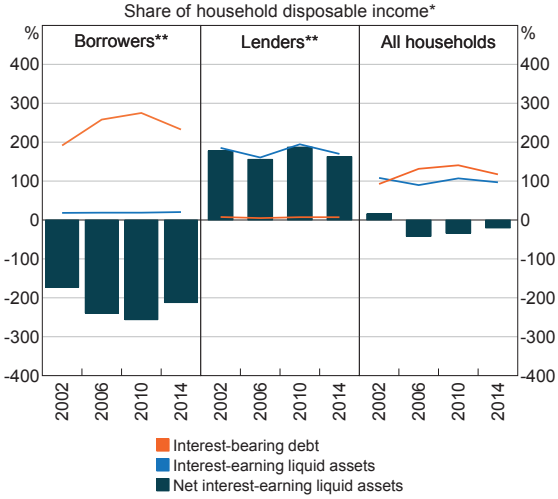
- differences in the sizes of the borrower and lender groups
- differences between borrowers and lenders in the average holdings of net liquid assets and debt
- differences between borrowers and lenders in their propensities to consume out of cash flow.

Household-level information on the distribution of expenditure, cash flow and wealth is available in the HILDA Survey. This household-level longitudinal study, with information collected annually since 2001, tracks individuals over time and provides detailed information on various household characteristics.[6] The decomposition of the average household balance sheet into interest-earning liquid assets and interest-bearing debt is shown in Table 1.

As Table 1 highlights, the distributions of interest-earning liquid assets and interest-bearing debt are skewed. In particular, the mean household has more interest-bearing debt than interest-earning liquid assets, while the opposite is true for the median household. On average, most liquid assets are held in the form of bank deposits, while interest-bearing debt is primarily variable-rate mortgage debt.

The HILDA Survey indicates that the population is fairly evenly split between net borrowers and lenders. While there are roughly the same number of borrowers and lenders in the economy, on average, borrowers hold two to three times as much net debt as lenders hold in net liquid assets (Graph 5).

Graph 5
Net Interest-earning Assets
Share of household disposable income*



* Disposable income is before the deduction of interest payments
** Borrowers (lenders) are households with negative (positive) net interest-earning assets

Sources: HILDA Survey Release 14.0; RBA

Table 2 summarises the characteristics of net borrowers and lenders. Borrowers and lenders mainly differ because of their positions in the lifecycle: the average borrower is younger, earns more income and is twice as likely to be in the workforce as the average lender. The average borrowing household is also typically larger, less wealthy and more educated than the average lending household.

The influence of the life cycle for borrowers and lenders is also shown by the way in which the composition of wealth varies with the age of the household head (or 'reference person').[7] Interest-

6 The HILDA Survey provides detailed information on the wealth holdings of Australian households at four-year intervals (in 2002, 2006, 2010 and 2014).

7 The head of each surveyed household is determined by applying the following criteria, in order, until a unique person is selected. These criteria are: in a registered or defacto marriage (and still living together); a lone parent; the person with the highest income; the eldest person.

Table 1: Assets and Debt per Household
2014

	Assets Mean $'000	Median[(a)] $'000	Share of mean assets Per cent
Bank deposits	51.0	11.0	5.6
Cash investments (e.g. bonds)	2.1	0.0	0.2
Total interest-earning liquid assets	53.1	12.0	5.8
Housing assets	530.0	393.8	58.0
Superannuation	185.7	65.0	20.3
Other assets (e.g. equities, vehicles)	145.6	25.5	15.9
Total assets	**914.3**	**579.0**	**100.0**
	Debt Mean $'000	**Median $'000**	**Share of mean debt Per cent**
Variable-rate housing debt	114.1	0.0	65.8
Variable-rate personal debt[(b)]	8.4	0.0	4.9
Variable-rate business debt[(b)]	6.0	0.0	3.5
Total interest-bearing debt	128.6	5.0	74.1
Fixed-rate housing debt	28.5	0.0	16.4
Fixed-rate personal debt[(b)]	6.9	0.0	4.0
Fixed-rate business debt[(b)]	3.2	0.0	1.9
Credit cards	1.7	0.0	1.0
Other debt (e.g. student debt)	4.6	0.0	2.7
Total debt	**173.5**	**22.0**	**100.0**

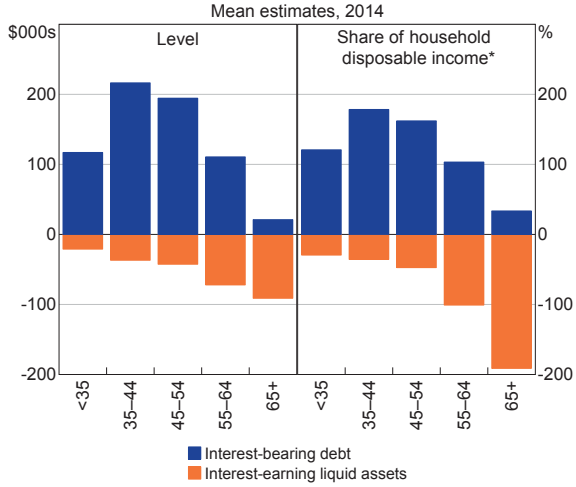
(a) Median estimates do not sum to totals
(b) The HILDA Survey provides direct estimates of the share of housing debt at fixed and variable interest rates but the shares for personal debt and business debt are approximated using banking data, which indicate that around 55 per cent of personal lending and 65 per cent of small business lending is at variable interest rates
Sources: HILDA Survey Release 14.0; RBA

earning liquid assets make up a greater share of net wealth for older households (aged 55 years and above), while middle-aged households hold higher levels of interest-bearing debt (Graph 6).

To estimate how responsive consumption is to cash flow changes for borrowers and lenders a household-level consumption model is used to control for various household-level characteristics.[8]

This model provides an estimate of the marginal propensity to consume (MPC) durable goods (for example, cars, computers and audio-visual equipment) from cash flow for borrowers and lenders. Expenditure on durable goods is typically more discretionary and sensitive to changes in

Graph 6
Net Interest-bearing Debt by Age of Household Head
Mean estimates, 2014



* Disposable income is before the deduction of interest payments
Sources: HILDA Survey Release 14.0; RBA

8 The model is similar to those used extensively in the consumption literature. See, for example, Jappelli and Pistaferri (2010).

Table 2: Summary Statistics[(a)]
Mean estimates, 2002 to 2014

	Borrowers	Lenders
Durables consumption ($'000)	11.2	7.4
Total consumption ($'000)	45.6	26.9
Cash flow ($'000)	87.8	68.3
Interest-earning liquid assets ($'000)	17.6	68.7
Interest-bearing debt ($'000)	214.7	4.7
Net interest-earning liquid assets ($'000)	–197.1	64.1
Net total wealth ($'000)	673.9	721.6
Age of household head (years)	43.0	55.7
Household size (persons)	3.0	2.2
Share that are home owners (%)	75.9	57.8
Share that are mortgagors (%)	66.3	4.5
Share that is employed (%)	81.3	45.2
Share that is tertiary educated (%)	27.4	19.2
Observations	15 066	15 806

(a) All variables in dollar amounts are deflated by the consumer price index to express them in 2014 dollars; all estimates are based on HILDA wealth module years (i.e. 2002, 2006, 2010, 2014)
Sources: HILDA Survey Release 14.0; RBA

interest rates than expenditure on non-durable goods and services.[9] The HILDA Survey collected information on durable goods expenditure only between 2006 and 2010 so attention is focused on this sample period. While the sample period is relatively short, it does span the global financial crisis period and hence captures some important cyclical fluctuations in interest rates, income and spending.

The focus of the model is on the components of household cash flow that are directly sensitive to interest rates (required mortgage payments and income earned directly on bank deposits).[10] These cash flows are distinguished from the remainder of total cash flow ('other cash flow', which includes wages, business income, pensions, taxes etc).[11]

The regression model relates the level of consumption of household i in year t (C_{it}) to interest sensitive cash flow $\left(Y_{it}^{ICF}\right)$ and other cash flow $\left(Y_{it}^{OCF}\right)$. The model is estimated separately for lenders ($j = L$) and borrowers ($j = B$) to examine any differences in the MPC out of cash flow. The model is specified as:

$$\ln\left(C_{it}\right) = \beta_{ICF}^{j}\ln\left(Y_{it}^{ICF}\right) + \beta_{OCF}^{j}\ln\left(Y_{it}^{OCF}\right) + \gamma^{j}CONTROLS_{it} + \theta_{i} + \varepsilon_{it}^{j} \quad (1)$$

9 Hughson *et al* (forthcoming) find little evidence that expenditure on non-durable goods and services is responsive to interest-sensitive cash flow.

10 For retirees that receive superannuation income in the form of a pension, some fraction of that income reflects changes in interest rates on their indirect holdings of bank deposits. The key results on the aggregate cash flow channel are little affected if such indirect interest flows are included in the household-level estimates of interest-sensitive cash flow.

11 Each cash flow is available in the HILDA Survey except required mortgage repayments, which were not collected until 2014. Annual required repayments are estimated using a credit foncier model, which requires information on the loan interest rate, the number of years remaining on the mortgage and the loan size at origination. Information on loan size at origination and the age of the mortgage is available in the survey in the wealth modules. For the loan interest rate, separate estimates for variable and fixed-rate owner-occupier mortgage debt are constructed using the average annual interest rates on each type of debt at the time of origination. A standard 30-year term for each mortgage is assumed. The interest rate is assumed to be equal to the average advertised interest rate on new mortgage loans.

The model includes a set of variables that theory suggests are important determinants of household spending. These 'control' variables ($CONTROLS_{it}$) include demographic characteristics (such as age of the household head), labour market characteristics (such as whether the household head is employed) and housing characteristics (such as whether the household has recently moved or refinanced its mortgage). Importantly, the models include an estimate of home equity for each owner-occupier household, which should account for the effects of monetary policy on household spending via the (housing) wealth channel.

The model also controls for household-level characteristics that affect household spending but are difficult for econometricians to observe and which, presumably, do not vary with time, such as a household's degree of impatience or its appetite for risk. These characteristics are captured by the household 'fixed effect' (θ_i). This should capture, to some extent, the effects of monetary policy on household spending via the intertemporal substitution channel.

The results are consistent with the presence of both borrower and lender cash flow channels (Table 3). We present the elasticities of consumption with respect to cash flow estimated by the model and calculate MPCs (that is, the dollar change in spending as a result of a dollar change in cash flow) by multiplying these elasticities by the mean ratio of spending to cash flow for borrowers and lenders. For borrowers, lowering required mortgage payments is associated with more durable goods spending (column 1). The estimated MPCs indicate that lowering required mortgage payments by one dollar is associated with durables spending rising by over 20 cents, on average. For lenders, the MPCs indicate that an extra dollar of interest income is associated with durables spending rising by around 4 cents, on average (column 2).

The estimated MPC is five times larger for borrowers than for lenders, indicating that, for a given dollar change in cash flow, the borrower cash flow channel is a stronger channel of monetary transmission. On top of this, borrowers typically hold more net debt, on average, than lenders hold in net liquid assets so a given change in interest rates leads to a much larger change in cash flow for borrowers than for lenders. Given the shares of borrowers and lenders in the economy, back-of-the-envelope calculations suggest that lowering interest rates by 100 basis points would be associated with the level of aggregate household consumption rising by 0.1 to 0.2 per cent. By way of comparison,

Table 3: Consumption Response to Cash Flow[(a)]

Sample period: 2006 to 2010	All households		Liquidity constrained households	
Key variables	Borrowers	Lenders	Borrowers	Lenders
Interest-sensitive cash flow elasticity	–0.40**	0.02*	–0.50**	0.03
	(–2.53)	(1.79)	(–2.18)	(1.27)
MPC	**–0.21**	**0.04**	**–0.23**	**0.23**
Other cash flow elasticity	0.40***	0.35***	0.73***	0.40**
	(3.08)	(5.07)	(3.63)	(2.54)
MPC	**0.04**	**0.04**	**0.07**	**0.03**
R^2	0.52	0.64	0.53	0.60
Within R^2	0.01	0.01	0.02	0.01
Observations	5 186	12 165	2 204	3 288

(a) ***, ** and * denote statistical significance at the 1, 5 and 10 per cent levels, respectively; t statistics shown in parentheses; standard errors are clustered by household; estimated coefficients on control variables are omitted

Sources: HILDA Survey Release 14.0; RBA

this is within the range of estimates produced by a number of macroeconomic models that assess the effect of an exogenous change in the cash rate on household consumption in Australia, including through other channels and second round effects.[12] Overall, our results suggest that the cash flow channel is an important channel of monetary policy transmission to household consumption in Australia.

The model is also estimated on the sub-sample of households that are identified as being liquidity constrained (or 'hand-to-mouth'), following the framework outlined in Kaplan, Violante and Weidner (2014). In effect, liquidity constrained households are those that have liquid wealth that is low relative to income and therefore tend not to save from their current income. In theory, if there is a cash flow channel, the effect of cash flow on household spending should be strongest for households that are liquidity constrained because their consumption is more likely to be limited by their current income. The results are reported in Table 3.

The estimated MPCs are slightly higher for liquidity constrained households than for other households (columns 3 and 4). This is consistent with the existence of a cash flow channel of monetary policy. Somewhat surprisingly, the estimated MPC for liquidity constrained lenders is about the same as for liquidity constrained borrowers.[13] However, in aggregate, the borrower cash flow channel is still a lot stronger than the lender channel. This is because the average liquidity constrained borrower holds over 20 times more net debt than the average liquidity constrained lender holds in net liquid assets.

12 See, for example, Jääskelä and Nimark (2011), Lawson and Rees (2008) and Rees, Smith and Hall (2016).

13 The concept of a liquidity constrained lending household is a bit unusual in the context of standard consumption theory. It may be the case that households have 'mental accounts' for saving and only consume out of certain types of cash flow (such as interest earnings) (Laibson 1997).

Conclusion

This article finds evidence for both the borrower and lender cash flow channels, but the borrower channel is estimated to be the stronger channel of monetary transmission. One reason for this is that while there are roughly similar shares of borrower and lender households in the Australian economy, the average borrower holds two to three times as much net debt as the average lender holds in net liquid assets. Another reason is that the sensitivity of spending to changes in interest-sensitive cash flow is estimated to be larger for borrowers than for lenders based on statistical analysis using household-level data.

Overall, the estimates suggest that the cash flow channel is an important channel of monetary transmission; the central estimates indicate that lowering the cash rate by 100 basis points is associated with an increase in aggregate household income of around 0.9 per cent, which would, in turn, increase household expenditure by about 0.1 to 0.2 per cent through the cash flow channel.

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Chinese Household Income, Consumption and Savings

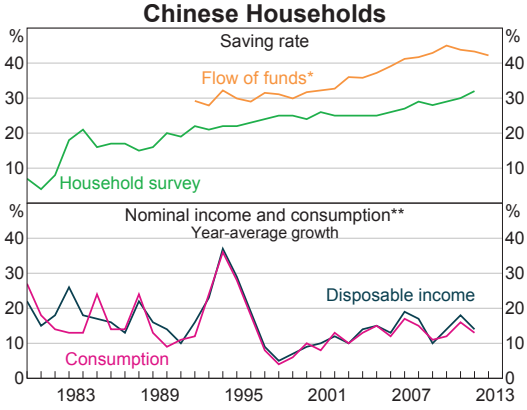
Kate Stratford and Arianna Cowling*

Household income and spending in China have grown rapidly over the past few decades, and income inequality has also risen. The various measures of China's aggregate household saving rate have all increased since the 1990s, and variation in saving behaviour by income group suggests that increasing the income of poorer households in particular would boost aggregate consumption. Changes in Chinese household consumption patterns as incomes rise have the potential to lead to higher imports of services and food from Australia in the long run. However, uncertainty around the outlook for growth of Chinese household income, consumption and saving is increasing as economic growth moderates in China.

Introduction

China has experienced rapid growth in household income over recent decades. This has been accompanied by both strong consumption growth and a large rise in the saving rate (Graph 1).[1] The increase in household income has not been evenly spread, however, and income inequality has risen significantly. This article discusses why income inequality has increased and some of the possible implications, with a focus on differences in saving and consumption behaviour across the income distribution. Measures of China's aggregate household saving rate are discussed, and reasons for the increase in these measures over the 1990s and 2000s are outlined. We also examine the changing trends in consumer spending and the effect these might have on Chinese demand for Australian exports.

Graph 1
Chinese Households



* Adjusted for acquisition less disposal of other financial assets
** From urban and rural household surveys
Sources: CEIC Data; NBS; RBA

Income Distribution

Income is a key determinant of households' consumption and saving behaviour. If households' propensities to consume and save vary with income, then aggregate consumption and saving at any point in time will depend on the distribution of household income. In addition, changes in the distribution of household income over time will affect the growth rates of aggregate consumption

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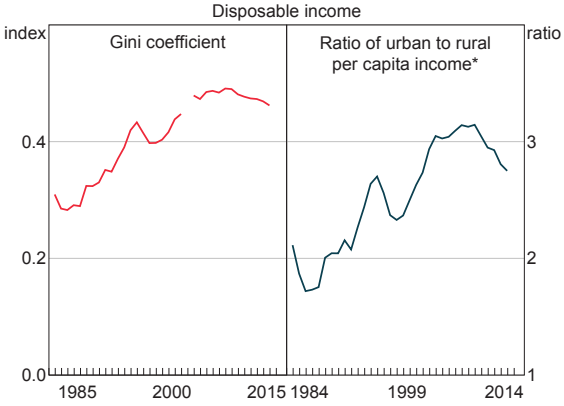
1 China's household saving rate can be calculated using data from household surveys or from flow-of-funds statistics. These are discussed later in this article.

and saving, relative to what they might have been had the distribution of income remained unchanged.

Over the past two decades, real household incomes in China have averaged annual growth of 10 per cent, but this rapid growth has been accompanied by a notable rise in income inequality. In China, the Gini coefficient – a commonly used measure of income inequality – rose from a relatively low level of around 0.3 in the early 1980s to 0.5 in the mid 2000s (Graph 2).[2] Since 2009, China's Gini coefficient has declined a little, but it remains in the top quintile worldwide.[3] The rise in inequality has not reflected a stagnation of incomes for the poorest households, but has instead been due to wealthier households seeing even stronger income growth. Rural incomes have grown strongly through most of the period since the 1990s, as have incomes of poorer households in urban areas. The World Bank has estimated that the proportion of Chinese living in poverty declined from 67 per cent in 1990 to 11 per cent in 2010.[4]

Graph 2
China – Income Inequality
Disposable income



* Rural disposable income spliced with net income before 2013
Sources: CEIC Data; RBA

One of the key reasons cited for the rise in national measures of income inequality in China since the 1980s is a widening of the urban-rural income gap. The World Bank estimates that this income divide explained around 40 per cent of overall income inequality in the early 2000s and around half of the increase in inequality between 1985 and 1995 (Park 2008). In the mid 1980s, average urban disposable income was less than twice rural income; by 2010 that ratio had increased to more than three times (Graph 2). The gap between average urban and rural incomes has fallen in recent years but remains high.

The wide urban-rural income gap is partly a consequence of the household registration (*hukou*) system, which has hindered the free movement of labour and limited the access of rural migrants to urban areas to certain employment opportunities, education for their children, healthcare and social security. Over the course of China's industrialisation, urban areas became more prosperous than rural areas as higher productivity growth in secondary industries (relative to agriculture) meant that urban incomes grew faster (Kuijs and Wang 2005). While rural workers might be expected to move to urban areas with higher wages, the *hukou* system created disincentives for internal migration and has thus restricted the closure of the income gap.[5]

Government transfers play a role in redistributing income from urban to rural households, but so far these have made a relatively modest contribution to reducing the income gap, notwithstanding

2 The Gini coefficient is a commonly used measure of inequality, which takes a value between zero and one, where zero represents complete equality and one represents complete inequality. For 1981 to 2001, we show estimates from Ravallion and Chen (2007), who use unpublished household income distribution tabulations from the National Bureau of Statistics of China (NBS) to construct an estimate of the Gini coefficient. For 2003 onwards, we use Gini coefficients published by the NBS; these are based on disposable income. All estimates are ultimately sourced from data collected by NBS household surveys.

3 These figures are based on World Bank estimates of Gini coefficients by country. By way of comparison, the estimated Gini coefficients for Australia, the United States and India are 0.35, 0.41 and 0.34, respectively.

4 The World Bank defines the poverty ratio as the percentage of the population living on less than US$1.90 a day in 2011 prices.

5 The *hukou* system was introduced in the late 1950s to regulate population movements and, in particular, to control movement between rural and urban areas. Since the start of the reform era, restrictions on physical movement have been eased substantially, but a range of social welfare benefits continue to be attached to a household's formal residence status.

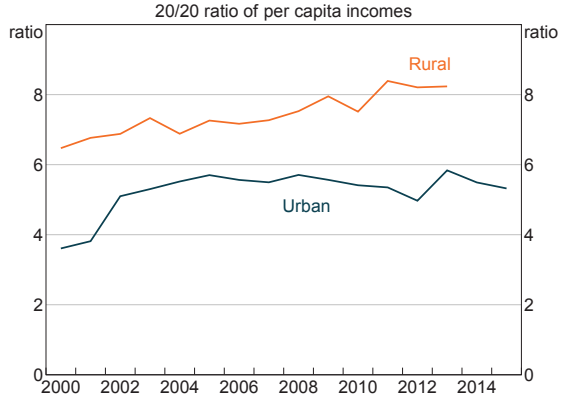
policy initiatives over the past decade.[6] For both urban and rural households, net government transfers – which include income from welfare payments and pensions, less income tax and social security contributions – make up almost one-fifth of disposable income. Even so, the income differential between urban and rural households is such that there is still a large disparity in the *level* of net transfers. In recent years, on a per capita basis urban households have received more than 2½ times the amount in net transfers than rural households. As a result, the ratio of average urban to rural household income is not much changed after accounting for net government transfer payments.

There is also a large geographical variation in Chinese household income, resulting from development policies that favoured coastal regions in the early stages of reform in an attempt to attract foreign investment (Zheng and Chen 2007; Xie and Zhou 2014). As a result, households in coastal regions tend to earn more than those living inland, even after controlling for urban/rural differences.

Even within urban and rural areas, there is a large dispersion of incomes (Graph 3). In 2013, on average, urban households in the highest income quintile earned almost six times more than households in the bottom income quintile. In rural areas, this figure was eight times. As might be expected, much of the variation in income depends on education levels. For example, results from the 2010 China Household Finance Survey (CHFS) suggested that in urban areas, individuals with a bachelor's degree or a higher qualification earned almost four times more than people who had only finished high school, and six times more than people who had only finished primary school or below (Gan 2013). In rural areas, those with a bachelor's degree or a higher qualification earned six times more than those who had only finished high school, and eleven times more than people who had only finished primary school or below.

6 As Wong (2013) notes, the *San Nong* ('three rurals') policies of the Hu Jintao–Wen Jiabao administration resulted in a large injection of fiscal resources into rural services, social security and income support schemes.

Graph 3
China – Income Inequality*
20/20 ratio of per capita incomes



* Ratio of average income for the top household income quintile to average income in the bottom household income quintile; for urban households, disposable income is used; for rural households, net income

Sources: CEIC Data; RBA

Saving Behaviour

To the extent that the propensity for households to save varies across the income distribution, income inequality also has implications for the level of, and changes in, aggregate saving. China's aggregate household saving rate appears to have risen notably over the past few decades. However, due to measurement challenges, there is some uncertainty about its precise level. One way to estimate the household saving rate is to use the flow-of-funds accounts, which are consistent with the national accounts on an income and expenditure basis. An alternative is to use data from the National Bureau of Statistics of China's (NBS) urban and rural household surveys. The two data sources measure income and consumption differently and both have potential sources of bias in the estimated saving rate. For example, the urban component of the household survey does not adequately sample rural–urban migrant workers even though they make up a considerable share of the urban population; to the extent that their income and consumption patterns differ from other urban households, the survey-based saving rate could be biased upward or

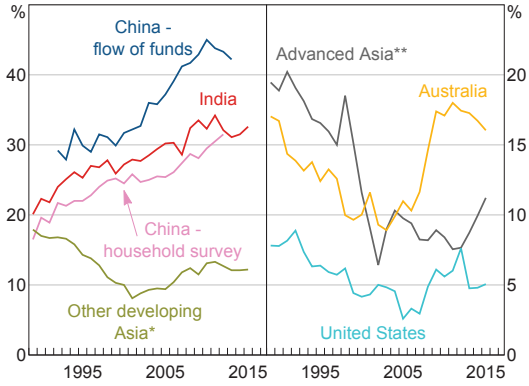
downward.[7] In the flow-of-funds data, imputed rent is reportedly understated (Ma and Yi 2010; Koen *et al* 2013). Although including imputed rent will, all else being equal, reduce the estimated saving rate for owner-occupier households, understating imputed rent will result in a higher estimated saving rate than if imputed rent were measured correctly.

There has been a consistent difference in the levels of the two estimated aggregate saving rates over time. This is because estimated aggregate household consumption and income are both lower according to the household survey data, but income is lower by a greater margin, so the implied aggregate saving rate is lower. The flow-of-funds saving measure has also grown a little faster, reflecting slightly higher growth of household income than for the household survey measure. In contrast, although the levels of the consumption measures vary, their growth rates have been quite similar. Despite the differences between the two aggregate saving rate estimates, they both display a rising trend through the 1990s and 2000s, and both measures suggest that the household saving rate in China is high relative to other emerging or advanced economies (Graph 4).[8] China's high and rising household saving rate helped to support the strong growth of investment during the 1990s and 2000s (Ma, Roberts and Kelly 2016).

China's household saving rate has been studied extensively in the academic literature. There are a range of explanations for why it has been so high and rose over the 1990s and 2000s, including:

- *Precautionary motives* resulting from the income and employment uncertainty brought about by the transition to a more market-based economy, pension reform, the weakening of the social safety net, and a rising private burden of health and education expenses (Chamon, Liu and Prasad 2010; Meng 2003; Chamon and Prasad 2010; Blanchard and Giavazzi 2005; Ma and Yi 2010)
- Changes in China's *demographic structure in combination with the life-cycle hypothesis*. This may have increased household saving through the effects of 'fewer mouths to feed' (as the dependency ratio began to decline in the late 1970s) and the need for people to save for their old age (Modigliani and Cao 2004). China's one-child policy, a birthcontrol policy that encouraged couples to have one child only, influenced not only the dependency ratio, but also limited the role that family support could provide in old age, which could have encouraged saving by individuals
- *Increases in the sex-ratio imbalance* leading families with male children to increase savings to improve their son's chances in the face of rising competition in the marriage market (Wei and Zhang 2011)
- A *desire to own housing* (Blanchard and Giavazzi 2005; Chamon and Prasad 2010), as well as the strong increase in housing prices since the

Graph 4
Household Saving Rates
Gross saving rate



* Indonesia, Malaysia, Philippines, Thailand
** South Korea, Singapore, Taiwan
Sources: CEIC Data; NBS; RBA; Thomson Reuters

7 It has also been claimed that there are various measurement problems with the NBS survey measures of household income and consumption. For example, Wang and Woo (2011) claim that wealthier households tend to under-report income. It has also been noted that the household survey consumption measure does not distinguish between current and capital expenditures, and so over-reports consumption (Kraay 2000). It is difficult to determine the net effect of these measurement issues on the household survey-based estimate of the aggregate saving rate.

8 The household saving rate shown here for Australia is the gross saving rate rather than the net saving rate typically cited. The net saving rate adjusts for the consumption of fixed capital.

development of the private property market began (Ha 2006).

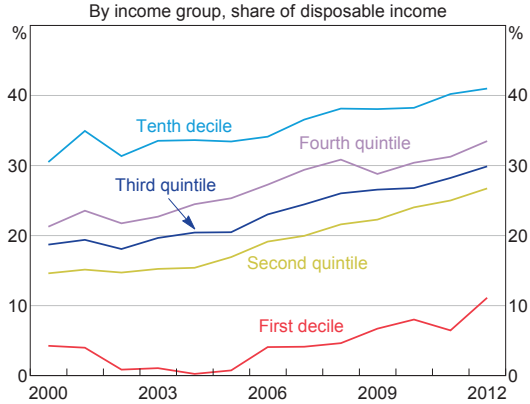
Despite the high aggregate household saving rate, there are notable variations in household saving behaviour by income level, with strong evidence that households' average propensity to save increases with income. All else being equal, this would suggest that the uneven distribution of the growth in household income may have also contributed to higher aggregate saving than otherwise. Cross-sectional urban household-level data from the 2000s suggest that there is a positive relationship between income and whether a household saves, and that some poorer households may have insufficient income to save. For example, a survey undertaken by the NBS in 2009 indicated that around 35 per cent of urban households in the lowest income decile did not save at all, while only 10 per cent of households in the top four income deciles did not save at all. In a separate survey, Gan (2013) found that almost half of Chinese households did not save at all in 2010.[9]

There is also considerable variation in the saving *rate* by income level, with higher-income households saving a greater proportion of their income (Graph 5). This pattern has persisted since the mid 1980s. The data suggest that wealthier rural households also save significantly more than their poorer rural counterparts. Despite these differences, all urban household income groups saw a rise in saving rates over the 2000s, and the share of urban households not saving declined from 23 per cent in 2002 to 16 per cent in 2009. The share of households with zero or negative saving rates is likely to continue to fall to the extent that real incomes continue to rise, particularly if some of those poorer households are currently liquidity constrained.

The heterogeneity in households' propensity to save suggests that, all else equal, a higher level of inequality in household income would reduce aggregate consumption more than otherwise

9 This result was based on household-level data from the CHFS, which covers both urban and rural households.

Graph 5
China – Urban Household Saving Rates
By income group, share of disposable income



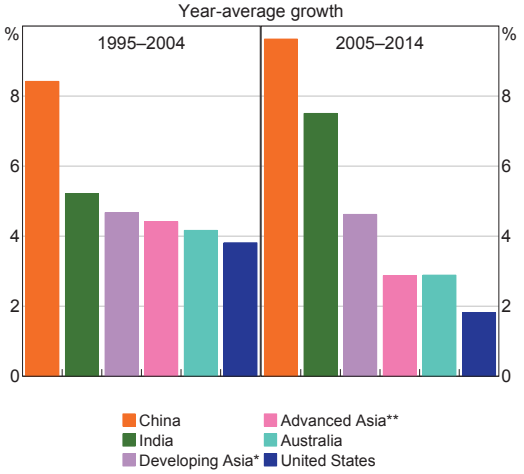
Sources: CEIC Data; RBA

(Gan 2013). In other words, the variation in saving behaviour also suggests that increasing the income of poorer households would have a positive effect on aggregate consumption and assist in the process of rebalancing to a domestic consumption-driven economy, as liquidity-constrained households would be likely to use at least some of the extra income to consume more (Gan 2013).

Changing Consumption Patterns

In addition to the distribution of household income affecting the level of aggregate consumption, it can also affect the composition of aggregate consumption. Notwithstanding the increase in China's aggregate saving rate over the past two decades, growth of real household consumption has still been persistently strong, averaging 9 per cent per annum. This pace of growth is very rapid compared with other economies. Since 1995, Chinese consumption growth has been, on average, nearly 2.5 percentage points higher than in India, 4.5 percentage points above that in other developing Asian economies and stronger still than in advanced economies (Graph 6). Even with this impressive growth, consumer spending per person in China remains low relative to many other economies, including economies with similar incomes per capita. Consumption per capita is only just over half the world average and less than one-fifth of that in

Graph 6
Real Household Consumption
Year-average growth



* Indonesia, Malaysia, Philippines and Thailand
** Hong Kong, Singapore, South Korea and Taiwan
Sources: IMF; Thomson Reuters

Australia on a purchasing power parity basis (which accounts for differences in local living costs).

Growth in all types of consumer goods and services has contributed to the growth of Chinese household consumption in recent decades (Table 1). The composition of household spending, however, has changed significantly. In particular, the share of average household expenditure on food has declined from almost 60 per cent of total household consumption in the early 1980s to 30 per cent in 2015, and higher-income households spend a smaller share of expenditure on food than lower-income households (Table 2). Both of these observations are consistent with Engel's Law, which states that as income increases, the share of expenditure on food declines. Despite a decline in the share of food in total household expenditure, per capita food consumption and households' spending on food have been rising over time. Moreover, food consumption has shifted away from staples towards more protein-rich foods, such as dairy and meat (Graph 7).

Coinciding with these changes in the typical household consumption basket, transport and communication now account for a larger share of household spending, especially for higher-income households (Table 2).[10] Education and recreation and medical expenditures have also grown in importance. As higher-income households spend a greater share of their consumption basket on these more services-intensive expenditure categories, it is possible that increasing income inequality has

Table 1: Chinese Urban Household Consumption[(a)]

	Component share, per cent		Average annual growth, per cent	
	1993	2012	1993–2002	2003–12
Food[(b)]	50.1	36.2	7.8	12.4
Housing and household goods	15.4	15.6	8.6	11.8
Clothing	14.2	10.9	25.2	9.3
Recreation, education and culture	9.2	12.2	25.6	14.6
Transport and communication	3.8	14.7	18.6	9.0
Other	7.2	10.3	18.1	8.7
Total	**100**	**100**	**8.9**	**10.7**

(a) Nominal consumption per capita
(b) Includes tobacco and liquor
Sources: CEIC Data; RBA

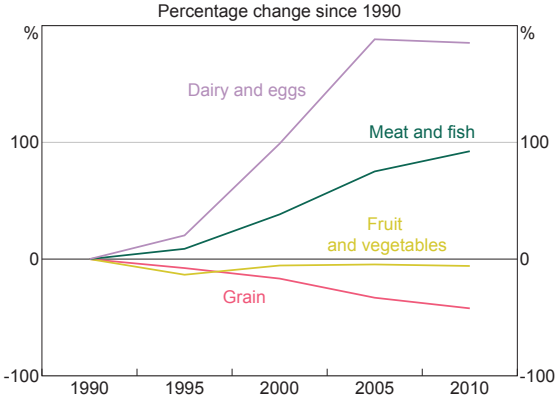
10 By way of comparison, in 2011 around one-quarter of Australian household spending was on food, tobacco and alcohol, around 15 per cent was on transport and communication, around 16 per cent on recreation, culture and education, and 4 per cent on clothing and footwear.

Table 2: 2012 Chinese Urban Household Consumption Shares
Per cent, by income group[a]

	Low-income	Lower-middle-income	Middle-income	Upper-middle-income	High-income
Food[b]	43.2	40.9	38.6	35.8	33.2
Housing and household goods	10.9	11.5	11.2	11.2	10.7
Clothing	5.9	6.2	6.6	6.8	7.1
Recreation, education and culture	7.0	6.8	7.0	6.3	6.1
Transport and communication	9.9	11.3	13.1	14.9	16.7
Other	10.8	10.8	11.4	12.4	13.3
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

(a) Low-income corresponds to the second income decile; lower-middle-income, middle-income and upper-middle-income to the second, third and fourth income quintiles; high-income corresponds to eighth decile
(b) Includes tobacco and liquor
Sources: CEIC Data; RBA

Graph 7
China – Per Capita Food Consumption*
Percentage change since 1990



* Percentage change in kilograms of consumption per capita
Sources: NBS; RBA

provided some support to growth in aggregate consumption of these categories. As average incomes rise further, the share of expenditure on services is likely to continue to increase further.

Implications for China-Australia Bilateral Trade

Continued growth in Chinese household consumption will benefit economies that export to China, including Australia. The growth in Chinese household spending on services is already apparent in the rapid growth of imports of travel services from Australia (Table 3). Indeed, much of the growth in visitor arrivals to Australia in recent years has

Table 3: Australian (Nominal) Exports to China[a]

	2003	2013	Average annual growth 2003–13
	$m	$m	Per cent
Merchandise	9 089 (81)	94 344 (93)	26
Iron ore and concentrates	1 739 (16)	52 653 (52)	41
Coal, coke and briquettes	243 (2)	9 086 (9)	44
Food and live animals	488 (4)	3 145 (3)	20
Services	2 068 (19)	7 064 (7)	13
Travel	1 733 (16)	6 208 (6)	14
Total	**11 157 (100)**	**101 408 (100)**	**25**

(a) Percentage shares of annual total in brackets
Sources: ABS; RBA

been driven by Chinese travellers and students. This is a trend that is likely to continue as the Chinese middle class grows (Dobson and Hooper 2015; RBA 2016).

While China is a net exporter of food, the trade surplus in food has narrowed significantly over the past five years and China has become a net importer of meat and dairy products. Further increases in the demand for food by China are likely to put pressure on domestic supply and could lead to further increases in imports. Australian exports of food to China have grown rapidly over the past few years. This growth has been driven by exports of cereals, meat and meat products. The gradual transition to higher meat consumption in China should support imports of meat, live animals and animal feed. Ongoing concerns around domestic food safety standards are also likely to contribute to demand for higher-value food imports such as dairy and organic produce (McCarthy, Liu and Chen 2015; Roberts *et al* 2016; FT Confidential 2016).

However, services and food account for only a small share of total exports from Australia to China. Even if growth of Australian services and food exports to China were to continue at the pace of the previous decade, it would take 13 years for the value of those exports to rise to the current combined value of iron ore and coal exports to China.[11] Moreover, in an environment of slowing economic growth in China, it is uncertain whether the levels of growth in Australia's services and food exports to China seen in the past decade can be maintained. Australia is also likely to have to compete more aggressively for Chinese imports of services and food. In the absence of a large-scale reorientation of bilateral trade patterns, the impact of any rebalancing in China from investment-driven to consumption-driven growth is, on balance, likely to be negative for demand for Australian exports, as Chinese investment is more import-intensive than consumption (Kelly 2014; Ma *et al* 2016).

Conclusion

Although Chinese household income and consumption have grown at a rapid pace in recent years, alongside a marked increase household saving rates, the outlook is uncertain. Household income growth is likely to slow alongside a general decline in the growth of Chinese economic activity, while the evolution of income inequality depends, at least in part, on the progress of *hukou*, social security and pension reforms. Although some progress has been made on these fronts, it is likely to take time before the rural–urban income gap narrows. To the extent that households' propensities to save and consume differ across the income distribution, reductions in income inequality could have implications for aggregate saving and consumption.

Precautionary motives for saving are likely to remain important in an environment of economic uncertainty. Also, households will still need to save for housing and other large expenditure items such as education and healthcare, unless public spending on the latter rises significantly. However, at the same time China's working-age population has started to decline – a trend that is expected to continue in coming years (Lim and Cowling 2016). This demographic shift is likely to put downward pressure on saving rates.

Chinese consumption per capita remains low relative to levels seen in other developing Asian economies, as well as advanced economies.[12] Although household incomes are likely to continue to grow over the long run, there could be volatility

11 Assuming that the total value of services, food and live animal exports from Australia to China continues to grow at the same average annual rate as for the period 2003 to 2013. Roberts *et al* (2016) construct scenarios for bilateral merchandise exports to China under alternative projections for Chinese growth. These scenarios similarly suggest that the share of food exports in bilateral trade is unlikely to overtake that of traditional resource commodities over the next two decades.

12 Accounting for differences in local living costs, China's household consumption per capita is lower than in Indonesia, even though GDP per capita is higher; while Thailand's GDP per capita is only 20 per cent higher than China's, consumption per capita is more than 60 per cent higher.

along the way as the economy rebalances. Growth in household incomes is vulnerable to the slowing of economic growth, and the path to higher levels of household consumption may not be a smooth one.

Nevertheless, if future income growth does lead to higher demand for service-intensive components of consumption, this should support Chinese demand for services imports, including from Australia. Exporters of agricultural commodities should also benefit as household food consumption shifts away from staples to higher-protein foods such as dairy and meat. However, services and food exports currently account only for a relatively small share of the total value of Australia's exports to China and would need to grow significantly to offset any future slowing in exports of key bulk commodities such as iron ore or coal.

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Developments in the Australian Repo Market

Chris Becker, Ashley Fang and Jin Cong Wang*

The market for repurchase agreements (repos) – where cash is borrowed and lent using securities as collateral – plays an important role in the implementation of monetary policy and as a source of finance for the bond market. The Reserve Bank has commenced publishing more detailed data about the repo market. This article introduces these data and highlights some key developments. The domestic repo market has grown considerably in recent years, with non-residents emerging as prominent borrowers of cash in return for securities. The spread between repo rates and expectations for the cash rate has risen noticeably over the past couple of years. This increase appears to be linked to developments in the foreign exchange swap market as well as arbitrage related to the Australian bond futures market. Demand from non-residents to fund trading activities and, to a lesser extent, regulatory requirements have contributed to the increase in repo rates.

Introduction

In Australia, most transactions secured by financial instruments are undertaken as repurchase agreements or 'repos'. Repos involve the transfer of a security for cash with an undertaking to reverse the transaction at an agreed future date and price.[1] Financial institutions use repos to manage cash flows, as well as to finance positions in securities. Holders of securities use these transactions to raise cash, while lenders of cash (and therefore receivers of securities) can temporarily acquire a position that they do not wish to hold on an outright basis (Wakeling and Wilson 2010).[2]

The repo market helps to promote liquidity in the bond market, including in Australia.[3] Repos are also a key instrument used by the Reserve Bank in its domestic market operations: buying debt securities under reverse-repo agreements provides the Reserve Bank with a low-risk means of lending cash to participants (Baker and Jacobs 2010).

The main financial intermediaries undertaking repo transactions in Australia are banks and registered financial corporations (RFCs), hereafter referred to as 'repo dealers'. The Reserve Bank recently began publishing more detailed information on the value of repo and stock lending by repo dealers. It covers the positions dealers have with each other, the Reserve Bank, non-residents and other counterparties (which include insurance corporations, pension funds and

* The authors are from Domestic Markets Department.

1 Viewed from the cash lender's perspective the transaction is a reverse repo. The annualised percentage difference between the sale price and the repurchase price is the repo rate. For further discussion refer to Wakeling and Wilson (2010), Cheung, Manning and Moore (2014), as well as RBA (2015).

2 Cash refers to settlement balances that market participants transfer between each other, rather than banknotes. These are typically Exchange Settlement balances that the largest repo dealers hold at the Reserve Bank.

3 Secured financing transactions may also be undertaken under securities lending agreements, although equities are usually provided as collateral. In contrast to repos, under securities lending the economic benefits of the security are generally passed through to the recipient. This segment of the market is relatively small in Australia. A range of global securities lending transactions and market trends are described in more detail by Dive, Hodge and Jones (2011).

state government borrowing authorities).[4] Details are also provided about the type of collateral: Australian Government Securities (AGS), semi-government debt issued by the state governments (semis) and all other securities (including equities). This article uses the new data to examine recent trends in the repo market.

Repo Market Developments

The current structure of the Australian repo market is illustrated in Table 1, which aggregates the absolute gross cash lending and borrowing positions reported by repo dealers as at the end of June 2016. The repo positions between dealers were around $38 billion and were predominantly secured by AGS collateral. The preference for AGS rather than semis reflects the fact that banks (who are a large share of dealers) tend to hold semis on their balance sheet as high-quality liquid assets to satisfy prudential regulations in an unencumbered form, rather than use them in the repo market. The use of AGS could also reflect an increase in the stock that is on issue, relative to the stock of semis that has grown by less. Repo dealers also participate in the Reserve Bank's open market operations and therefore have a $59 billion position that almost always reflects borrowing cash from the central bank in exchange for securities. The main form of collateral provided in these operations are AGS and semis, with securities issued by authorised deposit-taking institutions comprising most of the remainder. Non-resident financial institutions are significant participants in the repo market, using both AGS and other securities (including non-government securities) as collateral in their transactions with repo dealers. Repo dealers also transact with other market participants, such as asset managers. As at June 2016 these other market participants were net borrowers of cash from repo dealers, predominantly using AGS as collateral.

Separating the aggregated gross positions into lending and borrowing indicates that, in aggregate, repo dealers typically only borrow as much cash under repo as is required to fund their repo lending (Graph 1). An exception to this was during the financial crisis. At that time, financial institutions were facing considerable uncertainty and hence temporarily had a higher precautionary demand for holdings of cash. The Reserve Bank met that demand by supplying more cash through its open market operations.

More recently, there has been a notable increase in gross positions in the repo market, with aggregate borrowing and lending of cash by repo dealers rising significantly over the past four years. Some of this

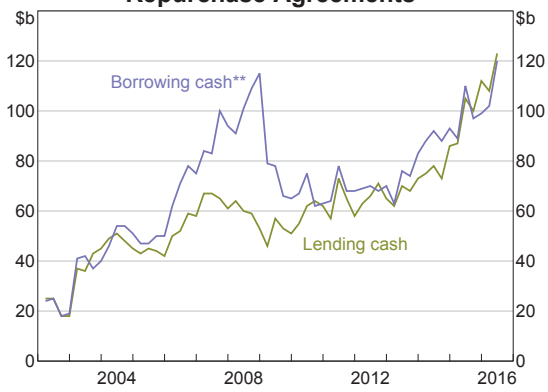
Table 1: Gross Positions of Repo Dealers
By counterparty and collateral type, as at end June 2016, $ billion

Counterparty	Total	Australian Government Securities	Semi-government securities	Other securities
Other repo dealers[(a)]	38	30	6	3
RBA (open market operations)[(b)]	59	29	5	25
Non-residents	78	40	5	33
Other market participants	30	18	5	6
Total	**205**	**117**	**21**	**67**

(a) As repo dealers report each transaction twice, these figures are adjusted for double counting
(b) Excluding open RBA repos
Sources: APRA; RBA

4 Refer to statistical table B3 Repurchase Agreements and Stock Lending by Banks and RFCs. Additional information related to the Reserve Bank's activity in the repo market is published in statistical table A3 Open Market Operations. These data are available at <http://www.rba.gov.au/statistics/tables/>. For a definition of RFCs and discussion of their activities, see RBA (2012).

Graph 1
Repurchase Agreements*



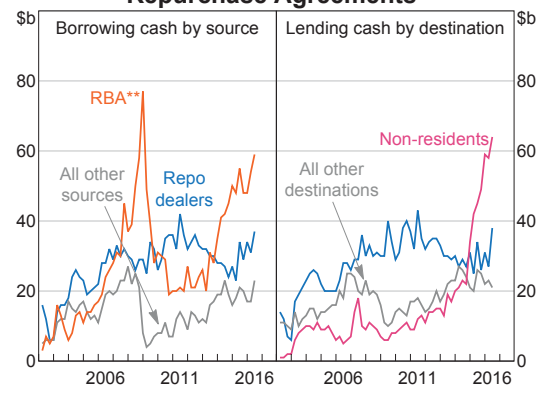
* Entered into by banks and RFCs; data prior to 2009 is unpublished
** Excluding open RBA repos
Sources: APRA; RBA

reflects the increase in the size of the Reserve Bank's cash lending position, which was around $60 billion as at the end of June 2016 compared with around $20 billion as at the end of June 2012 (Graph 2). As a result of this increase, transactions with the Reserve Bank currently represent around 50 per cent of the outstanding cash borrowing positions of repo dealers. The increase in the size of the Reserve Bank's repo book reflects the need to inject cash back into the financial system owing to an increase in banknotes on issue as well as an increase in deposits at the Reserve Bank (mainly Australian Government term deposits, but excluding Exchange Settlement balances). As repos contracted in open market operations are typically for longer terms (generally up to six months) than transactions in the repo market (generally only up to one week), the Reserve Bank is a less significant share of market 'turnover' than the stock of repos.

Over recent years there has also been a sharp increase in the gross cash lending position that repo dealers have with non-residents. As at the end of June 2012 non-residents were relatively minor participants, borrowing around $14 billion in cash in the repo market, but as at the end of June 2016 this had increased to over $60 billion (or around 50 per cent of total cash lending positions).

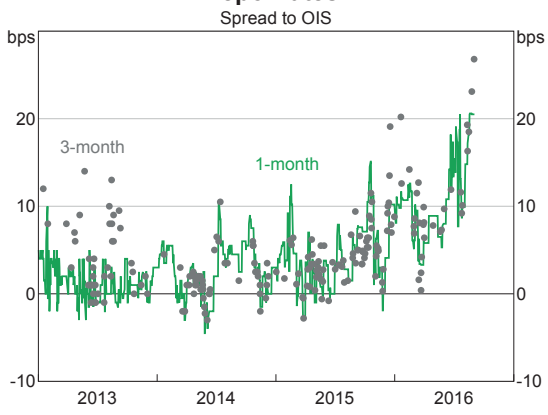
The increased participation of non-residents in the repo market has coincided with a rise in repo rates (Graph 3). Since June 2015, the repo rate at which the Reserve Bank conducts its open market operations has risen from a spread to overnight indexed swaps (OIS) of around 2 basis points, to around 20 basis points in September 2016. Elevated repo rates are also evident in major economies such as the United States, United Kingdom and Canada. The increase in repo rates in recent years can largely be attributed to different causes in different jurisdictions. The introduction of prudential regulations that require dealers to hold more capital against their market-making activities may have

Graph 2
Repurchase Agreements*



* Entered into by banks and RFCs; data prior to 2009 is unpublished
** Excluding open RBA repos
Sources: APRA; RBA

Graph 3
Repo Rates*
Spread to OIS



* Estimated from RBA open market operations
Sources: RBA; Tullett Prebon (Australia) Pty Ltd

been a factor where the leverage ratio is a binding constraint (CGFS 2015). In Australia, this is less likely to be the main factor, given that the repo market is a relatively small share of the financial system. Instead, market developments related to the foreign exchange swap market and the bond futures market appear to be contributing to the recent increase in repo market activity by non-residents.

Foreign exchange swap basis

A common transaction that takes advantage of a trading opportunity in the foreign exchange swap market is a collateral swap.[5] Typically, a non-resident holder of AGS lends the securities for Australian dollar cash using a repo dealer as the intermediary.[6] These Australian dollars are then lent in the foreign exchange swap market in exchange for Japanese yen. The Japanese yen are then lent under repo against Japanese Government Bonds (JGBs). In effect, the non-resident has entered into a collateral swap of AGS for JGBs. Each of the transactions can be undertaken separately with different repo dealers, or it can be arranged by a single repo dealer that operates in both markets.

The transaction is profitable because of the foreign exchange swap basis.[7] This relates to the fact that holders of Japanese yen are willing to pay a premium (the basis) to enter into a foreign exchange swap to borrow foreign currency, in this case, the Australian dollar. This reflects the strong demand of Japanese residents to diversify their financial assets internationally, while limiting their exposure to movements of the exchange rate.

Investors who borrow Australian dollar cash can earn a premium of around 70 basis points if the proceeds are swapped into yen cash and then invested in Japanese assets at a three-month tenor (Graph 4).[8]

5 This is just one of a number of strategies that take advantage of the existence of the Japanese yen swap basis.

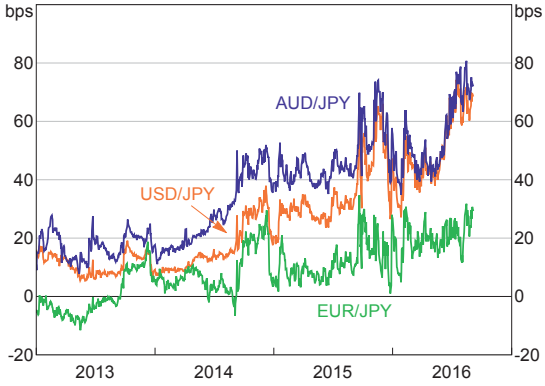
6 Non-residents currently hold about 60 per cent of outstanding AGS.

7 For a more detailed discussion of the Japanese yen basis, see BIS (2016).

8 The foreign exchange basis is expressed as a spread to a benchmark rate, such as the London Interbank Offered Rate (LIBOR) or the Australian Bank Bill Swap Rate (BBSW).

Hence these investors can be relatively insensitive to the cost of borrowing Australian dollars under repo because the yen basis is currently so wide. In this way, the non-resident demand for repo finance contributes to upward pressure on repo market rates. While the Japanese yen basis is also evident against other major currencies such as the US dollar and the euro, it may be playing a smaller role in explaining elevated repo rates in those larger markets. Importantly, there have been no flow-on effects from the upward pressure on repo rates to other money market rates, such as bank bills.

Graph 4
Japanese Yen FX Swap Basis
3-month, spread to funding rate*



* AUD BBSW, USD LIBOR and EUR LIBOR
Source: Bloomberg

Bond futures market basis

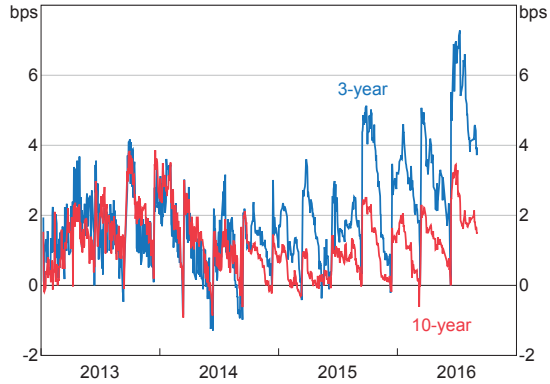
There are also arbitrage opportunities in the Australian bond futures market that involve the repo market. One relates to differences between the price of AGS and their implied price in the ASX bond futures market. Resident and non-resident investors who seek to acquire a long positon in AGS and a short position in the bond futures contract can use the repo market to fund these arbitrage trades; as an incremental source of demand for repo cash borrowing, this could put some upward pressure on repo rates.

Over recent years, trading in ASX bond futures has regularly implied a higher price (lower yield) for the bonds in the reference basket than prevailing prices

for those bonds in the physical market (Graph 5). This may be partly explained by the greater liquidity in the futures market, which provides market participants with a leveraged exposure to the AGS market without incurring the cost of holding securities. The difference in pricing between the two markets varies over time but tends to converge to zero as the contract approaches expiry, at which time the final settlement yield is defined as a composite of live market prices for the underlying bonds.

This gives rise to a trading opportunity, which is typically exploited via a strategy called 'trading the basis' (Figure 1). An investor initiates this trade by simultaneously selling bond futures (which are relatively overvalued) and purchasing physical bonds (which are relatively undervalued).[9] The investor can finance the long physical bond position by borrowing cash in the repo market against the bonds. To exit the trade, the investor closes these positions by buying back the futures, unwinding the repo and selling the physical bonds. This allows the investor to realise profits resulting from the convergence in futures and physical bond prices, as well as the reinvestment of any coupons paid by the bonds during the holding period.

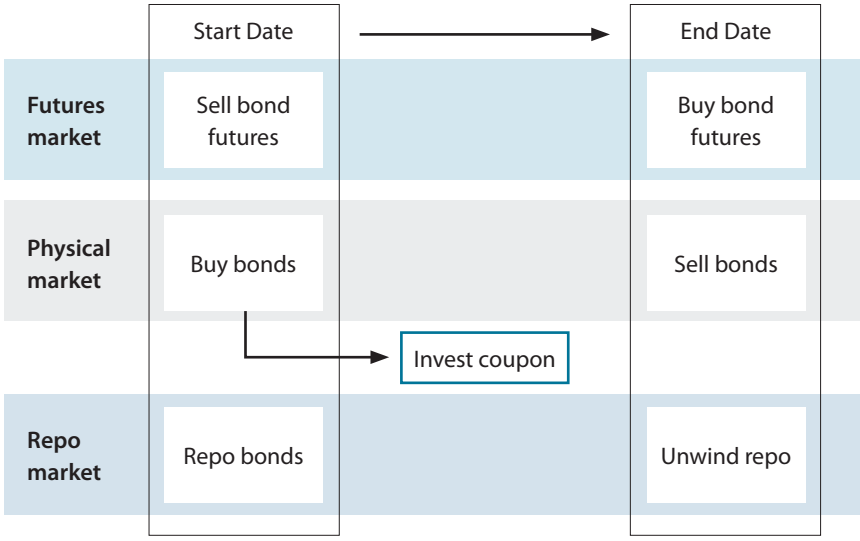
Graph 5
ASX Bond Futures Basis



Sources: RBA; Thomson Reuters

Because trading the bond futures basis often involves the financing of the long bond position via a repo, the repo rate is a key determinant of the profitability of this arbitrage strategy. Trading

Figure 1: Bond Futures Market Basis Trade



Source: RBA

9 Investors will typically calibrate the notional value transacted in the futures market relative to that in the physical market in order to offset interest rate risk. This calculation will depend on the specific features of the futures contract and underlying bonds, as well as prevailing market yields.

the basis is also a source of demand for securities financing in the repo market and can create upward pressure on repo rates. However, while repo rates have increased relative to OIS rates as shown in Graph 3, they do not appear to be a significant constraint on the profitability of the bond futures basis trade in the current environment.

This reflects that the implied repo rate from the bond futures contract, which would eliminate the basis, is considerably higher than the actual repo rate an investor pays to finance their long bond position. To illustrate this, Table 2 shows what the bond futures basis would be at a range of repo rates (a positive basis indicates overvalued bond futures relative to physical bonds). On the day of the example, the repo rate was around 1.79 per cent, which would imply a basis of 2.66 basis points; the repo rate would have needed to be almost 1 percentage point higher for the basis to close.[10]

Table 2: Bond Futures Basis
10-year AGS futures, as at 16 June 2016

Repo rate Per cent	Basis Bps
1.50	3.53
1.75	2.77
2.00	2.02
2.25	1.26
2.50	0.51
2.75	–0.25
3.00	–1.00

Source: RBA

Conclusion

A well-functioning repo market supports the efficient functioning of financial markets. Understanding the repo market is therefore important to interpreting market developments, as well as the implementation of monetary policy. Consistent with this, the Reserve Bank has recently begun publishing data that allows users, including the Reserve Bank itself, to better understand the repo market in Australia.

10 The 3-month OIS rate plus the open market operations cut-off rate spread to OIS on that day is used as an indicative repo rate.

The size of outstanding positions in the repo market has grown considerably in recent years. This primarily reflects an increase in the size of the Reserve Bank's repo book, as well as non-residents emerging as prominent borrowers of cash in return for securities. While the former is the result of day-to-day central bank liquidity management, the latter appears to be related to arbitrage of the basis that exists in both the foreign exchange swap market and Australian bond futures market. Growing demand from non-residents to fund these trading activities has contributed to a noticeable increase in repo rates. Changes in regulatory requirements and the business practices of market participants may also have played a role, but are likely to have been less important than in other advanced economies.

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The Kangaroo Bond Market

Michelle Bergmann and Anna Nitschke*

Australian dollar-denominated bonds issued by non-resident entities in Australia are referred to as Kangaroo bonds and represent a significant share of the Australian bond market. Issuance has generally been dominated by highly rated issuers such as supranational and quasi-sovereign agency entities; more recently there has been an increase in non-financial corporate issuance, albeit from a low base. Kangaroo bond issuance has increased substantially since the early 2000s, supported by the global demand for highly rated and relatively high-yielding Australian dollar-denominated assets. Kangaroo bonds have been attractive to non-resident issuers as they enable non-residents to diversify their funding bases and have relatively favourable issuance costs (including hedging costs) compared with issuance in other currencies. Kangaroo issuers play an important role in the cross-currency swap market because, by converting the Australian dollars they raise into foreign currency, they act as indirect counterparties for Australian corporations looking to convert funds raised offshore into Australian dollars.

Background

Foreign entities issue bonds in Australian dollars despite typically having limited need for Australian dollar funding. This issuance is generally converted back to a currency that the issuer requires using instruments such as cross-currency swaps. These instruments are used to hedge the foreign exchange risk associated with the issuer's need to pay coupons and repay principal in Australian dollars. In the early 2000s, the majority of non-resident Australian dollar issuance occurred in offshore markets but issuance into the domestic market has since increased rapidly.[1] Australian dollar-denominated bonds issued into the domestic market by non-resident issuers are referred to as Kangaroo bonds.

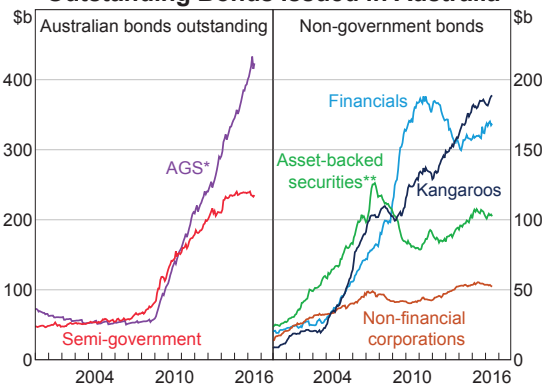
* The authors are from Domestic Markets Department.

1 The difference between domestic and offshore Australian dollar issuance depends on where the securities are deposited. For example, domestic issuance is typically issued and deposited in the Austraclear central securities depository (CSD) while offshore issuance is deposited in international CSDs such as Euroclear and Clearstream.

The Significance of Non-resident Issuance in Australian Dollars

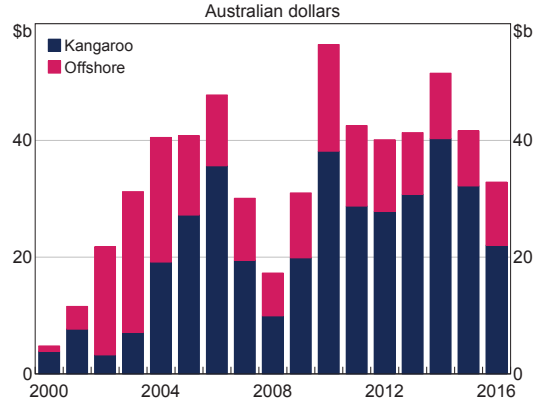
Kangaroo bonds are the largest segment in the domestic bond market after Australian Government Securities (AGS) and semi-government securities (semis). They represent around a third of non-government bonds outstanding in the domestic market (Graph 1). In the past, the majority of non-resident Australian dollar issuance occurred in offshore markets, but since 2004 Kangaroo bond issuance has become the preferred mode of issuance (Graph 2). The largest Kangaroo bond issuers now issue very little Australian dollar debt offshore. The shift has been particularly pronounced among AAA rated issuers who, prior to the financial crisis, issued Australian dollar-denominated bonds mainly offshore into the Uridashi market (bonds issued specifically to Japanese investors). In contrast, Australian corporations, in particular the major banks, have generally favoured offshore markets for raising funds, with around two-thirds of non-government issuance conducted offshore.

Graph 1
Outstanding Bonds Issued in Australia



* Excludes bonds repurchased by the Australian Government
** Excludes authorised deposit-taking institutions' self-securitisations
Sources: ABS; Australian Office of Financial Management; RBA; State Treasury Corporations

Graph 2
Non-resident Bond Issuance*
Australian dollars



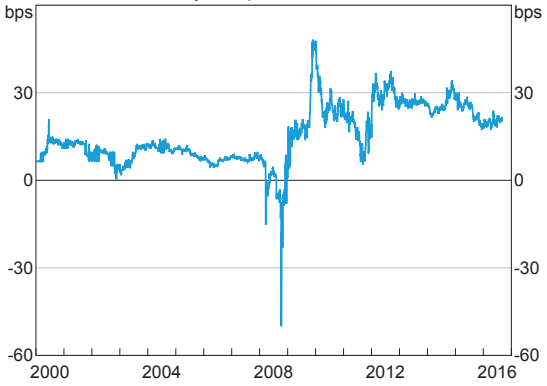
* 2016 issuance is year to date
Source: RBA

Non-resident issuance of Australian dollar-denominated bonds, particularly Kangaroo bonds, rose substantially during the early to mid 2000s. This was supported by a number of factors, including increased demand from foreign investors for higher-yielding Australian dollar assets and the development of the Australian dollar swap market, which enabled foreign investors and issuers to hedge their foreign exchange risk. Both Kangaroo bond issuance and non-resident offshore issuance of Australian dollar-denominated bonds dipped around the time of the financial crisis, but subsequently recovered and have since been fairly stable. The value of bonds outstanding has continued to increase.

The Attraction of Non-resident Issuance in Australian Dollars

Kangaroo issuers access the Australian bond market in order to diversify their funding sources. The decision by non-residents to issue in Australian dollars is driven by factors such as the relative cost of issuance (including hedging costs) and the liquidity of underlying derivative and bond markets. A key characteristic of the Australian swap market is the persistent positive 'basis' that issuers receive as a premium for their Australian dollars in exchange for foreign currencies, such as the US dollar, in the cross-currency swap market (Graph 3). For example, through a cross-currency basis swap, the issuer can lend Australian dollars at the bank bill swap rate (BBSW) plus the basis, while paying the US dollar London inter-bank offered rate (LIBOR) for the US dollars.[2]

Graph 3
US Dollar Cross-currency Basis Swap Spread*
5-year, spread to BBSW

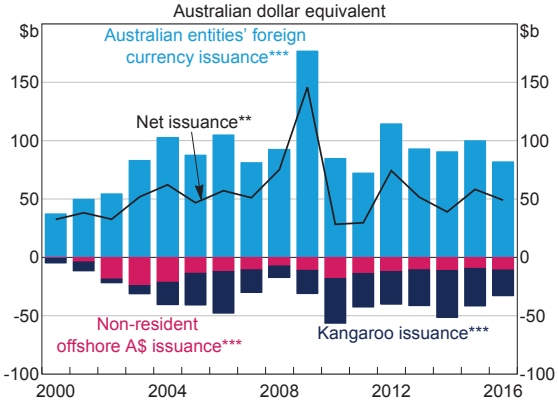


* The cost of hedging US dollar issuance back into Australian dollars
Source: Bloomberg

2 A cross-currency basis swap is a derivative instrument that involves an exchange of principal in different currencies, as well as the payment of interest in one currency and the receipt of interest in a different currency at a predetermined fixed exchange rate. They are often used to hedge the foreign exchange risk associated with longer-term debt securities. For further details, see Arsov *et al* (2013).

The basis is generally positive because the demand to swap foreign currency for Australian dollars exceeds the supply of those wanting to swap Australian dollars for foreign currency. This imbalance partly reflects the fact that Australian corporations, in particular Australian financial institutions, conduct the majority of their issuance offshore in foreign currency and, as noted above, swap this back into Australian dollars to hedge against the foreign exchange risk.[3] Offshore issuance allows Australian issuers access to a greater range of investors and deeper capital markets that are able to better meet their funding requirements. Through the use of intermediaries (such as global banks), non-resident issuers operate as important, indirect counterparties for Australian issuers interested in hedging their foreign currency exposures. Australian dollar issuance by non-residents is equivalent to around 40 per cent of foreign currency-denominated bonds issued by Australian entities (Graph 4).

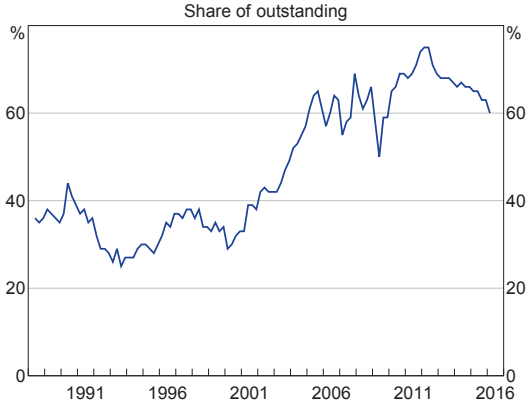
Graph 4
Resident and Non-resident Bond Issuance*



* 2016 issuance is year to date
** Net balance of Australian entities' foreign currency issuance and non-residents total A$ issuance
*** Gross issuance
Source: RBA

At the same time, there has been substantial global demand for Australian dollar-denominated assets. This reflects the combination of relatively high credit ratings (many non-resident issuers of Australian dollar bonds are AAA rated) and relatively high yields. In particular, these assets have considerable appeal to investors with mandates to only invest in highly rated securities, such as some reserve managers. Foreign interest in Australian dollar-denominated debt is also evident in the increase in foreign investment in AGS over the past 15 years (Graph 5).

Graph 5
Non-resident Ownership of Australian Government Bonds



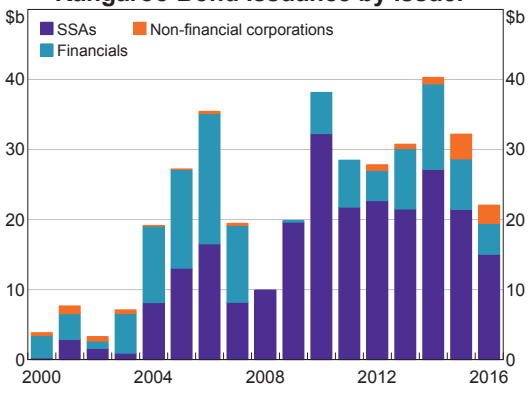
Sources: ABS; RBA

Types of Non-resident Issuers

The majority of non-resident Australian dollar issuers are supranational, sovereign or quasi-sovereign agency entities (collectively known as SSAs) (Graph 6). Non-SSA issuers largely comprise financial firms, although activity by non-financial corporate issuers has increased in recent years supported by US companies such as Apple and Coca-Cola.

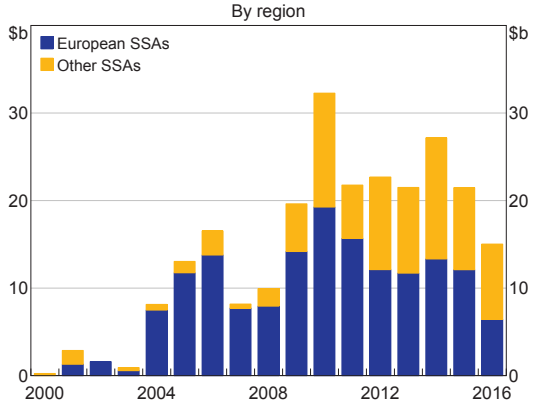
3 Some Australian entities (in particular the major mining companies that have US dollar earnings) do not hedge back their offshore issuance as they have foreign income and assets that are more appropriately matched by foreign currency debt liabilities.

Graph 6
Kangaroo Bond Issuance by Issuer*



* 2016 issuance is year to date
Source: RBA

Graph 7
Kangaroo SSA Issuance*
By region



* 2016 issuance is year to date
Source: RBA

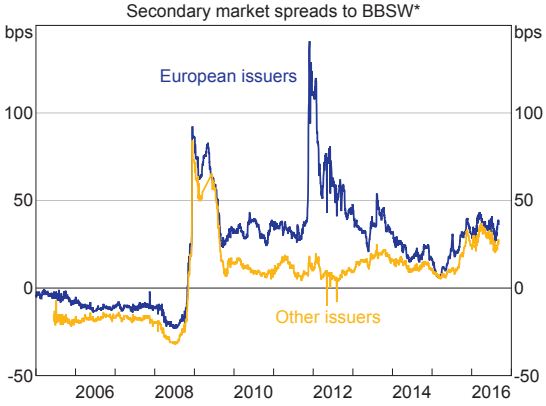
Issuance by SSAs

SSAs cover a broad range of issuers, which have different levels of government support. Supranational entities have multinational ownership structures, with institutions such as the World Bank (through the International Bank for Reconstruction and Development and the International Finance Corporation) and European Investment Bank accounting for a large share of SSA Kangaroo issuance. Quasi-sovereign agency issuers are standalone entities that often benefit from government support (either directly or indirectly) and are generally established to support a certain part of the economy, such as export financing and housing development. These agencies, particularly European agencies such as the German based KfW and Rentenbank, account for a large proportion of Kangaroo issuance. There is limited issuance by foreign sovereign issuers in Australia.

Sizeable Kangaroo bond issuance by SSAs began in 2004 as European supranationals and agencies shifted their Australian dollar issuance away from offshore markets (Graph 7). Kangaroo bond issuance declined substantially during the global financial crisis, amid heightened volatility in bond markets and a spike in issuance costs. Higher costs reflected a widening in Kangaroo bond spreads relative to benchmark interest rates and higher foreign currency hedging costs (Graph 8). Nevertheless, AAA rated supranationals continued to issue Kangaroo bonds during this period. Following the financial crisis, SSA issuance picked up sharply, peaking in 2010, and has been broadly stable in recent years.

The global funding programs of many SSAs have declined over the past five years and a larger proportion of their funding has been sourced in US dollars, reflecting more favourable US dollar

Graph 8
AAA Rated SSA Kangaroo Bond Spreads
Secondary market spreads to BBSW*



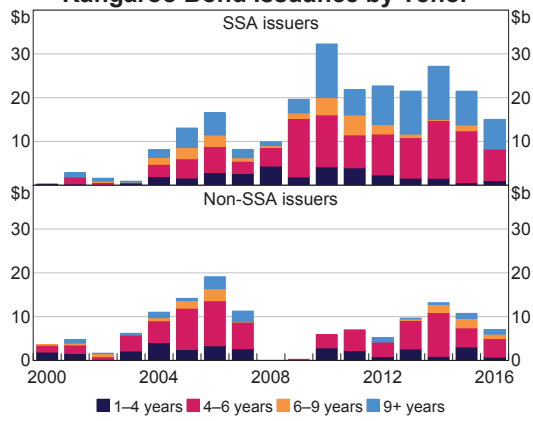
* 4–6 years to maturity
Sources: RBA; UBS AG, Australia Branch

funding conditions of late due to movements in the cross-currency swap market. Despite this, the share of SSAs' funding in Australian dollars has been largely unchanged over the past few years. Large issuers typically aim to issue into the Kangaroo market regularly, even when issuance in other markets is more cost effective, as they prefer to maintain access to a broad range of capital markets and investors prefer issuers that regularly issue bonds.

SSA issuance has been dominated by AAA rated entities. This may partly reflect investors' preferences, with AAA rated issuance attracting substantial demand from reserve managers and other institutional investors (as discussed above). While issuance by non-AAA rated SSAs has picked up since 2011, this has been concentrated among a few issuers, mostly Canadian provinces. In contrast, a number of SSAs ceased issuing Kangaroo bonds after losing their AAA credit ratings following the global financial crisis and amid concerns around European sovereign debt.

Around half the bonds issued by SSAs have maturities of around five years, with reserve managers reported to be significant buyers up to this tenor (Graph 9). An increasing share of issuance has had a tenor of around 10 years, which has been supported by a shift among SSA issuers to conduct frequent small 'taps' of existing longer-dated bonds. Some lengthening in the maturity of issuance is consistent with a general shift among issuers to increase the term of their fixed-rate debt given historically low interest rates. According to market participants, a lengthening in the tenor of SSA bonds has also been a response to increased investor interest from Japanese pension fund and life insurance companies, which prefer longer-dated investments to match the long duration of their liabilities (Collins 2014; Davison 2016).

Graph 9
Kangaroo Bond Issuance by Tenor*

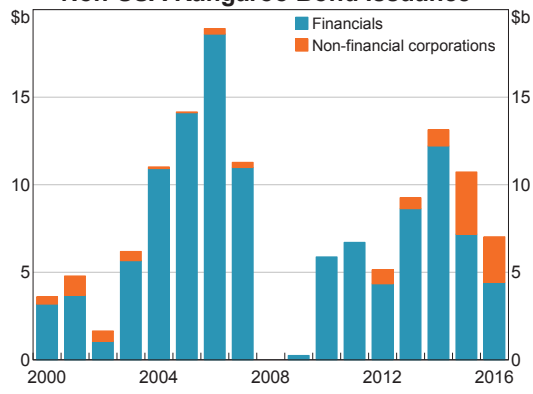


* 2016 issuance is year to date
Source: RBA

Issuance by financial corporations

The next largest Kangaroo bond issuers by volume have been financial corporations, with sizeable issuance from both European and US-domiciled banks. Issuance patterns have been notably cyclical, with a complete absence of the banks from the market during the financial crisis (Graph 10). Issuance by banks resumed in 2010, albeit with consistently lower volumes by both European and US banks compared with the pre-crisis peak. However, this reduction has been partly offset by issuance from Canadian banks, which have tended

Graph 10
Non-SSA Kangaroo Bond Issuance*



* 2016 issuance is year to date
Source: RBA

to issue AAA rated covered bonds. Asian banks have never had a significant presence in the Kangaroo market, as many Asian banks with higher credit ratings have limited borrowing needs due to strong deposit bases or have issued bonds through their Australian branches or subsidiaries that have a requirement for Australian dollar funding.

Issuance by non-financial corporations

Following an extended absence precipitated by the global financial crisis, non-financial corporate Kangaroo issuance resumed in 2012 (Graph 10). Initial activity was supported by issuance from a handful of larger British and US companies as well as Korean entities (often with strong government links). Non-financial corporations have comprised a greater share of non-SSA Kangaroo issuance since 2012 compared with the pre-crisis period, accounting for close to 20 per cent of recent non-SSA issuance. According to market participants, the increase in non-financial corporate issuance has been supported by increased investor appetite for non-AAA rated issuance alongside the global 'search for yield' trend driven by low government bond yields.

Issuance by non-financial corporations increased substantially in 2015 and 2016. Much of the increase was driven by a small number of very large deals by US corporations. In particular, Apple completed the largest ever Kangaroo deal in August 2015, raising $2.25 billion, followed by a further $1.45 billion in June 2016.[4]

In contrast to SSA issuance, corporate Kangaroo deals have tended to be larger and have often involved multi-tranche deals across different tenors. These deals have generally entailed a combination of bonds with a shorter tenor (often four years) and longer tenor bonds (generally seven to 10 years). This strategy enables corporations to issue bonds with a wide range of maturities to attract different investors. Recent deals have generated substantial demand from domestic participants at shorter tenors, while longer tenors have been dominated by offshore investors.

Conclusion

Kangaroo bonds are an important source of highly rated securities in the Australian bond market, with issuers also acting as important indirect counterparties for Australian firms in the cross-currency swap market. Kangaroo bond issuance has increased significantly since the early 2000s and has recovered strongly after a dip in issuance during the global financial crisis. Since the financial crisis, issuance has primarily been from AAA rated SSAs, but over the past few years there has been increased issuance from a broader range of entities, particularly non-financial corporations.

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4 Apple has undertaken sizeable global corporate bond issuance in recent years despite having considerable cash holdings outside the United States.

Banks' Wealth Management Activities in Australia

Theodore Golat*

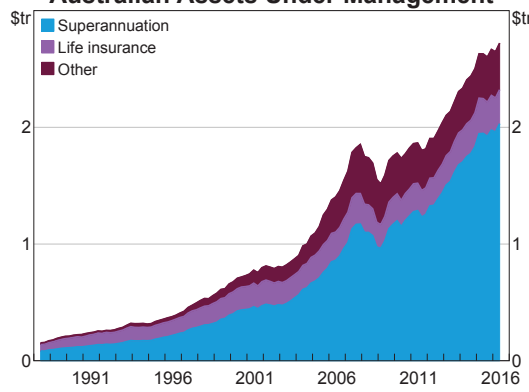
Wealth management activity has grown rapidly in Australia over the past 25 years and the major banks now comprise a much larger share of the industry than they did previously. The returns on these activities across the major banks have varied, being close to those on traditional banking activities in some cases but below the cost of capital in others. By undertaking this line of business, banks have increased their resilience (by diversifying their income) but also face new risks. In part reflecting these risks, as well as a greater focus on capital management, banks have begun to re-examine the nature and extent of their involvement in wealth management.

The Wealth Management Industry in Australia

Wealth management activities account for a large part of Australia's financial system. Total assets under management (AUM) in the sector were $2.72 trillion at the end of June 2016, equivalent to around 40 per cent of financial sector assets and over 160 per cent of GDP (Graph 1). The wealth management industry has expanded rapidly over the past two decades, growing in excess of 10 per cent a year over most of this period.

Wealth management is defined here to include various forms of funds management (superannuation, managed funds and life insurance) and financial advisory services.[1] Of these, superannuation is the largest and fastest growing component, accounting for around three-quarters of AUM; the Australian superannuation system is also large by international standards, ranking fourth (relative to GDP) among Organisation for Economic Co-operation and Development (OECD) nations. Life insurance AUM have grown more slowly and now account for only a modest share of total AUM. Other AUM (such as managed funds) have grown strongly, but are currently only slightly larger than assets managed by life insurers.

Graph 1
Australian Assets Under Management



Source: ABS

One major change to the structure of the wealth management industry over the past two decades has been the growing role of the major banks in the industry.[2] Historically, wealth management services were largely provided by independent fund managers and life insurers such as AMP Limited

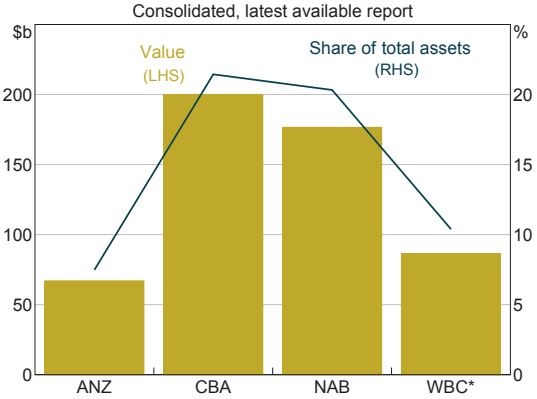
* The author completed this work in the Financial Stability Department. This work has benefited greatly from previous internal analysis by Fiona Price.

1 For data availability reasons, general insurance income has been included as wealth management activity in this report.

2 Australia and New Zealand Banking Group (ANZ), Commonwealth Bank of Australia (CBA), National Australia Bank (NAB) and Westpac Banking Corporation (WBC).

(AMP), Colonial Group, BT Financial Group (BT) and MLC. During the late 1990s and early 2000s, each of the major banks acquired or merged with a fund manager; of the four listed above, only AMP remains independent. These acquisitions resulted in the major banks' AUM increasing from the equivalent of 13 per cent of the Australian total in the late 1990s to around one-fifth (or $530 billion) today (Graph 2). In aggregate, the major banks' AUM are equivalent to around 15 per cent of their consolidated assets. CBA currently has the largest wealth management operation relative to its other activities – AUM are equivalent to over 20 per cent of its consolidated assets – while ANZ's share is the smallest at 7 per cent. The key motivations for these acquisitions were the opportunity to cross-sell a broader range of financial services to their existing customer base and to gain exposure to the rapidly growing superannuation market.

Graph 2
Major Banks' Assets Under Management
Consolidated, latest available report



* Includes a proportionate share of BT Investment Management's assets under management

Sources: ABS; Banks' annual and interim reports

The Structure of Banks' Wealth Management Operations

The major banks' wealth management operations are typically structured as wholly owned subsidiaries that operate as separate divisions to the more traditional banking operations.[3] Rather than consolidating their wealth management brands under their name, banks generally operate multi-brand strategies; this is possibly because of the reputations (goodwill) attached to these brands as specialised fund managers. Banks' wealth management subsidiaries are also required to have their own boards. These boards are generally separate from the parents' boards and are composed of a mix of internal staff, independent directors and executives from the parent entity.

The major banks' subsidiaries provide all stages of wealth management services: they offer financial advice, distribute products and manage funds or insurance policies on behalf of clients. The advice and distribution roles are undertaken by both the banking and wealth management divisions, while funds management is entirely contained within the latter. However, banks have begun to rethink this vertically integrated framework and in some cases have decided to partially step back by divesting majority ownership of their funds management operations, leaving the parent banks to focus on advice and distribution.[4]

In addition to the four major banks, other financial conglomerates also have a significant presence in the wealth management industry. AMP, Challenger (a non-bank) and Suncorp collectively hold around $300 billion in AUM, while Macquarie Group manages around $500 billion globally. Suncorp, Macquarie Group and AMP offer a diversified range of wealth management services similar to those offered by the major banks, while Challenger focuses on funds management. These operations differ from the wealth management divisions of major banks in that these firms have historically focused on wealth management activities (or, in

3 The main exception is WBC, which only owns 31 per cent of its associate (BT Investment Management).

4 This includes WBC, which began divesting BT Investment Management in 2007 and sold a further portion last year, and NAB, which is in the process of transferring an 80 per cent stake in its life insurance business to Nippon Life.

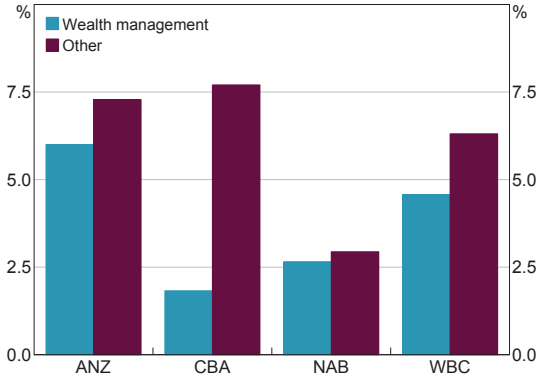
the case of Macquarie Group, investment banking), rather than retail banking.

Performance

One way to examine the profitability of banks' wealth management businesses is to look at income growth. This is a relevant metric because part of the business case set out by the banks when acquiring these businesses was an expectation that the acquisitions would lead to faster income growth for the banking groups as the Australian superannuation system matured. However, wealth management income has instead grown more slowly than income from other activities since 2007 (Graph 3). A key reason for this has been that margins on these businesses (measured by revenue as a proportion of AUM) have fallen by around 20 per cent over the same period.

Competition from other superannuation funds is one reason why margins have narrowed and wealth management income has grown slower than other income over this period. The main source of competition has been industry super funds, which have consistently delivered higher returns to their customers (after fees) than retail funds, partly due to a different product mix.[5] In addition, self-managed super funds (SMSFs) have increased their market share, possibly because they offer more control than funds that are regulated by the Australian Prudential Regulation Authority (APRA). While this is likely to have affected member participation in bank-owned funds, banks have been able to generate income by providing advice on establishing and managing SMSFs, as well as lending to them. A second reason why incomes from wealth management activities have not grown more strongly has been the subdued growth in life insurance AUM and various weaknesses in historical risk management practices (including under-pricing new product features, vague definitions in contracts and poor underwriting and claims management practices; see discussion in Laughlin (2015)).

Graph 3
Major Banks' Income Growth Rates*
Average for 2007 to 2015



* Adjusted for the acquisitions of Bankwest, ING Australia and St. George Bank, but not for the acquisition of Aviva

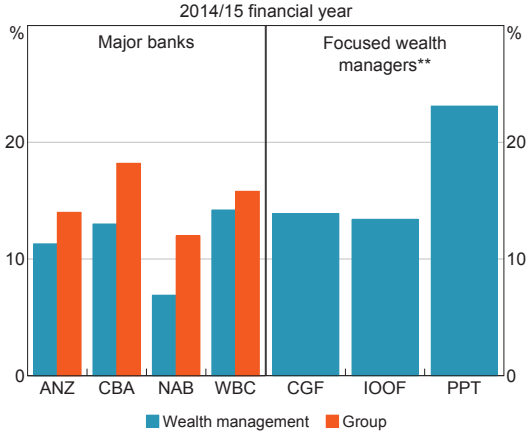
Source: Banks' annual and interim reports

Returns on equity from the major banks' wealth management operations also appear to have been lower on average than those from their more traditional banking activities, but, in a number of cases, are still well above estimates of the banks' cost of capital. According to Citi Research estimates, the return on equity (ROE) for wealth management was a little below 15 per cent at both CBA and WBC in 2015 (Graph 4). In contrast, returns on ANZ and NAB's wealth management operations were lower.[6] ROE for specialist wealth management firms are comparable to those of CBA and WBC, suggesting that ANZ and NAB's lower returns are likely due to idiosyncratic factors such as differences in product mix. NAB in particular has a greater focus on life insurance activities where industry-wide profitability has been weak. NAB's recent sale of 80 per cent of its life insurance business to Nippon Life is expected to improve the overall returns on its wealth management business.

5 Rowell (2015) argues that industry funds have a much larger share of members in their default products than retail funds, whose members are often in choice products that allow the asset allocation strategies to be chosen by members.

6 Data limitations make estimating the return on equity of individual divisions difficult, but analysts at Citi Research have provided estimates for the 2014/15 financial year by allocating equity to different divisions within banking groups using a proprietary model.

Graph 4
Major Banks' and Fund Managers' ROE*
2014/15 financial year



* Cash ROE
** Challenger, IOOF and Perpetual
Sources: Citi Research; Company annual reports

It is difficult to assess the extent to which banks have been able to realise the expected benefits from cross-selling opportunities associated with their wealth management activities. Research by Roy Morgan in 2014 indicated that around 10 per cent of the major banks' banking customers with wealth management products held them with the same bank. This could suggest that there are some customer retention benefits associated with their wealth management activities, but these are difficult to identify. In 2015, Roy Morgan reported that major banks had shown no significant advance over the past ten years in cross-selling wealth management products to customers. Nonetheless, it is likely that the acquisitions reduced banks' average costs by increasing the size of their distribution networks.

Benefits and Risks from Banks Involvement in Wealth Management

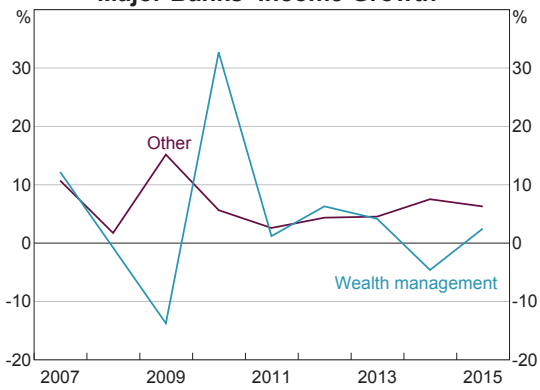
Financial conglomerates typically have more stable income than specialised firms because they are more diversified. There is some evidence that this makes them more resilient to shocks (e.g. Hsieh, Chen, Lee and Yang 2013). However, the consolidation of several businesses across financial industries can give rise to other risks that could offset these benefits. For example, Hoenig and Morris (2013) outline how consolidation creates larger and more complex institutions, generating additional risks as well as making it more difficult for management, boards and regulators to monitor and assess risks. Van Lelyveld and Schilder (2003), Dierick (2004), Lumpkin (2010) and APRA (2010) have also noted various potential sources of risk from large financial conglomerate structures. These benefits and risks are discussed in the remainder of this article.

Greater resilience

A more diversified source of income can increase the resilience of banking groups. A considerable body of literature exists on the diversification benefits of non-interest income for banks globally, but the findings are mixed and not always transferable across institutions (for example, Stiroh 2004 and Edirisuriya, Gunasekarage and Dempsey 2015). In Australia, the pattern of income growth for the major banks suggests that there has been some diversification benefit from their wealth management income stream, as the growth rates of their wealth management income and other income since 2007 have displayed a modest negative correlation (Graph 5). As a result, growth in banks' aggregate income has been less volatile than that of their non-wealth businesses, even though their wealth management income has been more volatile than income from other sources.

The resilience of banks could also be increased by the lower leverage associated with ownership of wealth management activities. The business of traditional banking involves a high proportion of debt funding but wealth management does not require leverage. Instead members commit equity, which is invested on their behalf, and bear the risk of any losses. As such, wealth management activities carry significantly less financial risk for the banking group and – all else being equal – may lower its overall leverage.

Graph 5
Major Banks' Income Growth*



* Adjusted for the acquisitions of Bankwest, ING Australia and St. George Bank, but not for the acquisition of Aviva

Source: Banks' annual and interim reports

Increased financial risks

If large financial exposures (direct or indirect) exist between banks and their wealth management subsidiaries, there is a risk of contagion between the businesses. For example, links between the two could see losses incurred by the wealth management subsidiary ultimately being borne by the parent entity, which could affect banks' capital levels. Contagion risks could also arise if the banking group relies too heavily on funding from its wealth management subsidiary.

One growing source of intragroup funding is bank deposits sourced from superannuation funds. While it is difficult to accurately estimate the size of exposures, large superannuation funds invest almost 13 per cent of their assets in cash products, equivalent to approximately 4 per cent of all Australian banks' liabilities.[7] In addition, superannuation funds often invest heavily in fixed income and equity securities issued by the major banks. A significant fraction of these investments can be expected to be those of bank-owned funds managers in the parent bank. While it is likely that much of this exposure would exist regardless of who owns the asset management company, these exposures create a risk that the banking group may need to raise funds externally when its wealth management arm is experiencing heightened customer redemptions.

A significant deterioration in the profitability of wealth management subsidiaries could, in principle, affect the broader banking group and impede banks' ability to accumulate capital. However, income from wealth management activities only accounts for around 10 per cent of the major banks' revenues. It is therefore unlikely that a large decline in wealth management income would threaten banks' stability. Indeed, while the poor results of these subsidiaries in 2009 were viewed unfavourably by market commentators, they did not trigger concerns about the major banks' viability or long-term profitability.

Some of these financial risks are mitigated by elements of APRA's regulatory framework. For example, life insurance companies and superannuation trustees regulated by APRA are required to have risk management frameworks in place to cover all material risks to which they are exposed; there are limits on the size of exposures banks can hold against such related entities. Similarly, APRA requires banks' boards to have policies in place to manage any material risks posed to the banking groups – including those relating to liquidity and capital – arising from their financial dealings with related entities.[8] Moreover, any attempts by a bank to assist distressed wealth management subsidiaries (for example, to protect the conglomerate's brand and customer relationships) would require approval by APRA if it resulted in the bank breaching relevant prudential limits. Such approval would only be granted under exceptional circumstances.

7 'Large' superannuation funds exclude SMSFs and APRA-regulated funds with fewer than four members.

8 For APRA's supervisory purposes, related wealth management entities do not form part of a banking group.

Operational failure and resolution challenges

More complex institutions may be more likely to experience operational failures, either internally or at outsourced service providers, and these failures could affect related entities. In recognition of this, APRA has regulations in place that require APRA-regulated institutions to have adequate risk management frameworks, including for operational risk. These regulations aim to ensure that banks can continue to operate even when a service provided to the bank by their wealth management businesses is unavailable.

A bank's ownership of a wealth management business could also potentially make the institution more complex to resolve in the event of failure. APRA intends to take complexity into account when preparing resolution plans in conjunction with large institutions so that any difficulties associated with greater complexity will not materially hamper a resolution.

Governance and other strategic issues

Financial conglomerates have to consider and balance the interests of recognised stakeholders of the parent and other entities in the group. Since these interests can vary significantly and intragroup conflicts of interest may arise, there is potential for decisions to be made that are sub-optimal for particular divisions.

Banks' ownership of wealth management businesses also exposes them to financial and reputational damage in the event of misconduct within these businesses. A number of instances of misconduct have occurred in bank-owned wealth management businesses over the past couple of years. Such incidents have not been confined to bank-affiliated businesses; misconduct has also occurred at wealth management businesses that were not owned by banks. Nonetheless, banks could expose themselves to potentially significant legal, regulatory and reputational risks as a result of their ownership of wealth management businesses, which could be especially concerning if they were realised at a time when the bank was under pressure more generally. One of the most effective means of managing such risks is the development of strong risk cultures across banking groups. In recognition of this, regulators have been increasingly focusing on monitoring and improving the culture of financial firms in recent years. For example, the Chairman of APRA recently announced that both APRA and the Australian Securities and Investments Commission (ASIC) had set up teams specifically to focus on improving corporate culture. APRA has also introduced a prudential standard on risk management that requires boards to form a view of the risk culture in their firm and the adequacy of that culture in supporting risk management goals.

As a complement to such efforts to improve ethical culture, APRA has other regulations that aim to reduce the risk of poor governance. In particular, banks are required to develop and maintain integrated governance arrangements covering the banking group to which they belong. They must also ensure that material risks posed by related entities (such as wealth management businesses) to the banking group and its beneficiaries are addressed by the group's risk management framework. Wealth management businesses (besides life insurers) are not required to adhere to APRA's board composition and representation requirements. There can therefore be overlap of directors on boards of banks and their wealth management subsidiaries, but the boards of banks' wealth management businesses generally include several independent directors. Any conflicts could also be reduced by the current prudential limits on banks' financial dealings with related entities and the requirement that banks' wealth management businesses clearly disclose the banks' and other group members' roles and responsibilities to customers. In addition, a number of regulations

exist that aim to reduce the risk of misconduct occurring. These include: regulations mandating clear disclosure of banks' roles and responsibilities in related non-bank businesses; comprehensive risk management frameworks for banking groups; and the Future of Financial Advice reforms, particularly the ban on conflicted remuneration structures for financial advisers and the requirement for financial advisers to act in the best interests of their clients.

Conclusion

The major banks' wealth management activities have not lived up to initial expectations for income growth and cross-selling opportunities, and are generating lower returns than core banking activities. However, these operations are, in most cases, generating returns in excess of the banks' costs of capital, and have reduced the volatility of banks' income through diversification. Ownership of these businesses exposes banks to a number of new risks, which the authorities have addressed through the regulation of these industries. In light of these developments, and the increased focus on capital requirements, banks have been rethinking the nature of their involvement in wealth management; in some cases, they have chosen to narrow the scope of their involvement in wealth management activities. Nonetheless, it appears that wealth management activities are likely to remain part of banks' businesses for the foreseeable future.

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GDP-linked Bonds

Joel Bowman and Philip Naylor*

A GDP-linked bond is a debt security with repayments that are linked to the issuing country's GDP. These securities have recently attracted some attention, including within the Group of Twenty (G20), in the context of discussions about possible ways to improve the resilience of the international financial system. In view of this, we discuss the potential benefits and challenges associated with issuing GDP-linked bonds and estimate a range of plausible risk premiums using the capital asset pricing model (CAPM). Our analysis suggests that there is significant uncertainty about how these instruments would be priced and, therefore, the borrowing costs that would be faced by governments. Given that borrowing costs play a crucial role in determining what type of debt governments choose to issue, further work could investigate how private market participants are likely to price GDP-linked bonds in practice.

Introduction

Governments typically issue bonds with fixed coupon payments. However, it is possible to issue bonds with coupon payments that are linked to a government's ability to repay. GDP-linked bonds, for which repayments are linked mechanically to the issuing country's GDP, are a commonly cited example of such an instrument. In principle, this type of debt is attractive because the issuing government's repayments would move with the country's economic growth, thereby improving its ability to service its debt during periods of weak economic activity and resulting in the ratio of debt to GDP being more stable than if the government borrowed using traditional fixed coupon debt. On the other hand, governments would be likely to need to pay a premium to investors in order to entice them to accept the risks associated with variable repayments.

To date, GDP-linked instruments have only been issued by governments as part of debt restructuring processes. For example, securities with some similarities to GDP-linked bonds were issued by several countries as part of the Brady restructuring process that started in 1989, as well as by Argentina in 2005, by Greece in 2012 and, most recently, by Ukraine in 2015. In each case, governments issued GDP-linked warrants, which offered higher returns in the event of a faster-than-expected recovery, thereby encouraging investors to accept a 'haircut' on their existing debt claims. However, these experiences provide limited guidance on the practicality of issuing GDP-linked bonds, as the GDP-linked warrants only provided investors with exposure to upside GDP risk (unlike GDP-linked bonds, which would also create an exposure to downside GDP risk). Also, each of the warrants varied considerably in their complexity and design (Bank of England (BoE) 2015). GDP-linked bonds can be structured in many ways. For example, principal and/or coupon payments could be linked to GDP, or the measure of GDP could be real or nominal.[1] However, regardless of their precise form, the benefits and challenges associated with issuing GDP-linked bonds are likely to be broadly similar. Members of the G20 have recently considered these benefits and challenges, which are explored further in this article.

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1 To address the challenge of different potential structures, the BoE is currently working on developing a standardised structure for GDP-linked bonds (BoE 2015).

The Benefits of GDP-linked Bonds

GDP-linked bonds have appealing attributes for both issuing governments and for investors. Their wider use could potentially enhance the resilience of the broader international financial system.

The primary benefit to a government of issuing GDP-linked bonds is its effect on debt sustainability. In particular, the government's burden of servicing its debt would be lessened during an economic downturn. More generally, the government's ratio of debt to GDP would be more stable than if it had borrowed using conventional bonds, holding all else constant. This is because the interest burden on GDP-linked debt would be positively related to economic growth, so any additional borrowing to cover debt-servicing costs would be lower during downturns and higher during upturns.

In addition to making a given level of debt more sustainable, GDP-linked bonds could also allow governments to increase their debt without putting at risk their ability to pay during periods of economic weakness. Previous studies have suggested that the use of GDP-linked bonds could increase the level of debt that a government can sustainably service as a share of GDP by up to 100 percentage points (Barr, Bush and Pienkowski 2014). Moreover, the use of GDP-linked bonds could also increase the scope for stimulatory fiscal policy during downturns, as the interest burden would decline as GDP growth eases. This option may be particularly attractive for governments of emerging market economies, which may otherwise face pressure to reduce their debt during a recession in order to restore market confidence. Alternatively, governments could choose to reduce their level of debt by keeping their debt repayments constant and allowing their repayments of principal to increase as their interest costs decline.

For investors, GDP-linked bonds would provide an opportunity to gain direct exposure to economic growth. Although equity markets currently provide this to some extent, the relationship between equity returns and economic growth is generally imperfect, in part reflecting differences in the sectorial composition of the equity market and the broader economy. In exchange for investors taking on the risk associated with having a direct exposure to a country's economic growth, investors are likely to demand a higher return.

Finally, it has been claimed that the issuance of GDP-linked bonds could generate positive spillovers. GDP-linked bonds could benefit holders of the issuing government's conventional bonds, as GDP-linked bonds might reduce a government's default risk (Chamon and Mauro 2005). The improvement in debt sustainability could also benefit other nations, since sovereign defaults often lead to contagion and turbulence in foreign financial markets more generally.[2]

Challenges Associated with GDP-linked Bonds

In practice, however, there are several factors that may discourage governments from issuing GDP-linked bonds or dissuade investors from purchasing them. These can broadly be grouped into problems associated with adverse selection, moral hazard and developing a market for a new product.

An adverse selection problem may arise if governments are more likely to issue GDP-linked bonds when they expect growth to be weak and therefore expect repayments to be low in the near term. If investors consider this adverse selection problem to be material, the issuance of GDP-linked bonds could cause them to revise down their expectations of growth for the issuing country. This could lead to higher premiums on both GDP-linked and conventional bonds for the issuer and could, in turn, create debt-servicing challenges for the government.

2 Sovereign defaults could also have adverse spillover effects on other countries' economic growth, although there is a significant degree of uncertainty around the size of these effects. In related research, De Paoli, Hoggarth and Saporta (2009) found a wide distribution in the size of effects of past sovereign defaults on domestic economic growth.

Concerns have also been raised in the literature that GDP-linked bonds could introduce moral hazard, because governments may have some incentive to stymie growth in an effort to reduce their borrowing costs. However, this incentive should not be overstated and ignores damage to the government's general revenue as well as the significant domestic political pressures to support growth and keep unemployment low (Chamon and Mauro 2005; Griffith-Jones and Sharma 2006). Governments that issue GDP-linked bonds could also have an incentive to manipulate published GDP data to show lower growth in order to reduce the cost of servicing their debt. This incentive could, in turn, undermine investor confidence in GDP-linked bonds and increase the premium that investors demand for holding these securities. However, these challenges could be mitigated by strengthening the independence of national statistical agencies or by involving international organisations in data verification.

As with any new financial instrument, the development of a market for GDP-linked bonds could also face some initial challenges as issuers and investors gain familiarity with the product. These challenges could include concerns about a lack of liquidity, a lack of existing markets for hedging GDP growth risk and difficulties in pricing – especially given the potentially complex nature of some GDP-linked products (Griffith-Jones and Sharma (2006); also discussed below). To a large degree, these issues could be expected to dissipate as markets for GDP-linked bonds become more established. However, the high initial costs of issuing the first GDP-linked bonds may discourage governments from doing so. The 'first-mover' problem is often cited as a reason why international coordination is needed to develop the market for GDP-linked bonds. For example, Brooke *et al* (2013) suggest that international organisations could play a role in helping to coordinate GDP-linked bond issuances by a number of countries. Greater coordination could also potentially alleviate the adverse selection problem described previously, particularly if the group of issuing governments includes some sovereign entities with relatively high credit ratings.

Costs of GDP-linked Bonds

In assessing the benefits and challenges of issuing GDP-linked bonds, a critical consideration is the borrowing costs for the government. Given that there is no clear historical precedent, the cost of issuing GDP-linked bonds, which includes the premiums demanded by investors, is highly uncertain. However, it is likely that investors would demand a higher return on GDP-linked bonds than they would on conventional bonds. If the premium is too high, the government's borrowing costs over the life of the bond would outweigh the benefits associated with the lower burden of servicing these bonds during economic downturns.

The total premium paid on GDP-linked bonds, relative to conventional bonds, would be composed of four sub-premiums (Blanchard, Mauro and Acalin 2016):

- A *liquidity premium* is required to compensate investors for the degree of difficulty in converting the asset into cash at fair market value.
- A *novelty premium* is the additional return investors would demand on new, unfamiliar investment products.
- A *default premium* is required to compensate investors for the risk that the debtor will not make the required repayments (this could theoretically be negative, if GDP-linked bonds were to make debt more sustainable).
- A *growth risk premium* is unique to GDP-linked bonds and is required to compensate investors for taking on some of a country's economic growth risk.

The liquidity and novelty premiums could be high initially but would be likely to decrease over time and could become negligible if the market for GDP-linked bonds were to develop sufficiently.

For example, Costa, Chamon and Ricci (2008) found that the novelty premium on Argentina's GDP-linked warrants declined by about 600 basis points during the first year and a half. The default risk of GDP-linked bonds would be closely linked to the size of the premiums on existing debt, but would also depend on the extent to which investors perceive the issuance of GDP-linked bonds as having changed the sustainability of the issuer's debt. The growth risk premium will depend on investors' outlooks for the issuing country's GDP growth and the level of uncertainty surrounding these projections.

Assessing the likely size of the growth risk premium is therefore critical in determining the viability of GDP-linked bonds, because the liquidity and novelty premiums are likely to dissipate over time and the default premium is likely to be closely linked to the default premiums inherent in other sovereign securities on issuance. The literature has therefore focused on estimating the size of the growth risk premium as the most important medium-term independent influence on the cost of issuing GDP-linked bonds.

The growth risk premium

Previous studies have estimated that the benefits of issuing GDP-linked bonds are likely to outweigh the costs if the growth risk premium is less than 200–350 basis points (Barr *et al* 2014; Blanchard *et al* 2016). Other studies have estimated that the growth risk premium is likely to be somewhat lower, at around 150 basis points or less (Miyajima 2006; Kamstra and Shiller 2009). While this suggests that governments would benefit from issuing GDP-linked bonds, there is considerable uncertainty surrounding the estimates of the growth risk premium.

Previous estimates of the growth risk premium have generally been underpinned by the CAPM.[3] The CAPM estimates investors' required returns from an asset given the degree of systematic 'risk' – that is, risk that cannot be avoided by holding a diversified portfolio of assets. The premise underlying the CAPM is that investors are risk averse and care only about the mean and variance of expected returns. More precisely, the CAPM calculates the price of a risky security using the relationship between the relative riskiness of the security and that of the 'market portfolio', as shown in Equations (1) and (2) below.

$$\hat{r}_i = r_f + \beta_i\left[E\left(r_m\right) - r_f\right] \tag{1}$$

$$\beta_i = \frac{cov\left(r_i, r_m\right)}{var\left(r_m\right)} = \left(\rho_{r_i, r_m}\right)\left(\frac{\sigma_{r_i}}{\sigma_{r_m}}\right) \tag{2}$$

Where, in the context of GDP-linked bonds, $\hat{r}_i$ is the required return on a GDP-linked bond, r_f is the risk-free rate, $E\left(r_m\right)$ is the expected return on a 'market portfolio' and β_i is the 'beta' of a GDP-linked bond (the measure of risk). The beta is estimated by dividing the covariance of returns on the GDP-linked bond and the market portfolio (that is, the degree to which they move together) by the variance of the returns on the market portfolio (the spread of returns). Beta can also be expressed as the product of the correlation coefficient between returns on the GDP-linked bond and the market portfolio $\left(\rho_{r_i, r_m}\right)$ and the ratio of the respective standard deviations of returns on the GDP-linked bond and market portfolio $\left(\sigma_{r_i} / \sigma_{r_m}\right)$. Intuitively, the beta term suggests that investors should seek higher returns on an asset

3 Previous studies have also developed various models to assess the sensitivity of the theoretical price of GDP-linked bonds to a number of variables. Miyajima (2006), using a discounted cash flow model, shows that the theoretical price of GDP-linked bonds is sensitive to investors' central projections of a country's GDP growth as well as the uncertainty around these estimates. Chamon and Mauro (2005), using a Monte Carlo framework, found that GDP-linked bonds reduce the probability of default and therefore the required return on conventional bonds assuming that default occurs as soon as the debt-to-GDP ratio exceeds a critical level. More recently, Barr *et al* (2014) explored the benefits of GDP-linked bonds using a calibrated model of endogenous sovereign default.

if its returns are highly correlated with, and more volatile than, the market portfolio – since it exposes the investors to a higher degree of systematic risk.

The growth risk premium is calculated by multiplying the beta of the asset with the expected market premium $\left(E\left(r_m\right)-r_f\right)$. This means that if a country's GDP growth is closely correlated with returns on the market portfolio and/or is relatively volatile it will have a higher beta and, hence, a higher growth risk premium.

The CAPM, like all financial models, is subject to a number of assumptions and is only illustrative (see Fama and French (2004)). In practice, there is considerable uncertainty involved in pricing financial instruments using the CAPM. In view of this, the robustness of the estimates are tested in three ways by: considering several alternative market portfolios; examining a variation of the CAPM that focuses on downside risks that investors face – the downside CAPM (D-CAPM); and adopting a rolling estimation approach in order to examine the variability of the premiums over time.

Effects of different assumptions about the market portfolio

While the market portfolio should include all types of assets held by investors, such a portfolio is not observable in practice (Roll 1977). This is important, since the market portfolio influences the estimate of both β_i and $\left[E\left(r_m\right)-r_f\right]$ and can therefore have a significant effect on the estimated cost of debt $(\hat{r}_i)$.

For these reasons, studies that have estimated the growth risk premium on GDP-linked bonds have considered several possibilities for the market portfolio: a US equity index, US GDP growth, a world equity index and world GDP growth (Borensztein and Mauro 2004). To highlight the impact of the market portfolio on the growth risk premium, we estimate the growth risk premium for all G20 members (excluding the European Union), using these four market portfolios.[4] More specifically:

- To measure the return on the market portfolio r_m we use annual data from 1989 to 2015 for four different benchmarks: world real GDP growth, US real GDP growth, world equity market returns deflated by a global measure of consumer prices (i.e. a world CPI), and US equity market returns deflated by the US CPI.
- For the expected market rate of return $E\left(r_m\right)$, we use the International Monetary Fund's (IMF) April 2016 *World Economic Outlook* projected growth rates five years ahead for world real GDP growth and US real GDP growth and assume that the expected market rate of return on world equities and US equities is equal to the long-run average return on US equities of 6.5 per cent (Siegel 2014).
- To measure the return on country *i's* hypothetical GDP-linked bond, $\hat{r}_i$, we use that country's real GDP growth rate.
- We assume a real risk-free rate r_f of zero, which is broadly consistent with US 10-year Treasury inflation-index bond yields at around the time of publication.[5]

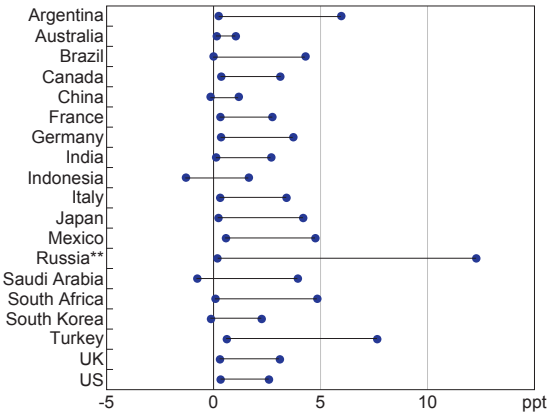
Our results show that the choice of the market portfolio has a large effect on the estimate of the growth risk premium across our sample of countries (Graph 1).[6] Consistent with the literature, for all of the 19 countries examined, the growth risk premium was highest when world GDP growth was

4 The data for real GDP and for CPI are from the IMF's *World Economic Outlook* database. The MSCI World Index is used for world equities and S&P 500 is used for US equity market returns, both of which are price, rather than total return, indices and are sourced from Bloomberg. Equity returns data are lagged by one year, consistent with the methodology used in the existing literature.

5 Although the real risk-free rates are currently low, assuming a real risk-free rate of zero produces projected market risk premiums that are close to the historical medians when using US and world equity markets as the market benchmark, but produces slightly higher projected market risk premiums when using world and US GDP as the market benchmark.

6 The estimated growth premiums may change over time to the extent that GDP-linked bonds reduce the probability of a crisis, and hence the potential relationship between domestic growth and the market portfolio.

Graph 1
Growth Premium Estimates – Different Market Portfolios*
Based on CAPM



* The graph range represents the minimum and maximum estimates of the growth risk premium using world GDP, US GDP, world equities and US equities as the benchmark portfolio

** Restricted sample beginning in 1993; estimates for all other countries use the full sample from 1989 to 2015

Sources: Bloomberg; IMF; RBA

used as the market portfolio and was, on average, 350 percentage points higher than the average of the three alternatives.[7] This is because GDP growth rates for most countries tend to be more closely correlated with world GDP than with US GDP, world equities or US equities. For almost half of the countries examined, the highest estimated cost would be large enough to make the issuance of GDP-linked bonds undesirable, based on the aforementioned finding that the benefits would outweigh the cost if the growth risk premium is less than 350 basis points. If, instead, the lower threshold value of 200 basis points is used, then issuance would be too costly for 16 of the 19 countries in the sample. For each country, any assessment of the costs of issuing GDP-linked bonds would need to be carefully weighed against the benefits, which may also vary by country and are not considered in this article.

7 Four of the countries sampled were estimated to have negative growth risk premiums (at the lower end of the range). Negative growth risk premiums occur when there is a negative correlation between a country's GDP growth and the returns on the market portfolio. Financial products that have a negative correlation with the market portfolio provide investors with a measure of insurance against a decline in the value of the market portfolio. This means that they should be willing to pay rather than receive a premium in exchange for investing in these products.

The D-CAPM framework

One of the criticisms of the CAPM is that it assumes that investors place equal weight on above-average and below-average returns when assessing the riskiness of an asset. However, in practice, investors may care more about below-average returns. Furthermore, the CAPM assumes that the distribution of expected returns is symmetrical, which means that above-average outcomes are assumed to be just as likely as below-average outcomes. There is evidence that this is often not the case, with many financial assets subject to much more downside risk than upside risk (Bakshi, Kapadia and Madan 2003). This phenomenon is particularly relevant for GDP-linked bonds, since economic growth tends to be slightly above average for extended periods of time whereas downturns tend to be deep but shorter in duration (Morley and Piger 2012).

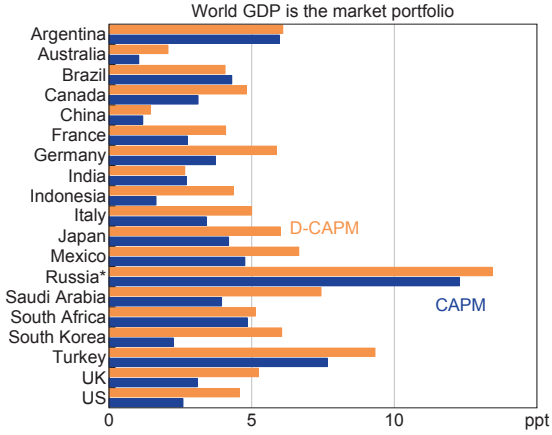
In contrast to the standard CAPM, the D-CAPM focuses on the variation of below-average returns. As such, the D-CAPM framework may be better suited to capturing risk aversion and asymmetric returns. Specifically, the D-CAPM framework uses an alternative beta, which, following Estrada (2007), is expressed below.

$$\beta^{D} = \frac{\text{cov}\left(r_i, r_m \middle| \left[r_m < \overline{r}_m; r_i < \overline{r}_i\right]\right)}{\text{var}\left(r_m \middle| r_m < \overline{r}_m\right)} \tag{3}$$

Where, in the context of GDP-linked bonds β^{D} is the downside beta, r_i is the GDP-linked bond's return (country *i's* real GDP growth), r_m is the market return on the benchmark portfolio, $\overline{r}_i$ is the mean historical return on the GDP-linked bond (country *i's* average real GDP growth), and $\overline{r}_m$ is the mean historical return on the benchmark portfolio. The D-CAPM therefore estimates beta in a similar way to the CAPM, but only includes observations when returns on *both* the benchmark portfolio and the GDP-linked bond are below their historical average.

The D-CAPM has been found to reflect prices of emerging market debt securities more accurately compared with the CAPM (Estrada 2007), which suggests it may also be a useful framework for gauging how GDP-linked bonds could be priced.[8] Our results show that the D-CAPM leads to slightly higher estimates of the growth risk premium for 17 countries in our sample of 19.[9] Graph 2 demonstrates this difference when world GDP is used as the market portfolio.[10]

Graph 2
Growth Premium Estimates – CAPM and D-CAPM
World GDP is the market portfolio



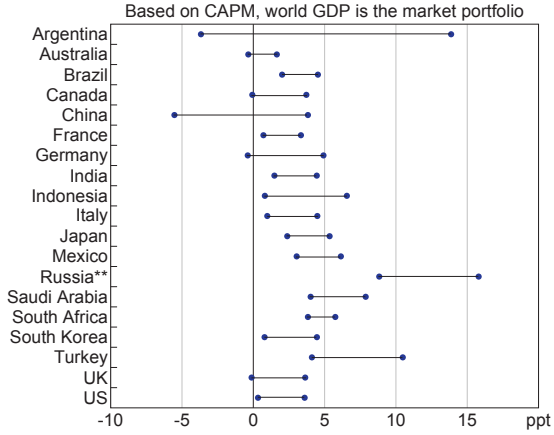
* Restricted sample beginning in 1993; estimates for all other countries use the full sample from 1989 to 2015

Sources: Bloomberg; IMF; RBA

Rolling estimation window

Finally, a large body of work finds that risk premiums in financial markets vary considerably over time (see, for example, Engle, Lilien and Robins (1987)). This raises additional uncertainty about the time frame that investors would use to price GDP-linked bonds, which in turn has implications for both the β_i and $\left[E(r_m)-r_f\right]$ components of the estimated GDP risk premium in Equation (1). To examine this, we estimate the CAPM over 15-year rolling windows, generating a wide range of growth risk premiums. Focusing on the minimum and maximum estimates across the rolling windows, our results highlight the substantial effect that the choice of the sample period can have on the estimated size of the growth risk premiums (Graph 3).[11]

Graph 3
Growth Premium Estimates – Different Time Periods*
Based on CAPM, world GDP is the market portfolio



* Based on 15-year rolling window

** Restricted sample beginning in 1993; estimates for all other countries use the full sample from 1989 to 2015

Sources: Bloomberg; IMF; RBA

Conclusion

In principle, GDP-linked bonds have features that appeal to both issuers and investors. If used widely, GDP-linked bonds also have the potential to improve the sustainability of sovereign debt and reduce the likelihood of default, thereby enhancing the resilience of the international financial system. In practice, however, there are many factors that may discourage governments from issuing

8 The study focused on emerging markets as they are likely to be susceptible to much larger downside shocks than advanced economies.

9 We use annual data from 1989 to 2015 to estimate $\overline{r_m}$ and $\overline{r_f}$. The estimated premiums can be less under the D-CAPM relative to the CAPM. This can occur when the covariance between the financial asset and market portfolio returns are greater when both experience above average returns relative to below average returns.

10 This finding is not sensitive to the choice of the market portfolio. Under the D-CAPM, the average estimated premium is 1.5 percentage points higher than the CAPM when world GDP is used as the market portfolio, compared to 0.8, 0.2 and 0.3 percentage points for US GDP, world equities and US equities, respectively.

11 The average difference between the minimum and maximum estimates when world GDP is used as the market portfolio is 4.8 percentage points compared to 2.6, 0.6 and 0.5 percentage points for US GDP, world equities and US equities, respectively.

GDP-linked bonds and/or investors from purchasing them. The estimated cost of borrowing is also critical in assessing the practicality of GDP-linked bond issuance from a government's perspective. This article highlights that the cost of borrowing using GDP-linked bonds is highly uncertain, largely due to the wide range of estimates for the growth risk premium. Given this, further investigation into GDP-linked bonds could draw on liaison with private market participants, particularly potential investors, to better understand how GDP-linked bonds are likely to be priced in practice.

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Sources of Financial Risk for Central Counterparties

Jennifer Hancock, David Hughes and Suchita Mathur*

Central counterparties (CCPs) play an important role in managing the risks present in financial markets and in increasing the overall stability of the financial system. This requires CCPs to be sufficiently financially resilient so that they can withstand extreme but plausible events that would pose significant stress. As use of CCPs becomes more widespread, increasing attention is being paid to how CCPs conduct stress tests to evaluate the adequacy of their financial resources. This article describes the sources of, and the circumstances in which CCPs are exposed to, financial risks and how CCPs typically manage these risks.

Introduction

CCPs act as the buyer to every seller and the seller to every buyer through a process known as 'novation'. By substituting the numerous bilateral exposures of a clearing participant with a single multilateral net exposure to a CCP, central clearing simplifies the network of interconnections between financial institutions and reduces total exposure. These arrangements provide substantial benefits to participants in terms of counterparty risk management.

Four CCPs are currently licensed to operate in Australia and are therefore subject to joint supervision and oversight by the Reserve Bank and the Australian Securities and Investments Commission. Two of these CCPs are domestically incorporated subsidiaries of ASX Limited.

- ASX Clear Pty Limited clears ASX-quoted cash equities, debt products and warrants traded on the Australian Securities Exchange and Chi-X Australia markets, and equity-related derivatives traded on the ASX market.
- ASX Clear (Futures) Pty Limited clears futures and options on interest rate, equity, energy and commodity products, as well as Australian dollar-denominated over-the-counter (OTC) interest rate derivatives (IRD).

The other two CCPs – LCH.Clearnet Limited and Chicago Mercantile Exchange Inc. – are overseas CCPs whose operations in Australia primarily involve clearing OTC IRD.

As part of their response to the global financial crisis, in 2009 the G20 Leaders committed to ensuring that all standardised OTC derivatives contracts are cleared through CCPs (G20 2009). Increased use of CCPs is intended to enhance financial stability, but this relies on CCPs being sufficiently financially resilient so that they can withstand even extreme stresses. Consequently, both regulators and market participants are paying increasing attention to how CCPs conduct stress tests to evaluate the adequacy of their financial resources (for example, JPMorgan Chase 2014; FSB *et al* 2015; ISDA 2015). A key part of evaluating the stress testing policies and practices of CCPs is understanding the sources of financial risk they face. This article discusses the sources of financial risk that CCPs are exposed to, including the

* The authors are from Payments Policy Department and would like to thank Mark Chambers for valuable comments during the preparation of this article.

circumstances in which these risks arise and how they are typically managed.

Financial Risks and Risk Management

The main financial risks faced by CCPs are related to credit and liquidity:

- *Credit risk* is the risk that the CCP will be unable to fully meet its financial obligations when required.
- *Liquidity risk* is the risk that the CCP will have insufficient funds to meet its financial obligations as and when expected – even though it may be able to do so in the future.[1]

The international standards for CCPs, the *Principles for Financial Market Infrastructures* (PFMI) (CPSS-IOSCO 2012), set out how CCPs are expected to manage credit and liquidity risks.[2] The PFMI require that a CCP maintain sufficient resources to cover the credit and liquidity exposures in a wide range of potential scenarios, including the default of the participant (and its affiliates) that the CCP has the largest potential exposure to in extreme but plausible scenarios.[3,4] To test the sufficiency of its resources, CCPs are required to conduct rigorous daily stress tests. In doing so, CCPs are expected to consider exposures to both clearing participants and other entities, such as investment counterparties and liquidity providers.

A CCP's financial resources are typically sourced from margin and the default fund contributions of participants or the CCP's own assets (referred to as 'skin in the game').[5] There are two main types of margin that a CCP typically collects:

- *Initial margin* is collected from participants to cover potential future exposures to a participant as a result of adverse changes in the value of the portfolio.
- *Variation margin* is designed to settle the mark-to-market changes in the value of participant's portfolios. It is paid by participants that have made a mark-to-market loss and (often) paid to participants that have made a mark-to-market gain.

To the extent that variation margin is paid to participants that have made a mark-to-market gain it is no longer part of the CCP's available financial resources.

The PFMI restrict CCPs to accepting collateral with low credit, market and liquidity risks to ensure that these assets maintain their value and are readily convertible to cash to cover losses when required. CCPs typically apply 'haircuts' to the value of non-cash collateral that is provided by participants to reflect the potential for changes in the value of collateral between the time that it was last marked to market and the time it may take the CCP to liquidate it following a default.[6] The PFMI also require that CCPs limit their investments to instruments with minimal credit, market and liquidity risks. These restrictions are important as a participant default is likely to coincide with stressed market conditions when the CCP is likely to need to liquidate collateral or investments.

When assessing the sufficiency of its resources to meet liquidity risks, the PFMI limit the 'qualifying liquid resources' to:

- cash (that is, at-call deposits) at the central bank of issue;
- cash at a creditworthy commercial bank;

1 Although CCPs are exposed to other types of risk, such as business and legal risks, they are beyond the scope of this article.

2 The relevant standard-setting bodies (the Committee on Payments and Market Infrastructures (CPMI), formerly the Committee on Payments and Settlement Systems (CPSS), and the International Organization of Securities Commissions (IOSCO)) recently released for consultation guidance intended to provide further clarity and granularity on aspects of the PFMI related to a CCP's financial resilience.

3 A CCP that is involved in activities with a more complex risk profile or that is systemically important in multiple jurisdictions is expected to maintain sufficient resources to cover the default of the *two* participants and their affiliates that would potentially cause the largest aggregate credit exposure to the CCP in extreme, but plausible, market conditions.

4 If a CCP's available financial resources are insufficient to absorb the loss, the CCP is expected to have tools to fully allocate the loss. For further discussion of these tools, see Gibson (2013).

5 For more information on these financial resources, see Carter and Garner (2015).

6 Participants lodging cash collateral typically do not face haircuts.

- committed lines of credit;
- committed foreign exchange swaps;
- committed repurchase agreements;
- highly marketable collateral that is readily available and convertible into cash with prearranged and highly reliable funding arrangements, even in extreme but plausible market conditions; or
- collateral that is eligible for pledging to (or for conducting other appropriate forms of transactions with) the relevant central bank, but only to the extent that the CCP has access to routine, and non-discretionary, credit at that central bank.

This definition is more restrictive than the requirements around collateral and investments, which means that not all available financial resources will necessarily be considered sufficiently liquid to be considered when assessing a CCP's management of liquidity risks.

Day-to-day Risks

In the absence of a counterparty default, a CCP's financial obligations are balanced. This is because its positions are created through novation, so for each long (buy) position there is a matching short (sell) position. Similarly, a CCP's financial obligations in relation to the collateral it has received from participants are typically matched by the assets it holds. However, a CCP needs to manage the liquidity risks that arise in its day-to-day operations, as well as in the event of default. A CCP's day-to-day liquidity requirements arise from timing mismatches including, but not limited to, a need to:

- Return initial margin – either following the closing out of positions or a request to withdraw excess collateral – that was provided as cash and has been reinvested in another asset[7,8]
- Pay out variation margin before all variation margin has been received from participants
- Fund the initial settlement of deliverable instruments (such as securities) where settlement occurs on an individual gross basis (known as delivery-versus-payment model 1, DvP 1).[9] The proceeds of that settlement can then be used to settle further obligations, with the CCP, in normal circumstances, ending the day with the same assets with which it started.

The last two of these requirements can be minimised or eliminated through the design of the CCP's operations. For example, if a CCP pays out variation margin only after it has received it from participants, there will be no net liquidity need. Similarly, if the securities settlement system used by the CCP settles obligations on a simultaneous net basis (known as delivery-versus-payment model 3, DvP 3), the CCP's obligations for both securities and cash will net to zero and there will be no net liquidity need. Even where the securities settlement system is on a DvP 1 basis, the amount of liquidity required can be minimised by 'shaping' settlement obligations (that is, splitting large settlement obligations into smaller parcels that can be settled sequentially).

Risks from a Clearing Participant Default

A CCP's credit and liquidity risks crystallise following the default of one or more clearing participants as the CCP's obligations are then no longer balanced. Until the defaulting participant's positions can be replaced, the CCP is exposed to changes in the value of the defaulter's portfolio as the CCP must

7 It is assumed that non-cash margin posted by participants is not re-used or 'rehypothecated' by the CCP.

8 While a CCP will also need liquidity to return clearing participant contributions to mutualised default resources (typically referred to as the default fund or clearing fund) if that clearing participant resigns, there is typically sufficient delay between the notice of resignation and when the funds are due to be returned, which should allow the CCP to liquidate the investment prior to fulfilling this obligation.

9 For more information on DvP models, see BIS (1992).

guarantee the equivalent financial obligations to other clearing participants until its exposure can be closed out.[10] This close-out period is expected to be short – typically between two and five days.[11]

Cash-settled instruments

The main source of risk for cash-settled instruments, such as many derivatives, is variation margin. During the close-out period, the CCP must meet variation margin obligations to the non-defaulting participants. This may involve a payment or a receipt, depending on the direction of the position and the daily price movements. When the CCP closes out the exposure, it will also need to pay for the offsetting position, which will be equivalent to the mark-to-market change in the price of the position. Over the close-out period, the obligations may offset, in which case the credit exposure will be less than the liquidity exposure, as the liquidity requirement is driven by the peak financial obligation at any point in time. The net credit exposure will be a function of the cumulative variation margin plus the cost of closing out the position.

Deliverable instruments

Often CCPs that clear deliverable instruments do not pay out variation margin to participants with a net mark-to-market gain; instead the CCP holds these funds until settlement, so they do not face this source of risk. However, a CCP that clears deliverable instruments will need to take on the defaulter's obligation to purchase the instruments delivered to the CCP by the defaulter's counterparties. The CCP is required to fulfil this obligation as and when the instruments are due to be delivered. To close out its exposure, the CCP will then resell these instruments, with the difference between the sale and the purchase price, less any net variation margin received on the position, representing the credit exposure. However, since the resale of the instrument occurs after the purchase, this creates a liquidity need in excess of the credit exposure due to the need to fund the purchase over that period. The liquidity need will evolve over time until all the deliverable instruments purchased by the CCP have been successfully resold (see 'Box A: Liquidity Exposures from Securities Settlement').

CCPs that clear deliverable instruments will also have an obligation to deliver instruments that the defaulter had sold but was yet to settle.[12] As is the case with purchase obligations, this exposes the CCP to the cost of replacing the position, since the cost of purchasing the instruments following the default of a clearing participant may be higher than the originally contracted sale price plus any variation margin received from the defaulter for this position. The liquidity exposure from this delivery obligation depends on whether there is a timing difference between the settlement of the purchase and sale of the instruments. Since the CCP cannot deliver an instrument until after it has been purchased, this timing difference is likely to be much shorter than when a CCP is closing out a defaulter's obligation to purchase a deliverable instrument. Indeed, if transactions are settled on a simultaneous net basis (DvP 3), the CCP only has to fund the net difference between the sale and purchase prices (that is, the liquidity exposure equals the credit exposure). Even under DvP 1 settlement, in which transactions are settled individually, the CCP can often 'shape' the settlements so that only part of the purchase is required to be funded before some funds are received from the settlement of the instruments due to be sold by the defaulting clearing participant.

10 This is typically done either by entering into an offsetting position on exchange or through an auction process with the surviving clearing participants for OTC products.

11 Close-out times will vary depending on product type; liquid exchange-traded products would generally take less time to close out than less liquid OTC products.

12 This exposure may be mitigated by the extent to which the defaulting participant had pre-positions on some (or all) of the securities due to be delivered into their settlement account, which are available to settle the defaulter's obligation.

Box A
Liquidity Exposures from Securities Settlement

Consider the example of a defaulter that had agreed to purchase securities two days prior to and the day before its default (Table A1).[1] For simplicity, assume that the CCP only clears one type of security (S) and that no variation margin is collected or paid.[2] On the day of the default (t), the CCP is required to finalise the purchase of S_{t-2} securities at the price agreed on two days prior, p_{t-2}, resulting in a liquidity requirement of $S_{t-2}\,p_{t-2}$. The CCP can contract to sell these securities at the current market price (p_t) with settlement occurring in two days. Similarly, on the following day, the CCP is required to finalise the purchase of S_{t-1} securities at price p_{t-1} and agrees to sell them at the new price p_{t+1}. The cumulative liquidity requirement on the day following the default is then $S_{t-2}p_{t-2} + S_{t-1}\,p_{t-1}$. The sales of securities occur over the next two days, allowing the CCP to recoup the funds outlaid for their purchase and reducing the outstanding use of liquid funds to the final level: $S_{t-2}\,(p_{t-2} - p_t) + S_{t-1}(p_{t-1} - p_{t+1})$; this represents the credit exposure from these positions. The liquidity need is determined by the peak cumulative liquidity requirement, which, in this example, occurs on day $t + 1$.

Table A1: Hypothetical Liquidity Exposures for a Securities CCP
Following the default of a clearing participant with obligations to buy securities

Day	Event	Daily liquidity requirement	Cumulative liquidity requirement
t	Clearing participant defaults		
	CCP settles purchase of securities bought by defaulter on $t-2$		
	CCP contracts to sell securities on $t+2$	$S_{t-2}\,p_{t-2}$	$S_{t-2}\,p_{t-2}$
$t+1$	CCP settles purchase of securities bought by defaulter on $t-1$		
	CCP contracts to sell securities on $t+3$	$S_{t-1}\,p_{t-1}$	$S_{t-2}\,p_{t-2} + S_{t-1}\,p_{t-1}$
$t+2$	CCP settles sale of securities purchased on t	$-S_{t-2}\,p_t$	$S_{t-2}(p_{t-2} - p_t) + S_{t-1}\,p_{t-1}$
$t+3$	CCP settles sale of securities purchased on $t+1$	$-S_{t-1}\,p_{t+1}$	$S_{t-2}(p_{t-2} - p_t) + S_{t-1}(p_{t-1} - p_{t+1})$

Source: RBA

1 The timeline in this example is consistent with the cash equities market in Australia, where trades are settled on a $t+2$ basis, where the actual transfer of cash for equity ownership (settlement) occurs two days after the trade is contracted.

2 If variation margin was collected on a next day basis then by day t the CCP would have received $S_{t-2}(p_{t-2} - p_{t-1})$. If the CCP does not pay out variation margin then it would be holding these funds and could use them to fund the obligations in Table A1. If the CCP pays out variation margin then the cost of the securities the defaulter had contracted to purchase on day $t-2$ would be $S_{t-2}\,p_{t-1}$.

Consider a further example where the defaulter had contracted to sell S'_{t-2} securities at price p'_{t-2} and S'_{t-1} securities at price p'_{t-1}. Again, assume that the CCP only clears one type of security with a two-day settlement cycle and that no variation margin is exchanged.[3] If the clearing participant defaults prior to the delivery of the securities at time t, the CCP must fulfil the defaulter's obligation to deliver the securities. To do so, it must first purchase S'_{t-2} and S'_{t-1} securities at the current market price p'_t. If p'_t is greater than p'_{t-2} and p'_{t-1}, the CCP incurs a loss of $S'_{t-2}(p'_t - p'_{t-2}) + S'_{t-1}(p'_t - p'_{t-1})$, which represents the CCP's credit exposure. As noted above, the liquidity requirement would depend on whether there is a timing difference between the settlement of the purchase and sale of the securities.

3 If variation margin was collected on a next day basis then the CCP would either have $S'_{t-2}(p'_{t-2} - p'_{t-1})$ or its obligation would be reduced by this amount.

Risks from the Default of Other Entities

As well as exposures to clearing participants, CCPs also face risks from the default of other entities that may affect the CCP's ability to meet its financial obligations as and when they fall due. These include risks related to:

- *Investment counterparties.* The default of an investment counterparty will result in a (potentially significant) reduction in the CCP's financial resources where the value received from the liquidator is less than the CCP's exposure to that counterparty (taking into account collateral held by the CCP where it exists). These risks can be managed by ensuring that counterparties are of high credit quality, minimising the size of unsecured exposures to any single counterparty and investing on a secured basis where possible. It is also likely that there will be delays in receiving funds from the liquidator, creating an additional liquidity exposure for the CCP.
- *Collateral issuers.* The default of a collateral issuer will create an obligation for the participant (or investment counterparty) to replace the collateral it provided, which it is usually required to do by the following business day. However, until this occurs the CCP faces a temporary decline in its financial resources.
- *Liquidity providers.* CCPs may use committed liquidity facilities with other institutions as a source of qualifying liquid resources. However, the default of a liquidity provider means that the CCP may be unable to convert its collateral into liquid resources when necessary. As CCPs typically hold sufficient liquid assets to meet their day-to-day liquidity requirements, in the absence of the default of a participant or an investment counterparty the CCP may not have an immediate need for these liquid assets.
- *Settlement banks, custodian banks, securities settlement systems and central securities depositories.* A problem at (including the default of) one of these entities may impede a CCP's access to the CCP's financial resources. For example, a problem at a securities settlement system, central securities depository or custodian may temporarily prevent a CCP from accessing collateral held at that entity, making it temporarily unavailable to access liquidity

to meet payments as and when they fall due. Similarly, a problem at a settlement bank could delay the receipt of payments due to the CCP that it may require to fund outgoing payments. However, as with the case of liquidity providers, a CCP may not have an immediate need for these liquid assets.

Conclusion

Understanding the sources of financial risk that CCPs face is a key part of evaluating the stress testing policies and practices of CCPs. The main financial risks faced by CCPs are related to credit and liquidity. Although CCPs will typically be exposed to liquidity risks in their day-to-day operations, following the default of a participant or other counterparty the CCP will face both credit and liquidity exposures. The sources of financial risk that a CCP faces in a default scenario will vary depending on the type of counterparty and, for clearing participant defaults, the type of instrument being cleared. To ensure that they have sufficient resources to cover the credit and liquidity exposures in a wide range of scenarios, CCPs need to consider all relevant sources of financial risk in their stress testing.

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