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Realisation Ratios in the Capital Expenditure Survey

Leon Berkelmans and Gareth Spence*

The Australian Bureau of Statistics capital expenditure survey is one of the inputs into the Reserve Bank's forecasts for private business investment. This article considers several methods for interpreting the expectations data from this survey and evaluates these methods using out-of-sample forecasts. Forecasts based on long-run average realisation ratios are found to be the most accurate of the options considered, although the use of these forecasts for predicting investment in the national accounts yields mixed results.

Introduction

Business investment reached 18 per cent of output in the second half of 2012, its highest share in over 50 years. This share has since declined and is expected to continue to decline, although by how much and over what period is unclear.

The Reserve Bank uses a variety of sources of information to guide its forecasts of business investment (Connolly and Glenn 2009). One potentially useful source is the quarterly Australian Bureau of Statistics capital expenditure survey (Capex survey). This survey provides expectations of capital expenditure for up to 18 months ahead, with breakdowns available by industry and type of asset.

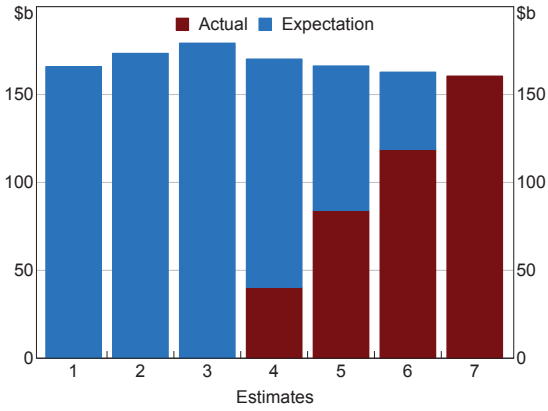
The expectations of capital expenditure are, naturally, subject to a degree of uncertainty, and final outcomes can differ substantially from earlier expectations. In other words, sometimes more or less of the earlier expected investment is realised. This article examines these errors in the investment expectations component of the survey, and considers the best method of adjusting the raw expectations in order to minimise these errors. Out-of-sample forecasting exercises indicate that adjusting for long-run bias appears worthwhile, but further adjustments that attempt to use information on the state of the business cycle are not. The ability of these forecasts to predict investment in the national accounts is also considered, with mixed results.

* The authors completed this work in Economic Analysis Department.

The Capex Survey

The Capex survey provides information on actual capital expenditure in the most recent quarter, along with firms' capital expenditure expectations. The expectations component of the survey is one of the few sources of information that quantifies the value of firms' expected investment. These expectations provide capital expenditure estimates for up to 18 months into the future in a series of observations for any given financial year. The expectations for each financial year are updated for five successive quarters after the initial estimate, providing a series of six estimates of expected capital expenditure for each financial year. The fourth and higher estimates are made after some of the year has elapsed, so these estimates include some expenditure that has already occurred. As an example, the December quarter 2011 Capex survey provided the first estimate of firms' expectations for capital expenditure for 2012/13, while the September quarter 2012 survey, which provided the fourth estimate, was the first to include some actual data for that financial year (Graph 1).

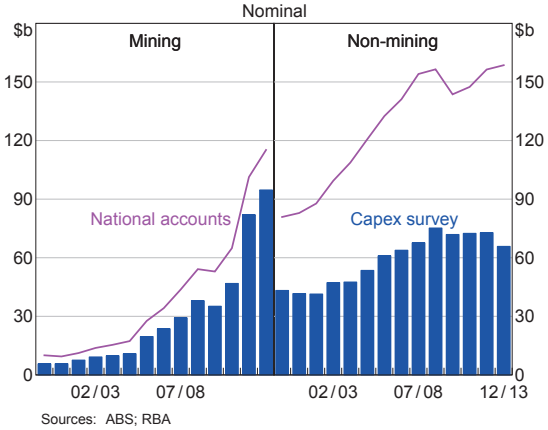
Graph 1
Capital Expenditure Survey
Estimates for 2012/13



Source: ABS

Details for both the actual and expected components of the survey are not available for every industry in the economy; only 15 of the 19 industries included in the national accounts are covered by the Capex survey. Also, the survey only covers expenditure on machinery & equipment and buildings & structures. Other business assets covered by the national accounts, such as research and development, are excluded. As a result of these differences in coverage of assets and industries, the value of the investment measured in the Capex survey is below that of the national accounts, particularly in the industries outside of mining, and the growth rates of the series can also differ substantially (Graph 2).

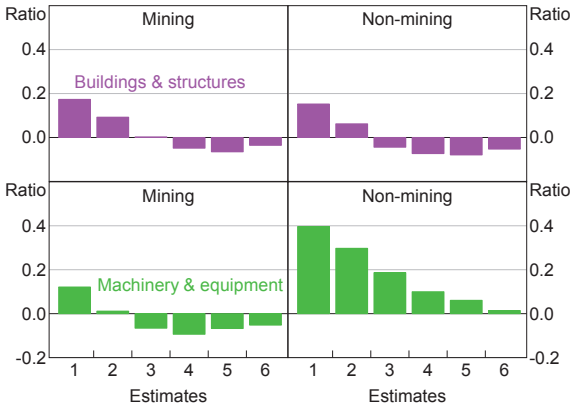
Graph 2
Measures of Business Investment
Nominal



Sources: ABS; RBA

Nonetheless, the expectations component of the Capex survey remains a potentially useful starting point for assessing the outlook for investment, given that it provides a dollar value of expected expenditure which is not generally available in other business surveys. Project-based databases such as the Deloitte Access Investment Monitor and the Bureau of Resources and Energy Economics major projects list provide the expected value of each project but do not provide a profile of spending for each project, and also only include a subset of all projects underway. The raw expectations from the Capex survey, naturally, will differ from the actual expenditure for that year for a number of reasons. The degree to which the expectations differ from the final outcome can be assessed by the 'realisation ratio' of the estimate; realisation ratios are the actual expenditure divided by the expected expenditure. If the estimates were unbiased, the average realisation ratio would be close to one, given a long enough sample. Many of the expectations, however, have an average realisation ratio greater than one (Graph 3). This is particularly pronounced for non-mining machinery & equipment, where final expenditure has been on average 30–40 per cent above the early estimates. Moreover, small firms' estimates suffer from more downward bias than large firms (Burnell 1994). There are several plausible explanations for these biases. For example, in forming their expectations, firms may not account for the expenditure required to replace existing machinery and equipment that depreciates. In addition, the investment planning horizon for small businesses may be relatively short, leading these firms to underestimate their expenditure over a year in advance, particularly if they only report expenditure that they are relatively certain they will undertake. It also appears that in some industries, later estimates of expenditure overestimate the final outcome. This possibly reflects the fact that once required expenditure is identified or new plans are made, firms are unable to undertake this expenditure at a short horizon. In any case, it appears necessary to adjust the raw expectations of the survey to account for the biases, and thereby produce more accurate forecasts of investment.

Graph 3
Average Realisation Ratio
Deviation from 1



Sources: ABS; RBA

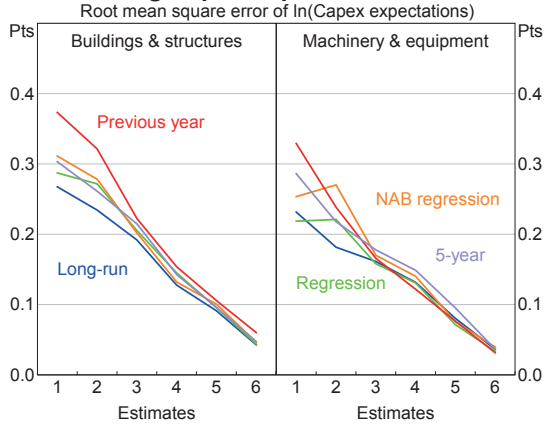
Methods of Adjustment

The adjustment of the raw expectations can be implemented by multiplying the raw estimate by an expected realisation ratio based on historical experience or other information. A simple method that would help to eliminate bias would be to use the historical long-run average realisation ratio. However, additional methods of realisation ratio projection may be appealing, particularly if the degree of bias is not stable over time. One option to capture any time-varying bias is to use a realisation ratio based on the average of the previous five years; indeed, the ABS reports the five-year ratio when they publish the results from the Capex survey. Another alternative is to use the previous year's realisation ratio.

Regression-based approaches may also be used to project realisation ratios to take account of how the expectation error could vary over time or in relation to other variables. A simple autoregressive model with one lag (i.e. an AR(1)) is an obvious starting point, but other variables may be added. For example, some measure of the business cycle could be useful, as there is some evidence that the realisation ratio varies systematically with economic activity (Cassidy, Doherty and Gill 2012). A timely indicator of the business cycle that would be suitable for this purpose is the measure of business conditions from the NAB quarterly survey. It is important, however, to be clear what this business cycle adjustment is supposed to be addressing. The business cycle would already be affecting firms' raw expectations. Further conditioning the realisation ratio on the state of the business cycle is an attempt to allow the difference between firms' capital expenditure expectations and actual outcomes to also be affected by economic activity.

These five methods of realisation ratio adjustment – the long-run average, the five-year average, the previous-year ratio, a simple AR(1) regression approach and an AR(1) regression augmented with the NAB survey measure of business conditions – are tested for out-of-sample accuracy.[1] The long-run average approach performs best over the sample period (Graph 4 and Graph 5).[2] For each of the four key aggregates which the Bank monitors – mining and non-mining capital expenditure for both machinery & equipment and buildings & structures – the long-run average generally outperforms the other methods of realisation ratio adjustment across most of the six estimates. In line with Cassidy, Doherty and Gill (2012), the accuracy of the forecasts improves as the

Graph 4
Mining Capex Expectation Errors
Root mean square error of ln(Capex expectations)

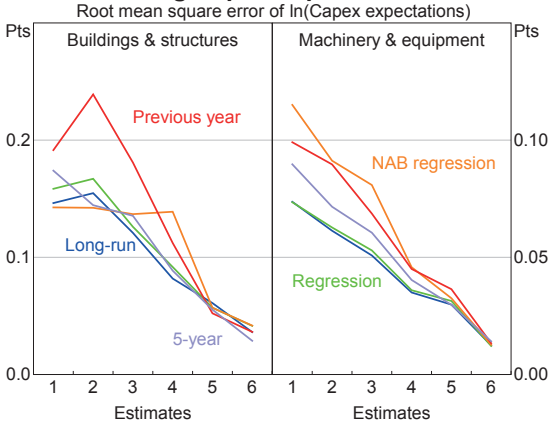


Sources: ABS; RBA

1 These forecasting exercises are based on the difference between the natural logarithm of the forecast and the natural logarithm of the outcome. These series increase at an exponential rate, so the natural logarithm is the appropriate way to evaluate the forecast.

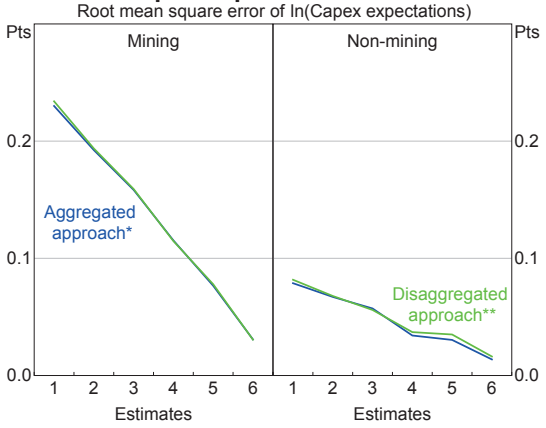
2 These exercises were based on out-of-sample forecasts beginning at the point at which 11 years of data informed the first forecast. The data begin for the financial year 1987/88 or 1988/89, depending on the estimate number.

Graph 5
Non-mining Capex Expectation Errors
Root mean square error of ln(Capex expectations)



Sources: ABS; RBA

Graph 6
Capex Expectation Errors
Root mean square error of ln(Capex expectations)



* Applies the long-run adjustment to total mining or non-mining capital expenditure

** Applies the long-run adjustment to mining or non-mining capital expenditure for machinery & equipment and buildings & structures individually, and then adds the forecasts together

Sources: ABS; RBA

estimates get closer to the actual time period under consideration (i.e. as the estimate number increases).

The superior performance of the long-run average approach suggests that other methods may lead to problems of over-fitting within sample, with little apparent benefit when it comes to forecasting out of sample. For example, while there is evidence that the realisation ratio is correlated with economic conditions, this correlation does not seem to be something that can be exploited for forecasting purposes. It may be that the correlation arises because the realisation ratio is affected by changes in economic conditions that are only apparent after firms are surveyed, so using the conditions at the time of the survey does not add any value.

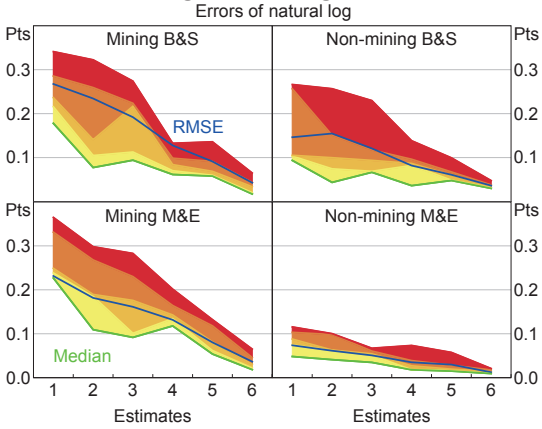
The Bank also considers expected capital expenditure data at a more aggregated level. For example, the *Statement on Monetary Policy* often refers to mining and non-mining investment. It is worth asking whether these aggregates are forecast by applying the same technique as above to the aggregates, instead of adding the disaggregated forecasts together. The results indicate that there is very little difference between these approaches, and so for ease of exposition it seems reasonable to forecast aggregates based on the addition of the disaggregated forecasts (Graph 6).

The Distribution of Forecast Errors

In the November 2013 *Statement on Monetary Policy* the Bank published error bands around the capital expenditure estimates associated with the long-run average technique (that are two root mean square errors (RMSEs) in width). It is useful to know what kind of uncertainty these error bands correspond to, which may be gauged by considering where the RMSE lies in the distribution of absolute errors. The RMSE for machinery & equipment capital expenditure often lies in the 60–70th percentile of the distribution, so the error bands can be considered as corresponding to a rough 60–70 per cent prediction interval (Graph 7).[3] The RMSE for the buildings & structures estimates sit higher at around the 70–80th percentile, pointing to a few relatively large misses in the past. For example, the adjusted forecast from the first estimate for 2005/06 mining buildings & structures capital expenditure was less than half that of the final outcome.

3 This assumes that there is no bias to the forecasts and that the errors are symmetric.

Graph 7
Distribution of Absolute Expectation Errors From Long-run Average Forecasts*
Errors of natural log



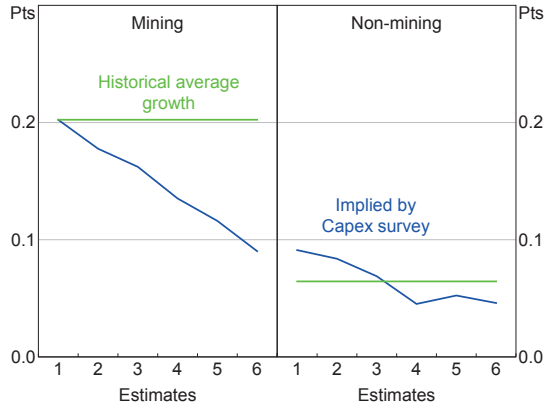
* B&S is buildings and structures, M&E is machinery and equipment; shading represents the 6th to 9th deciles of the distribution of expectation errors, with yellow the 6th decile and red the 9th decile

Sources: ABS; RBA

Relationship with National Accounts Investment

In developing an outlook for the domestic economy, it is desirable to have a forecast for total business investment, as measured by the national accounts, not just those components captured by the Capex survey. While there are coverage issues associated with the Capex survey when compared with the national accounts, the survey's appeal lies in its explicit quantification of firms' capital expenditure expectations. Moreover, the actual investment outcomes in the Capex survey are an input into the national accounts, so there is also a direct link which could make the expectations data useful. The Capex survey's utility for forecasting the national accounts measure of investment was assessed using out-of-sample forecasts. The implied growth of mining and non-mining investment from the survey is compared with the actual outcomes in the national accounts. The accuracy of these forecasts is assessed against the accuracy of out-of-sample forecasts arising from information only included in the national accounts. The national accounts based forecast is the historical average growth (excluding the previous year, which is not available at the time of the early estimates from the Capex survey used in this exercise).[4] Alternative methods were considered, such as simple regression approaches, but the results were little changed. For mining investment, the out-of-sample forecasts based on the Capex survey are more accurate, having a lower RMSE, than those based on the historical growth in the national accounts. For non-mining investment, the Capex-based forecasts are more accurate for estimates later than the third estimate for non-mining investment (Graph 8).[5] The more favourable results for mining than non-mining using Capex-based forecasts may reflect the fact that the Capex survey has a greater coverage of the mining sector than it does of the non-mining sector. It could also be that the boom in mining investment over recent years means that the past has been a relatively poor guide for the future, whereas the capital expenditure has picked up the boom to a better extent.

Graph 8
National Accounts Forecast Errors
Root mean square error of change in ln(Investment)



Sources: ABS; RBA

The results for mining investment are encouraging, although it should be noted that the RMSE for mining investment is much larger than for non-mining investment. That is, while the Capex survey seems to

4 Data from 1960 were used to form the long-run average. The current vintage of data was used for all calculations.

5 These calculations are based on assuming that the previous year's expenditure from the Capex survey is known at the time that estimates one and two are provided. This is in fact not the case, and so these calculations may understate the true RMSE arising from forecasts based on estimates one and two.

add some information over and above the average historical growth in investment in the national accounts, forecasts arising from the Capex survey are still relatively inaccurate. The non-mining results are disappointing. The first three estimates of the Capex survey do not seem, by themselves, to provide better information than a simple historical average. Later estimates do provide an improvement, but this is not a fair comparison, since from the fourth Capex estimate onwards, the expectations include some actual capital expenditure data for that financial year. To get a true indication of the extra information in the Capex survey, further work is required, which may involve using quarterly national accounts data and the short-term expectations included in the Capex survey.

Conclusion

The results in this article show that capital expenditure realisation ratios based on long-run averages are generally preferable to various alternatives. For the more aggregated measures that the Bank frequently considers, forecasts based on the addition of the disaggregated series are just as accurate as forecasts derived directly from the aggregated series. Nonetheless, judgement is required when interpreting these forecasts, given the relatively poor performance of these expectations in forecasting non-mining investment in the national accounts. Moreover, when forecasting total investment in both the mining and non-mining sectors, the Bank relies on a broader set of information, including from its liaison program. The Bank will continue monitoring the forecasting performance of these methods as more data become available.

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Burnell D (1994), 'Predicting Private New Capital Expenditure Using Expectations Data', *Australian Economic Indicators*, ABS Cat No 1350.0, January, pp xi-xvii.

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Korea's Manufacturing Sector and Imports from Australia

Tom Cusbert, Jarkko Jääskelä and Nick Stenner*

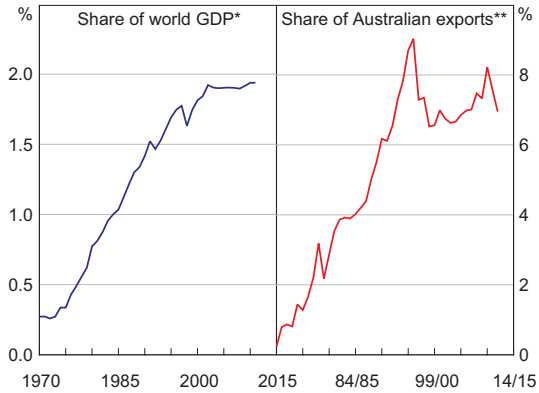
The Korean economy has grown rapidly over the past half century, driven in part by the development of an export-oriented manufacturing sector. While the electronics industry has expanded rapidly since the 1970s, there has also been a shift towards more steel-intensive industries, such as transport equipment and metal products. This shift, combined with Korea's reliance on resource imports, led Korea to become Australia's third largest export destination.

Introduction

The Korean economy has grown rapidly over the past half century, underpinned by the development of an export-oriented manufacturing sector. It is now the 12th largest economy in the world on a purchasing power parity (PPP) basis and the 8th biggest exporter of goods and services. The growth in the Korean economy, and the nature of that growth, has resulted in it becoming Australia's third largest export destination, with the share of Australian exports going to Korea rising to 7 per cent in 2012/13 (Graph 1). While this is a result of the Korean economy's strong growth over this period, it is also a consequence of the strong growth in resource-intensive manufacturing.

The structure of global manufacturing production has changed over the past few decades, particularly in east Asia and China. Processing trade, whereby the manufacture of components and assembly of the final goods take place in more than one country, has grown in importance (Craig, Elias and Noone 2011). The development of these supply networks has been associated with large flows of foreign direct investment into lower-income economies, which have become major destinations for the outsourcing of global manufacturing (Berger-Thomson and Doyle 2013). With this, manufacturing production has shifted from higher-income economies to lower-income economies.

Graph 1
South Korea – Share of World GDP and Australian Exports



* Based on PPP from 1980 onwards
** Merchandise exports prior to 99/00
Sources: ABS; IMF; United Nations (UN)

The growth in this processing trade has meant that many economies have experienced faster growth in their imported inputs than their production. That is, the share of domestic content in manufactured goods has declined. While Korea has participated in the increased integration of global supply chains, in contrast to many other economies in the region it has also experienced an increase in the domestic content of production. This reflects a reduction in the economy's reliance on imported capital and intermediate goods, particularly steel products.

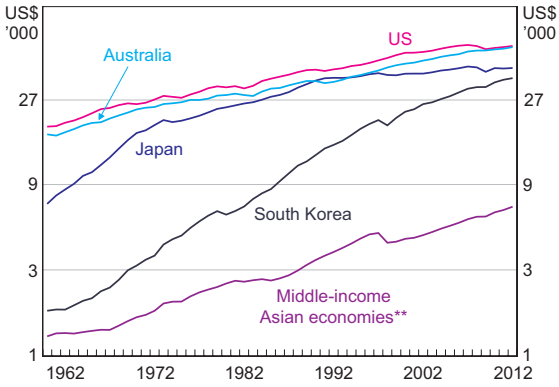
* The authors are from Economic Analysis Department.

This article explores how the Korean economy has evolved over time and developed a steel-intensive manufacturing sector, which has resulted in a high share of Australian resource exports going to Korea.

Korea's Economic Development

Korea's economy has expanded rapidly over the past half century; since the early 1960s, Korea's real GDP has increased at an average annual rate of about 8 per cent and around 5½ per cent on a per capita basis, exceeding that of many neighbouring and advanced economies (Graph 2).[1]

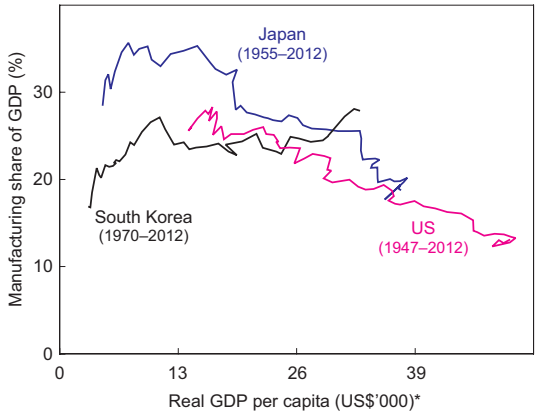
Graph 2
Real GDP per Capita*
Log scale



* 2012 prices converted at 2005 PPP exchange rates
** Indonesia, Malaysia, Philippines and Thailand
Sources: Conference Board; Penn World Table Version 7.1; RBA

Korea's rapid economic growth has been underpinned by the development of a broad-based export-oriented manufacturing sector from a relatively low base. The share of manufacturing in the economy has increased over the past four decades. This stands in contrast to the experience of Japan and the United States, where the manufacturing share of the economy has declined steadily as manufacturing production has shifted to lower-income economies (Graph 3).

Graph 3
Manufacturing and Economic Development



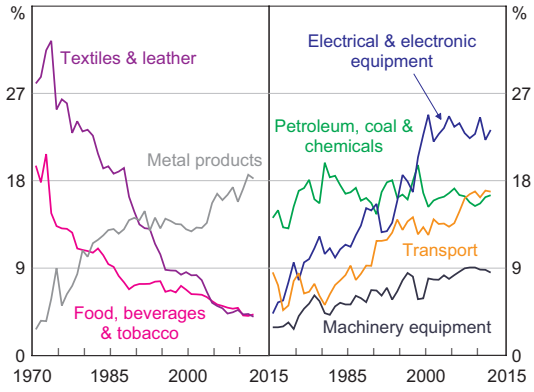
* 2012 prices converted at 2005 PPP exchange rates
Sources: Bureau of Economic Analysis; CEIC Data; Conference Board; RBA; UN

In Korea, the growth of manufacturing of transport equipment, machinery and metal products since 1970 has been driven by the output of a relatively small number of privately owned enterprises, known as 'chaebol'.[2] However, during Korea's rapid development phase their access to finance was controlled by the Korean Government. Given the underdeveloped state of the Korean financial markets at that time, access to credit was vital for their expansion (Krueger and Yoo 2002). The government's industrial policies were directed to the development of the sectors of the economy perceived to have long-term potential, and so the chaebol focused on the automotive, shipbuilding and electronics industries, and reduced the economy's reliance on imported capital and intermediate goods (Amsden 2004). The share of the textiles & leather industry, which had dominated manufacturing in the 1970s, declined over the past four decades, in part reflecting lower wages in less developed economies that have attracted a larger share of the global textiles industry (Graph 4).

1 Korea's economic expansion has been marked by a few slowdowns. The economy contracted in 1980 amid the global downturn. There was a more substantial contraction in 1997–98 during the Asian financial crisis (see, for example, Grenville (1998)). In response to that crisis, the Korean Government adopted a flexible exchange rate, moved to inflation targeting and pursued a range of reforms to improve corporate governance and financial resilience (Lee 2008). During the global financial crisis, the Korean economy experienced a relatively mild slowdown.

2 'Chaebol' refers to Korean large private business conglomerates, often family controlled and with strong ties to the government, such as Samsung, Hyundai and LG (Savada and Shaw 1990).

Graph 4
South Korea – Manufacturing Industries
Share of manufacturing gross value added



Source: CEIC Data

To promote export-led growth, some manufacturing industries were initially supported by export incentives, including reduced corporate and private income taxes, and tariff exemptions on raw materials imported for export production (Savada and Shaw 1990). With the rise in the importance of export-oriented industries over the past half century, the ratio of exports to GDP rose from 13 per cent in 1970 to almost 60 per cent in 2012.

Manufacturing in Korea

Currently, the main manufacturing industries in Korea are electrical & electronic equipment, metal products, chemicals, transport equipment and machinery. Australian resource exports are used intensively as inputs in industries manufacturing metal products, transport equipment and machinery – in particular, automobiles, shipbuilding and steel production. Although electrical & electronic equipment is Korea's largest manufacturing industry in terms of value added, it is less resource-intensive and therefore less important for Australian commodity exporters.

Automobile industry

Korea's automobile industry is the fifth largest in the world, representing around 6 per cent of global production. The majority of vehicles produced in Korea are exported. The industry accounts for around one-tenth of Korea's manufacturing sector. Three big manufacturers, Hyundai, GM Korea (formerly Daewoo) and Kia, collectively account for roughly 90 per cent of automotive production (KAMA 2012). The industry has gone through a radical shift over the past five decades. In the early 1960s, there was no automobile parts industry in Korea, and production consisted of assembling automobile kits primarily imported from Japan and the United States. Over time, domestic machinery and automotive parts industries have emerged alongside automobile assembly, increasing the domestic value-added component of production. Domestic content in automobiles rose to around 60 per cent in 1972, and was over 90 per cent by the end of the 1970s (Greenbaum 2002). Today, the expansion down the automotive supply chain has continued to the stage where some Korean automakers import raw materials and transform them into automobile components that are either exported or assembled into finished vehicles in Korea (Graph 5).

Graph 5
South Korea – Automobile Trade*

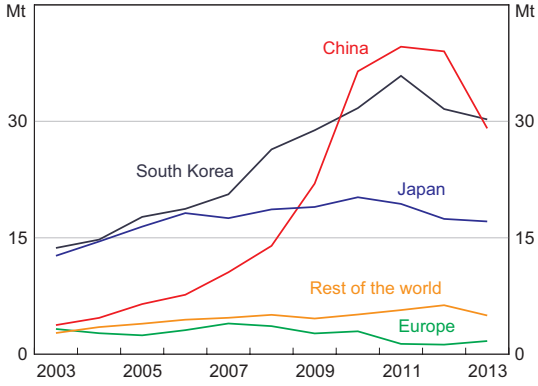
* Includes trailers and semitrailers
Source: OECD

Shipbuilding

Korea's shipbuilding industry became the largest in the world in 2003, surpassing Japan. Korea's share of global shipbuilding has remained relatively stable since then, while the market share of former global shipbuilding leaders Japan and Europe has declined as China's share has recently caught up to that of

Korea, which had previously been the world's largest shipbuilder (Graph 6). Since the global financial crisis, there has been a downturn in shipbuilding orders and prices. Competitive pressures remain strong as the industry faces significant overcapacity, which has caused prices to fall by around 50 per cent from their 2008 highs. The industry has also faced difficult funding conditions in recent years (BRS 2013).

Graph 6
World Shipbuilding
Annual completions*



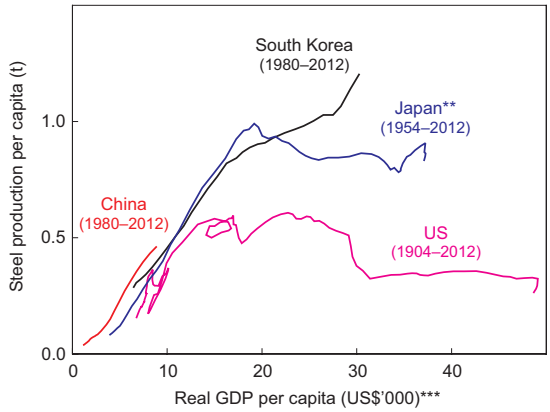
* 2013 based on first 6 months of the year
Sources: RBA; Shipbuilders' Association of Japan

The Korean shipbuilding industry is highly concentrated, dominated by three large shipbuilders: Hyundai Heavy Industries (the world's largest shipbuilding company), Samsung Heavy Industries and Daewoo Shipbuilding & Marine Engineering (European Commission 2009). The increased competition from Chinese shipbuilders has pushed Korean production toward specialised higher value-added units, such as LNG tankers in which Korea holds an 85 per cent market share. As Korean shipbuilders have faced rising costs of production in Korea, some, such as STX and Samsung, have increased production of less-specialised carrier ships in China (BRS 2013).

Steelmaking

Korea has the highest production of steel, per capita, in the world (Graph 7). Korean steel production per capita has continued to increase throughout its development. Echoing the experience with

Graph 7
Steel Production and Economic Development*



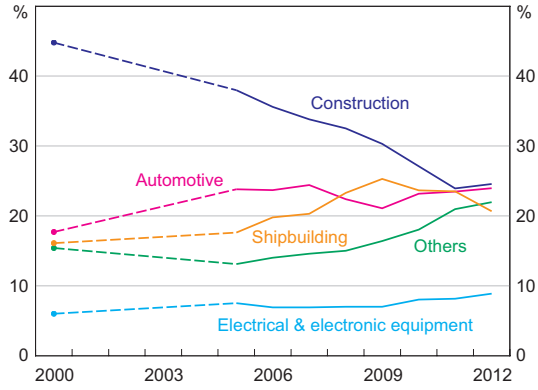
* Data series are 5-year moving averages
** Japanese fiscal years prior to 1980
*** 2012 prices using 2005 PPP exchange rates
Sources: CEIC Data; Conference Board; IMF; Japan Iron & Steel Federation; Maddison (2009); Thomson Reuters; US Geological Survey; World Steel Association (worldsteel)

manufacturing, the continued rise in steel use in Korea contrasts with the experience of the United States and Japan where steel production per capita peaked and then plateaued at an earlier stage of development.

Korea's steel industry ranks as the sixth largest in the world, accounting for around 4½ per cent of global steel production in 2012. In part, this reflects the intensive use of steel in its manufacturing and export sectors. Importantly for Australia, the majority of Korean steel is produced in blast furnaces (over 60 per cent in 2012). Blast furnaces use iron ore and coking coal as direct inputs, while the alternative electric arc furnaces produce steel from scrap metal (Worldsteel Association 2013b).

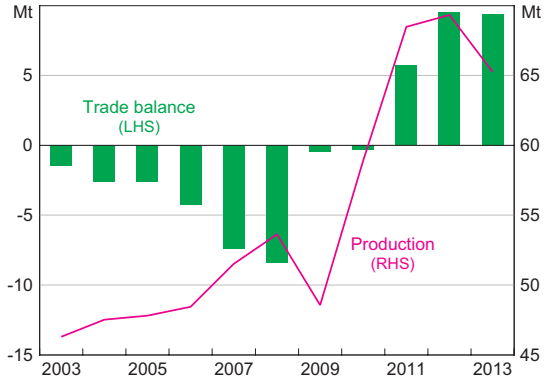
The proportion of Korea's total steel demand accounted for by the manufacturing sector grew from 55 to 70 per cent between 2000 and 2009, while the proportion used in construction declined (Graph 8). These shifts in steel demand by industry reflect the steady decline of the construction sector as a share of the economy over the past 10 years, while automobile production and shipbuilding have grown. There was a marked decline in steel used by the automobile industry following a fall in production during the global financial crisis,

Graph 8
South Korea – Steel Usage*
Share of total steel used by industry



* RBA estimates after 2009; dashes represent missing observations
Sources: Korea Iron & Steel Association; OECD; RBA; World Steel Association (worldsteel)

Graph 9
South Korea – Steel Trade and Production*



* 2013 based on the first 10 months of the year
Sources: International Steel Statistics Bureau; Korea Iron & Steel Association; RBA; World Steel Association (worldsteel)

but production has picked up since then (Haugh, Mourougane and Chatal 2010).

Korean steel production has grown rapidly since 2009, increasing twice as fast as both global and Chinese production. Recent growth in production has been largely the result of expansions in blast furnace production capacity, which has become relatively more important over time in Korea, while production in electric arc furnaces has remained little changed (Worldsteel Association 2013a). A recent example of the rise in production capacity is the construction of three blast furnaces with a combined annual capacity of 12 Mt at Dangjin steelworks by Hyundai Steel, Korea's second largest steelmaker after POSCO (Hyundai Steel 2012). Although the steelworks is primarily intended to supply Hyundai and Kia Motors, it also gives Hyundai Heavy Industries scope to increase domestically produced steel content in ships.

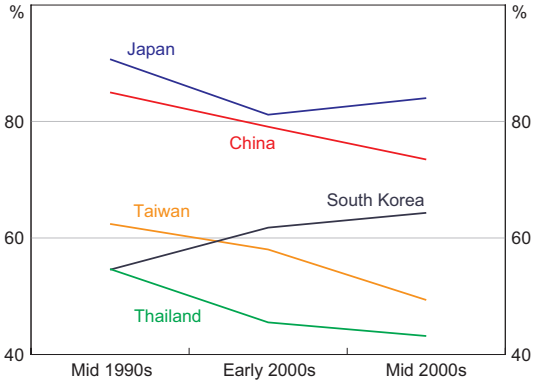
Korea is a major importer and exporter of steel in the global market. The significant growth of Korea's steel production capacity over the past couple of years means that Korea has moved from being a net importer of steel to a net exporter, with over half of these exports going to Asia (Graph 9; KOSA 2013). In 2012, Korea was the fifth largest net exporter of steel in the world. Around half of the steel used in Korean production is exported indirectly as a component of other traded goods shipped from Korea. In 2011, Korea was the third largest net indirect exporter of steel (Worldsteel Association 2013b).

Domestic content of production

Korea's domestic content of manufacturing production increased from around 55 to 65 per cent between the mid 1990s and mid 2000s. Much of this rise stems from the increased use of Korean made steel. In contrast, in most east Asian economies the domestic content of production has decreased over time owing to growth in intra-industry regional trade and use of international supply chains (Graph 10; see also Berger-Thomson and Doyle (2013)).

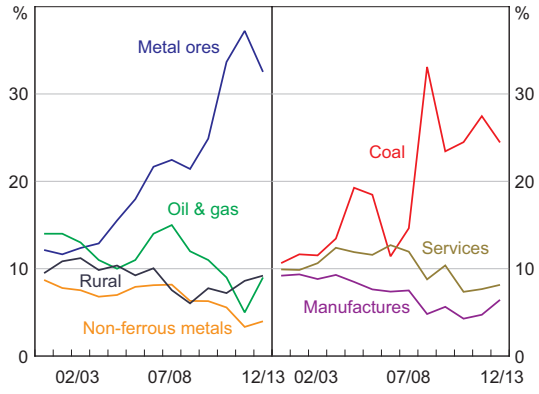
Despite the increase in the share of domestic content in production in Korea, Korean producers have also played a role in the integration of international supply chains. This role has mainly been as suppliers of intermediate goods, while Korean producers have also become increasingly important as suppliers of capital goods. Overall, Korea's share of the total value-added in manufacturing production in the east Asian region increased from 7 per cent of the total in the mid 1990s to 11 per cent in the mid 2000s.

Graph 10
East Asia – Domestic Content of Production
Manufacturing, share of total domestic value added in final demand



Sources: Bank of Korea; IMF; National Economic and Social Development Board (Thailand); OECD; RBA

Graph 11
Australian Exports to South Korea
Share of total exports to South Korea



Sources: ABS; RBA

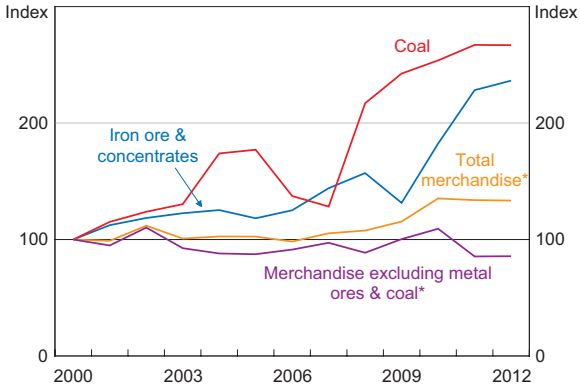
Australian Exports to Korea

Korea is a major importer of Australian resource commodities owing to the resource intensity of its production. Indeed, Korea is Australia's third largest export destination. In 2012/13, 7 per cent of Australia's total exports (by value) were sent to Korea.

Over the past decade, resource exports have accounted for around 80 per cent of exports to Korea with rural, services and manufacturing exports accounting for the remainder (Graph 11).[3] The share of Australia's exports to Korea that is comprised of Australia's two most important resource exports, metal ores and coal, has increased over the past years. In 2012/13, metal ores and coal accounted for 33 and 24 per cent of total exports, respectively. The vast majority of services exports to Korea are Korean tourists visiting Australia, and meat and cereals are the primary rural exports.

The surge in China's demand for resources has driven substantial price increases for a wide range of commodities, particularly for iron ore. However, the recent rise in the values of metal ores and coal exports to Korea is not entirely due to the rise in the price of these commodities, but also reflects rapid growth in the volume of these exports (Graph 12).

Graph 12
Australia – Export Volumes to South Korea
2000 = 100



* RBA estimates
Sources: ABS; RBA; UN

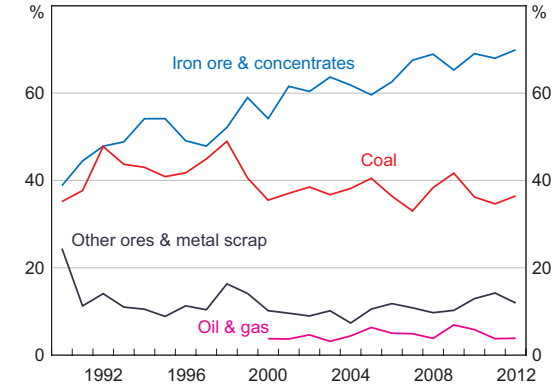
Nevertheless, the rapid rise in exports to China over the past decade has seen the share of Australian iron ore exports that are destined for Korea decline from 15 per cent in 2001 to around 10 per cent in 2012.

From Korea's perspective, Australia has become an increasingly important source of resource imports. The share of Korean iron ore imports coming from Australia has increased from just over 50 per cent in 2000 to around 70 per cent in 2012 (Graph 13). This increase reflects a global shift towards Australian iron ore and Korea's recent investment in blast furnace steel production.

Much of Australia's exports to Korea are inputs to their steel-intensive manufacturing industries, which

3 The Australian and Korean Governments recently concluded their free trade agreement negotiations. The agreement is set to reduce tariffs on a range of rural and manufactured goods, as well reducing barriers to services trade.

Graph 13
South Korea – Resource Imports from Australia
Share of total imports of each category

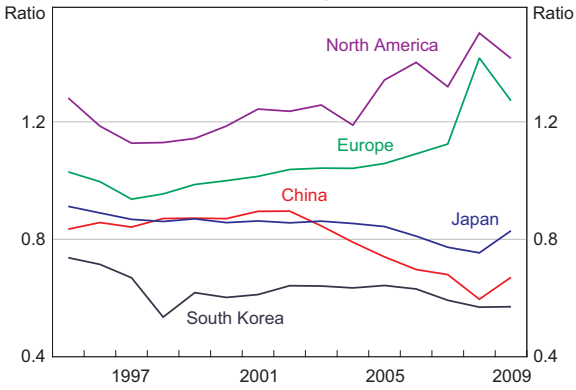


Source: UN

export a large share of their output. This means that demand for Korean exports in other countries has an effect on Korean demand for Australian exports. For example, around two-thirds of automobiles produced in Korea are exported, so demand for inputs to automobile production, including from Australia, depends to a large extent on final demand in those countries to which Korea exports automobiles.

Looking at the total Korean manufacturing sector, Kelly and La Cava (2013) note that only around 60 per cent of Australian exports to Korea are realised as final demand in Korea, which is a smaller share than any of Australia's other major trading partners (Graph 14). The remainder of Australian exports to Korea end up as final demand in other countries, including North American and European countries.

Graph 14
Australia – Ratio of Value-added to Gross Exports by Destination



Sources: RBA; World Input-Output Database

Conclusions

The Korean economy has grown rapidly over the past half century, with a notable expansion of export-oriented manufacturing, including steel-intensive industries, such as transport equipment and metal products. The reliance of these industries on raw material imports has made Korea an important destination for Australian exports.

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New Measures of Australian Corporate Credit Spreads

Ivailo Arsov, Matthew Brooks and Mitch Kosev*

Australian corporations access bond markets both domestically and offshore. Despite this, there is a lack of publicly available data on bond market conditions faced by non-financial corporations (NFCs). This gap in the data is particularly apparent at longer maturities where the low level of bond issuance, especially in the domestic market, makes it difficult to gauge the long-term credit spreads faced by resident issuers. To address this lack of data, the article presents a method for estimating aggregate credit spreads of Australian NFCs across maturities ranging from 1 to 10 years. The estimation method is simple, transparent and relatively robust in small samples. The Bank will commence publishing the estimated credit spreads monthly from December 2013.

Introduction

A number of Australian NFCs are well-established issuers in bond markets, both domestically and offshore. Despite this, historical data on Australian credit spreads are limited, especially at longer maturities.[1] To address this, the article presents newly constructed measures of secondary market credit spreads for bonds issued by Australian NFCs. Aggregate measures of spreads are estimated as a weighted average of observed spreads of outstanding bonds issued by Australian NFCs, with the weights determined by the distance between the bonds' residual maturities and the target tenor of the estimated spread.[2] The Bank will publish these measures of credit spreads and yields in a new Statistical Table F3 – Aggregate Measures of Australian Corporate Bond Spreads and Yields.[3] While the publication of spreads across tenors (3, 5, 7 and 10 years) is subject to the issuance of bonds with such maturities, the method used is relatively robust to changes in issuance trends.

The article proceeds by examining the issuance patterns of Australian NFCs since 2000. This informs the construction of the sample used to estimate the aggregate credit spreads. The estimation method is then discussed. The article concludes by presenting the results obtained for aggregate monthly credit spreads of A-rated and BBB-rated Australian NFCs since 2005.

The Australian Non-financial Corporate Bond Market

Bond issuance by Australian NFCs has grown markedly since the early 2000s.[4] Over this period, around three-quarters of Australian NFCs' bond issuance has been in offshore markets. Most of the offshore issuance has been denominated in US dollars, reflecting the depth and size of the US bond market (Graph 1). Corporate bond issuers, including Australian NFCs, source much of their longer-term bond funding from the US market where investor demand for longer-dated paper

* The authors are from Domestic Markets Department. Thomas Williams also contributed to the preliminary analysis while he was in Domestic Markets Department.

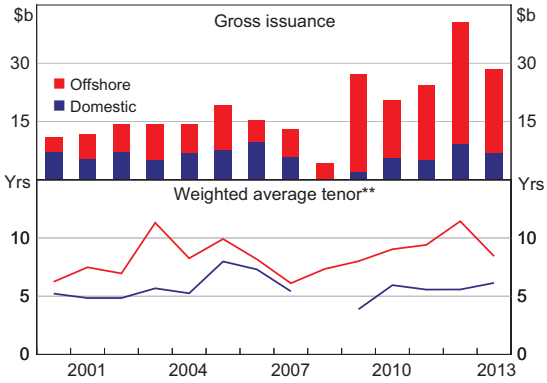
1 Besides the difficulty in constructing comprehensive samples of bond data from a range of sources, another factor explaining the lack of such measures is the cost of sourcing, storing and analysing the data for individual bonds necessary to produce measures of aggregate credit spreads.

2 For a given point in time, the bond's residual maturity measures the time left until its maturity date.

3 The new table will replace the existing Statistical Table F3 from December 2013.

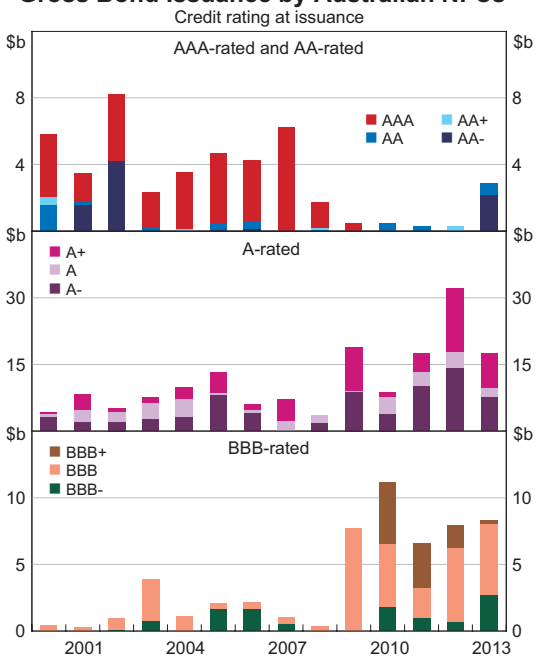
4 See Black *et al* (2012) for a history of Australian corporate bonds.

Graph 1
Gross Bond Issuance by Australian NFCs*



* For 2013, issuance is year to end November
** Weighted by face value; domestic weighted average tenor omitted in 2008 due to the small number of bond issues
Source: RBA

Graph 2
Gross Bond Issuance by Australian NFCs*



* For 2013, issuance is year to end November
Source: RBA

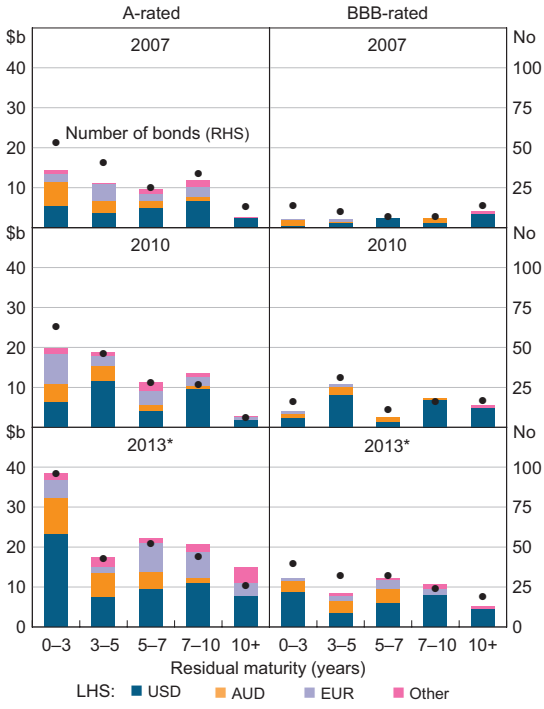
is strong. As a result, the average tenor of offshore issuance has been around 8 years, which is much longer than the typical tenor of slightly above 5 years in the domestic market.

Bond issuance by Australian corporations increased following the onset of the global financial crisis, alongside a decline in equity funding and a global retrenchment in bank loan funding. In recent years, bond funding, and debt funding more generally, have become more attractive for companies because the extended period of low nominal interest rates has seen the cost of debt funding decline to multi-year lows. The majority of issuance by Australian resident NFCs has historically come from companies with a broad A credit rating (A+, A or A-), although issuance by NFCs with a broad BBB credit rating (BBB+, BBB or BBB-) has increased significantly since 2009 (Graph 2). Very few resident Australian NFCs have been rated AA- or higher, resulting in very little issuance at these ratings. Issuance of AAA-rated bonds by Australian NFCs occurred with greater frequency in the years preceding the global financial crisis. These were mainly credit-wrapped bonds – bonds issued by lower-rated entities that achieved significantly higher ratings through insurance provided by specialist bond insurers. These were issued by airports, infrastructure financing vehicles and utility companies. The disappearance of bond insurers following the onset of the global financial crisis has contributed to increased bond issuance at the lower ratings.

As a result of the historical prominence of offshore issuance, the majority of outstanding Australian NFC bonds are denominated in foreign currencies, particularly in US dollars. By face value, around two-thirds of the bonds currently outstanding are rated A, and this share has increased over time (Graph 3). Close to half of the A-rated bonds are denominated in US dollars, distributed evenly across tenors, while euro-denominated bonds account for around 20 per cent of bonds outstanding. Most of the remaining outstanding A-rated bonds are denominated in Australian dollars, though these tend to be concentrated at the shorter residual maturities (i.e. of less than 5 years). US dollar-denominated securities account for an even larger share of the outstanding BBB-rated bonds. Almost all of the BBB-rated bonds outstanding with residual maturities above 7 years are denominated in

US dollars. Australian dollar-denominated BBB-rated bonds are slightly less than 20 per cent of the total outstanding at this rating, and are skewed heavily towards shorter residual maturities. Over time, the value and number of outstanding Australian NFC bonds with longer residual maturities has increased significantly, especially in the 7 to 10 year range.

Graph 3
Australian NFC Bonds Outstanding
Face value and credit rating at issuance



* As at end November
Source: RBA

Sample Construction

The paucity of Australian dollar-denominated issuance by NFCs, particularly at longer tenors, makes it impractical to estimate credit curves across a range of tenors solely from domestically issued bonds. Therefore, the sample includes bonds denominated both in Australian dollars and foreign currencies. An important feature of the longer-term bond issuance by Australian NFCs, and corporate issuers more generally, is the issuance of bonds with embedded options at longer maturities. Reflecting this, the sample includes bullet bonds and bonds with embedded options, such as callable bonds.[5]

The data in the sample are month-end from January 2000 to November 2013, covering bonds with residual maturities over one year. The sample includes all bonds identified by Bloomberg that were outstanding after 1 January 1990 and were issued by non-financial entities incorporated in Australia.[6] The sample is restricted to fixed-rate NFC-issued bonds raising the equivalent of at least A$100 million. The sample covers bonds denominated in Australian dollars, US dollars and euros. A total of 555 securities met these criteria, comprising 455 bullet bonds and 100 bonds with embedded options.[7]

Where a US dollar-denominated bond line had both 144A and Regulation S series, the latter were omitted to avoid duplication, as these are effectively the same bond but issued under different regimes, reducing the sample by 77 securities.[8] A further seven securities were excluded because of other forms of duplication.[9] The sample also excludes a number of securities that were downgraded multiple notches by credit ratings agencies during, or shortly after, the onset of the global financial crisis. This meant excluding seven credit-wrapped securities,

5 Bullet bonds are redeemable only at maturity, while bonds with embedded options may have significantly different maturities or cashflows, and as a result different prices and yields, if the embedded options are exercised. Therefore, the latter require the use of option-adjusted spreads to account for the value of their optionality.

6 Non-financial corporations are identified based on their classification by Bloomberg in a group other than banking, commercial finance, consumer finance, financial services, life insurance, property and casualty insurance, real estate, government agencies, government development banks, governments regional or local, sovereigns, supranationals and winding-up agencies.

7 The bonds with embedded options include callable, convertible and puttable bonds.

8 Issuers raising bond funding in US dollars can issue two types of securities for the same bond line that are intended for different investors and classified as either 144A or Regulation S (Reg S). Securities issued under the US Securities and Exchange Commission's Rule 144A are privately placed into the US market and are sold to Qualified Institutional Buyers. Reg S securities are issued in the Eurobond market for international investors and are exempt from registration under the *US Securities Act 1933*. Each security type is typically assigned its own International Securities Identification Number.

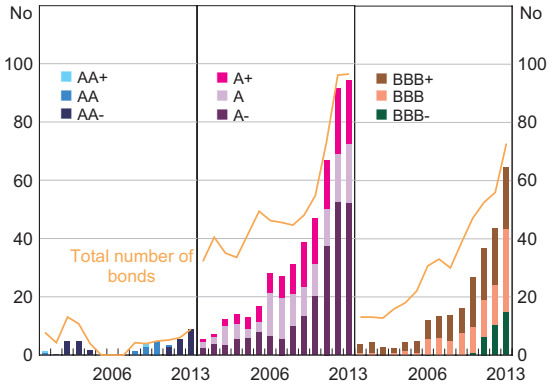
9 These include duplicate securities available to accredited investors, bonds with warrants and a second series of a bond line.

mostly bonds that were originally AAA-rated and were issued by airports and utility companies prior to 2008, and one bond which was downgraded to sub-investment grade status in early 2009.

The analysis primarily uses corporate bond price data from Bloomberg's BVAL pricing source, which combines information from a number of sources to generate a 'best-available' data point.[10] These data are supplemented, in order of priority, by Bloomberg generic prices and UBS data.[11] This approach is guided by an overarching objective to produce transparent credit spread measures derived from price observations provided by multiple contributors. The lack of historical bond price data is the main impediment to producing historical credit spread measures. However, the number of valid observations in the sample – bonds with prices, reported face values and available credit ratings – improves considerably over time as a share of the total number of bonds outstanding in the sample (Graph 4). Prior to 2005, around 25 per cent of the bond sample had adequate pricing data (mainly prices available from UBS). Data availability increases to around 50 per cent of the sample between 2006 and 2009, which largely reflects the availability of Bloomberg's BVAL pricing after 2008, before improving thereafter to over 80 per cent by 2013.

The analysis is conducted directly on corporate bond spreads over corresponding swap rates, which has two advantages: (1) credit spreads to swap can be sourced directly and consistently from Bloomberg; (2) hedging the credit spreads of foreign currency bonds into Australian dollar equivalent spreads, which as explained later is required for comparability within the sample, requires the calculation of swap spreads.

Graph 4
Average Number of Valid Securities by Credit Rating
S&P ratings, average annual number of bonds outstanding



Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

Traditionally, most bonds issued by Australian NFCs have been bullet securities, where the face value of the bond is redeemed at maturity. For these securities, obtaining the spread to swap is straightforward and is calculated as the security's yield to maturity over the corresponding interpolated swap rate. For Australian dollar bonds, this is the spread over the Australian dollar swap curve, which is an interpolated quarterly swap rate for tenors between 1 and 3 years, and a semiannual swap rate for tenors of 4 years and above.[12]

The analysis is complicated by the inclusion of bonds with embedded options, where the optionality affects the underlying value of the bond and, in turn, its yield and swap spread. This requires the use of an option adjusted spread (OAS), which measures the spread that is not attributable to the value of the

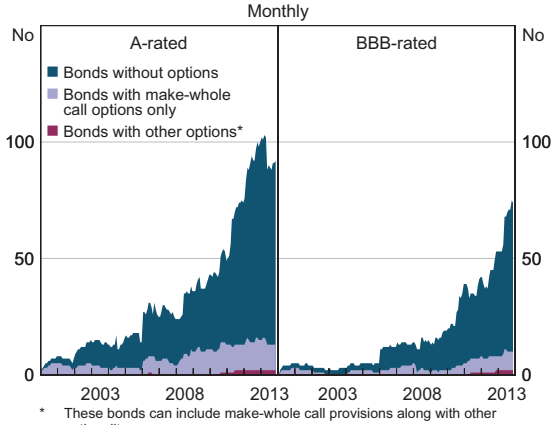
10 BVAL pricing is Bloomberg's best-available data point for a given instrument at a point in time. The BVAL price methodology uses three layers of price information, applied in the following order: (1) directly observed data based on traded market prices is used where available; (2) where insufficient data are available, BVAL applies its proprietary correlation model to derive a price from comparable bonds; (3) a relative value yield curve or pricing matrix may be used to derive a price where the correlation model is unable to generate an estimate. A small number of negative bond spread observations were excluded from the sample.

11 UBS data have previously been used by the Bank to generate the corporate bond spreads and yields series in Statistical Table F3, but are only available for Australian dollar-denominated bullet bonds. For the new dataset presented in this article, UBS data are used only to generate historical estimates before 2009.

12 While not used in this article, the new measures of credit spreads reported in Statistical Table F3 – Aggregate Measures of Australian Corporate Bond Spreads and Yields, include the credit spread to Commonwealth Government securities (CGS) rates. These are calculated by adding to the estimated credit spread to swap at each tenor the corresponding swap to CGS spread.

option.[13] The inclusion of securities with embedded options increases the sample of bonds with valid pricing (Graph 5). Because these securities tend to be over-represented at longer maturities, their inclusion assists in producing credit spread measures for longer tenors.

Graph 5
Number of Valid Securities by Optionality



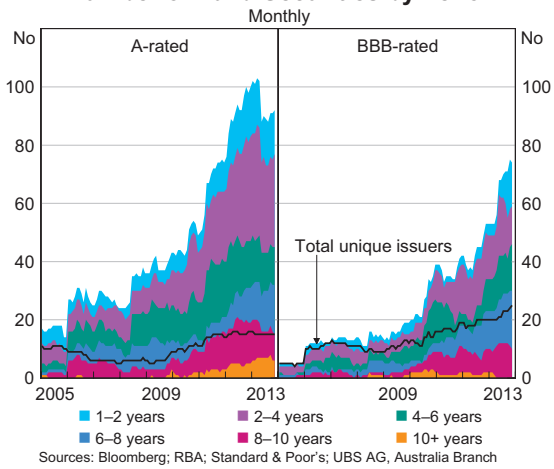
* These bonds can include make-whole call provisions along with other optionality

Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

For comparability within the sample, the credit spreads on foreign currency denominated bonds are converted to their Australian dollar equivalent spreads, which corresponds to the foreign exchange risk on the foreign currency bonds being completely hedged (see Appendix A for a discussion of the hedging method). Given the small number of bonds with a credit rating above AA-, only bonds with broad A and BBB credit ratings are included in the analysis. Individual bond ratings issued by Standard & Poor's (S&P) are used where available, and S&P's issuer rating otherwise.

The final sample captures around 90 A-rated securities and around 60 BBB-rated securities on average in 2013, with a significant increase in the sample size over time (Graph 6). The number of unique issuers included in the sample has also increased over time.

Graph 6
Number of Valid Securities by Tenor



Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

Based on the available data, it is possible to produce aggregate credit spreads from 2005 onwards. The choice of starting point attempts to balance the representativeness of the estimates with a desire to produce a historical time series of reasonable length. However, because of the smaller sample size, estimates generated for the A-rated bonds prior to 2008, and before late 2009 for the BBB-rated bonds, may be less representative of the underlying market than the estimates obtained for more recent years.

Estimating the Australian NFC Credit Spread Curve

Robust estimates of credit spreads for a given rating require the availability of a sufficient number of bonds, distributed widely across tenors. Despite the increase in the number of bonds in the broad A and BBB ratings since the mid 2000s, the number of bonds within the fine credit ratings remains relatively low. As a result, aggregate credit spreads are estimated separately at only the broad A and BBB credit ratings.

13 Conceptually, the OAS is the constant spread that has to be added to the spot yield curve in an interest rate option pricing model to equate the present value of a bond's cash flows with its market price. The option pricing model needs to make assumptions, including about interest rate volatility. Many bonds in the sample include optionality in the form of make-whole calls. However, the theoretical value of make-whole call options is small (Powers and Tsyplakov 2008) and is not currently incorporated into Bloomberg's OAS spread calculation. As a result, the spreads on bonds with only a make-whole call option are the simple spreads rather than the OAS. Bloomberg's estimates of the OAS are used for the bonds with all other forms of optionality.

A number of methods are available to estimate credit spreads. In this article, aggregate credit spreads of A-rated and BBB-rated Australian NFCs are estimated for a given (target) tenor as the weighted average of the Australian dollar equivalent credit spreads over the swap rate. The method is applied to the cross-section of bonds in the sample that have the desired credit rating. The weights are determined by a Gaussian kernel that assigns a weight to every observation in the cross-section depending on the distance of the observation's residual maturity and the target tenor according to a Gaussian (normal) distribution centred at the target tenor.[14] This method recognises the fact that the observed spreads on bonds with residual maturities close to the target tenor contain more information about the underlying spread at that tenor than spreads on bonds with residual maturities further away. The advantage of the Gaussian kernel over other more simplistic weighting methods, such as an equally weighted average, is that it uses the entire cross-section of bonds, albeit with weights approaching zero as the distance of the bonds' residual maturity from the target tenor increases. This provides a robust method capable of producing estimates even when the number of available observations is relatively small. The advantage of the Gaussian kernel over parametric methods, that have been popularised in the literature on the estimation of government yield curves, is its simplicity. Also, it does not impose a particular functional form on the credit spread curve but allows the observed data to determine its shape.[15]

Gaussian kernel weighting

Formally, the Gaussian kernel average credit spread estimator $S(T)$ at target tenor T for a given broad rating and date is:

$$S(T) = \sum_{i=1}^{N} w_i(T;\sigma) S_i \tag{1}$$

where $w_i(T;\sigma)$ is the weight for the target tenor T of the i^{th} bond in the sub-sample of bonds with the given broad rating, and S_i is the observed spread on the i^{th} bond in the sub-sample of N bonds with the given broad rating. The parameter σ (sigma), which is measured in years, controls the weight assigned to the spread of each observation based on the distance between that bond's residual maturity and the target tenor (sigma is the standard deviation of the normal distribution used to assign the weights). It determines the effective width of the window of residual maturities used in the estimator, with a larger effective window producing smoother estimates. The general form of the weighting function is:

$$w_i(T;\sigma) = \frac{K(T_i - T;\sigma) F_i}{\sum_{j=1}^{N} K(T_j - T;\sigma) F_j} \tag{2}$$

where $K(\tau;\sigma)$ is the Gaussian kernel function[16] giving weight to the i^{th} bond based on the distance of its residual maturity from the target tenor ($|T_i - T|$).[17] F_i is the face value of the i^{th} bond, which recognises that

14 For a discussion of the Gaussian kernel and kernel methods more generally, see Li and Racine (2007).

15 A number of estimation methods were investigated, although the details are not reported here. These methods produced very similar estimates of credit spreads across tenors and broad credit ratings. These methods included a range of parametric models estimated by least squares regressions applied to the cross-section in each period. In particular, the Nelson and Siegel (1987) method was examined in detail owing to its wide use in practice for estimating government yield curves (BIS 2005); this method has also been adapted for the estimation of corporate bond yield and spread curves (Xiao 2010). However, in our sample these models displayed spurious statistical properties, producing very high model fit but largely statistically insignificant coefficients. Other studies have also found evidence of possible over-fitting of the data using parametric methods, particularly in the case of the Nelson and Siegel model (Annaert *et al* 2013).

16 A kernel function is a symmetric, continuous and bounded real-valued function that integrates to 1. When the function is constrained to be non-negative it corresponds to a continuous distribution function. There are a large number of candidate kernels, with the Gaussian being the most widely used. Linton *et al* (2001) examines the application of kernel-based methods to the estimation of yield curves and establishes statistical properties of these estimators. Investigation of a number of other kernel specifications showed that the particular choice of kernel had little material impact on the credit spread estimates.

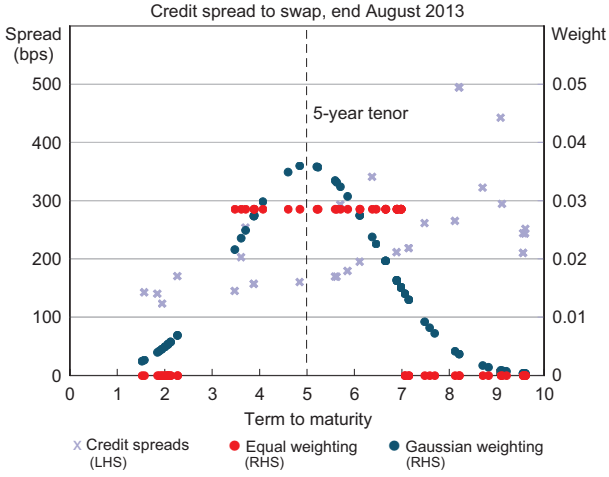
17 At the end points of the tenor range (1 and 10 years, but particularly at the 1-year tenor), the Gaussian kernel, and other similar methods, may be somewhat biased because there are no observations below and above the target tenor. Effectively, the weighted average is calculated from bonds on only one side of the estimation window. At the 10-year tenor, this is also an issue due to the sparse issuance above 10 years, but is less problematic for the A-rated bonds, for which some observations are available. However, the degree of bias depends on the true shape of the credit spread curve, with steeper curves resulting in more biased estimates.

larger bond issues are typically more actively traded and are therefore likely to more accurately reflect market conditions.[18] Finally, the Gaussian kernel is:

$$K(T_i - T;\sigma) = \frac{1}{\sqrt{2\pi}\,\sigma} exp\left[-\frac{(T_i - T)^2}{2\sigma^2}\right] \quad (3)$$

The mechanics of the Gaussian weighting method are illustrated in Graph 7 which shows its application to estimating the 5-year credit spread for BBB-rated Australian NFCs. (For clarity, the illustration abstracts from the impact of the bonds' face values on the weights.) The Gaussian kernel assigns positive weights to all bond spread observations with a BBB rating in the sample's cross-section on the estimation date, but assigns greater weights to the bonds around the 5-year maturity point. This contrasts, for example, with the equally weighted average where observations in the sample are assigned the same weight within some pre-specified range of the residual maturity around the 5-year tenor, but zero weight otherwise.

Graph 7
5-year BBB Kernel Weights
Credit spread to swap, end August 2013



Sources: Bloomberg; RBA; Standard & Poor's

18 The results produced by the Gaussian kernel are very similar when the face values of the bonds are not used in the weighting function; that is, when the weights are based only on the distance between the residual maturities in the sample and the target tenor.

Optimal smoothing of the Gaussian kernel

The Gaussian kernel method provides a degree of flexibility in weighting the observations around the target tenor through the choice of the value of the smoothing parameter, σ. There is a natural trade-off between the goodness-of-fit of the estimates, measured as the sum of squared residuals between the observed spreads and the estimated spreads, and the smoothness of the resulting credit curve.[19] Small values of the smoothing parameter produce estimates with smaller residuals by assigning higher weights to bonds closest to the target tenor. However, when the value of the smoothing parameter is too low the estimates are unlikely to be representative of the true credit spread for that tenor, as they reflect more of the noise in the observations. Moreover, the estimates are highly variable (for small changes in the tenor), and can produce credit spread curves that are quite irregular and for which there is little economic justification.[20] Conversely, higher values of the smoothing parameter produce less variable estimates but may have larger residuals within the sample.

The optimal choice of the smoothing parameter can be made objectively by casting the choice in the same framework as the one for smoothing splines. This involves explicitly trading off the goodness-of-fit of the estimates and the smoothness of the credit spread curve (Anderson and Sleath 2001).[21] The final choice of the optimal smoothing is also guided by the economic plausibility of the credit spread estimates.

19 This problem is not unique to credit spreads estimation. Indeed, it is an important consideration in the estimation of government yield curves, where the smoothness of the curve has a direct impact on the quality of the estimated forward rates, which are often used to provide an indication of market expectations of future monetary policy.

20 The slope at each point of the credit curve for a single issuer can be interpreted as an indicator of the instantaneous probability of default at that point. There are no intuitive or theoretical reasons to expect that the slope of the credit curve, and hence the probability of default, should change significantly for a small change in the tenor. Although this argument only applies to the credit spread curve of a single entity, it is nonetheless a desirable feature of an aggregate measure of credit spreads for a given credit rating. In other words, *a priori* it would seem reasonable for the slope of the credit curve to change gradually.

21 A number of risk-free yield curve estimation models use smoothing splines. For examples and details on this approach, see Anderson and Sleath (2001) and Yallup (2012).

Using the smoothing spline framework, the optimal value of the smoothing parameter on a single date is chosen as the one that minimises the sum of squared residuals of the credit spread estimates, while penalising excessive irregularity (or 'curvature') of the estimated credit spread curve:

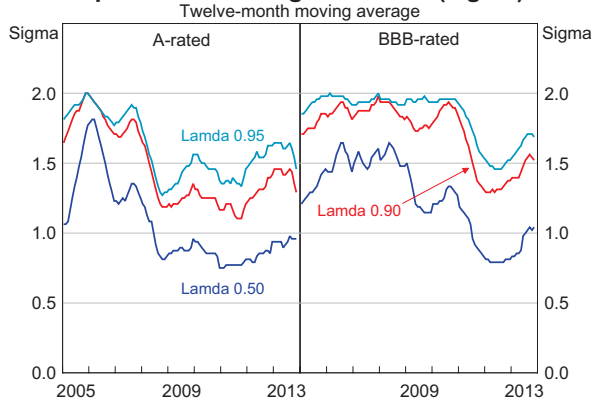
$$\min_{\sigma}\left\{(1-\lambda)\sum_{i=1}^{N}[S(T_i;\sigma)-S_i]^2+\lambda\int_1^{10}\left[\frac{d^2S(u;\sigma)}{du^2}\right]^2du\right\} \quad (4)$$

where $S(T_i; \sigma)$ is the Gaussian kernel estimate of the spread at the tenor of the i^{th} bond T_i, and S_i is the observed spread of the i^{th} bond. The first term of Equation (4) measures the goodness-of-fit of the Gaussian kernel estimate, while the second term measures the curvature of the estimated spread curve.[22] The parameter $\lambda(0 \leq \lambda \leq 1)$ controls the trade-off between the fit and the curvature terms in the objective function, with higher values putting more weight on smoothness.

There is little consensus in choosing the trade-off parameter λ.[23] Considering a range of plausible values for λ showed that for values above 0.9 there is little difference between the optimal sigmas. Relatively low values of λ tend to produce optimal values for the smoothing parameter that appear too small because they result in a large increase in curvature without a significant improvement in the fit. Consequently, the optimal sigma was chosen from the candidates generated by the higher values of λ.

For the A-rated bonds in the sample, a smoothing parameter of 1½ years is optimal and is also relatively stable from 2008 (i.e. the point after which the sample size of the A-rated bonds increases notably; Graph 8). The choice of the optimal value for the smoothing parameter is less clear for the BBB sample, with somewhat higher values for sigma before 2011 but closer to 1½ years thereafter. In the interests of simplicity, credit spreads are estimated with a fixed value of 1½ years for the smoothing parameter throughout the whole estimation period; that is, the weights around each target tenor are determined from a normal distribution with a standard deviation of 1½ years which is centred at the target tenor. This assigns around 50 per cent of the weight to observations with residual maturities within one year of the target tenor, around 80 per cent within two years and around 95 per cent within three years. The choice of 1½ years for the smoothing parameter is further supported by an examination of the credit spreads produced from a range of values for the smoothing parameter (½, 1, 1½ and 2). This revealed that lower values of the smoothing parameter (1 year or less) produce, at times, counterintuitive crossing of the credit spread estimates of different tenors, while higher values of sigma produce what appear to be excessively smooth results.

Graph 8
Optimal Smoothing Parameter (sigma)
Twelve-month moving average



Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

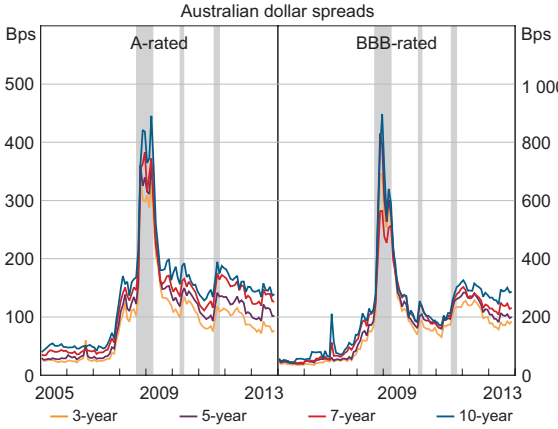
Australian Non-financial Credit Spread Curves

The credit spreads estimated with the Gaussian kernel are low and quite stable across tenors prior to 2007 (Graph 9). Broadly speaking, the estimated spreads since 2007 have exhibited the expected movements during episodes of financial stress (e.g. during the 2008–09 global financial crisis)

22 In practice, the second derivative in the curvature term is measured by the second difference calculated over a fine grid of tenors.

23 A popular choice in the risk-free yield curve literature is to set λ by minimising the generalised cross-validation (see Yallup (2012) for an overview). However, even in this setting a choice still needs to be made about the penalty that is applied to the number of model parameters and there is little consensus on this choice. Therefore, the generalised cross-validation approach was not pursued in the analysis.

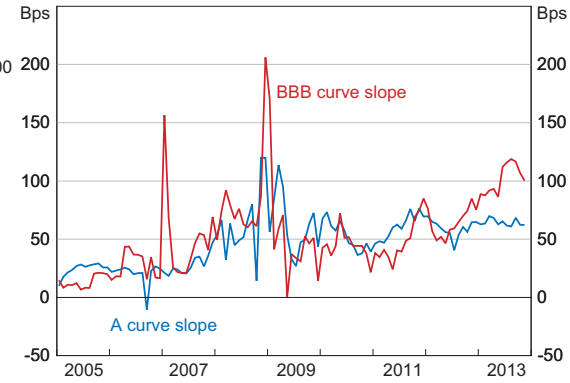
Graph 9
Australian NFC Spreads to Swap*
Australian dollar spreads



* Shaded areas indicate episodes of financial distress, which are identified by Bloom (2009) as the consecutive months during which the deviation of the VIX from its trend is above the 95th percentile; these episodes are: the US subprime crisis (coinciding with the collapse of Lehman Brothers in 2008); intensification of concerns over Greek sovereign debt in 2010; and a broadening of concerns over euro area sovereign debt in 2011

Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

Graph 10
Australian NFC Spread Curve Slope
10-year less 3-year spread to swap



Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

and changes in market expectations (e.g. in mid 2013 when financial markets brought forward their expectations for the unwinding of unconventional monetary policies by the US Federal Reserve).[24]

For the most part, since 2005, the credit spread curves of the A-rated and BBB-rated Australian NFCs have tended to shift in parallel across tenors. However, at the height of the global financial crisis in late 2008, when spreads experienced their most significant increase, the credit spread curve steepened sharply, especially for the BBB-rated bonds (Graph 10). Despite the decline in credit spreads since mid 2012, the BBB credit spread curve has steepened by around 50 basis points, suggesting that investors in BBB-rated bonds have, in recent years, required greater compensation for taking credit exposures at longer tenors. Interestingly, this has been accompanied by an increase in issuance of BBB-rated bonds at longer tenors and the downgrade of a number of previously A-rated issuers to the BBB rating.

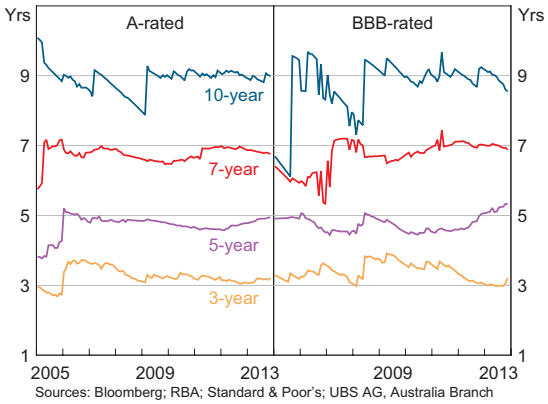
Overall, the Gaussian kernel method produces effective weighted average tenors that are very close to each of the target tenors (Graph 11). The exception is the 10-year tenor where the effective tenor is closer to 9 years. This reflects the dearth of issuance of bonds with tenors of 10 years or more. Notwithstanding the slightly shorter effective tenor for the 10-year point, the estimates of the 10-year spread from the Gaussian kernel are distinct from the estimates of the 9-year spread as the two are estimated by applying different weights to the bonds in the sample.

There are very few alternative measures of Australian credit spreads against which the Gaussian kernel estimates can be compared (Graph 12 and Graph 13).[25] The Gaussian kernel estimates for A-rated bonds have been consistently below the credit spread series in the Bank's previous Statistical Table F3 since mid 2007 because the latter include (non-bank) financial corporations, such as real estate investment trusts (REITs). These bonds have tended to have higher credit spreads for the same rating than non-financial entities since 2007. The new measures improve the previous series in the Bank's Statistical Table F3

24 The episodes of financial market stress are identified from the deviation of the option-implied volatility of the S&P 500 index (VIX) from its trailing average (Bloom 2009). It is not possible to determine with certainty whether the dramatic increase in BBB spreads in late 2008, particularly at the shorter tenors, is overstated owing to the small sample size around this time. During this period, the sample is heavily influenced by the sharp widening of the bond spreads for a major diversified mining company, having considerable influence on the spread estimates around the 5-year tenor.

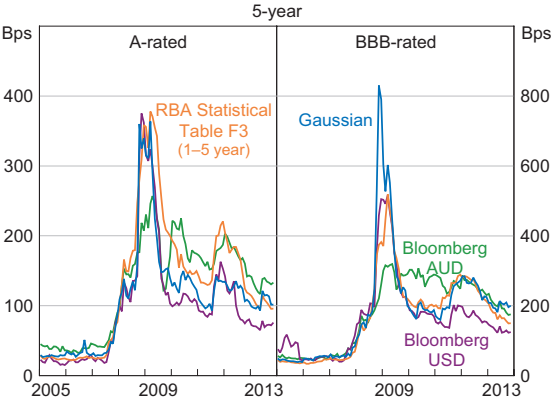
25 The available alternative measures are the 1–5 year credit spreads previously published by the RBA in Statistical Table F3 and Bloomberg's proprietary fair value curves. Currently, Bloomberg's fair value curve indices for Australian A-rated and BBB-rated corporate bonds are available up to a maximum tenor of 7 years, with historical data starting in the early 2000s; the Bloomberg indices are produced using a method which is not disclosed publicly in detail.

Graph 11
Effective Tenor



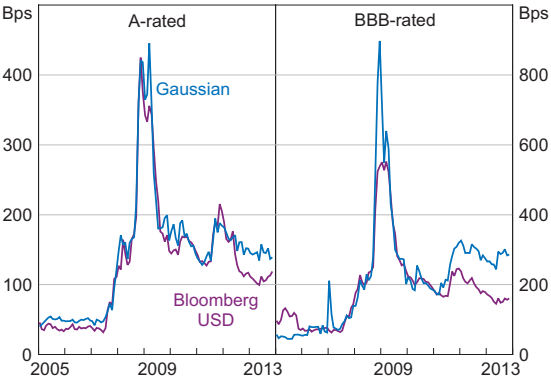
Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

Graph 12
Australian NFC Spread to Swap Comparison
5-year



Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

Graph 13
Australian NFC Spread to Swap Comparison
10-year



Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch

by significantly expanding the sample, separating financial and non-financial corporations, estimating spreads across different maturities, and by using a more robust method that gives greater weight to more representative observations. The new measures of credit spreads for the A-rated and BBB-rated bonds are similar to corresponding measures produced by Bloomberg prior to late 2008. However, they have diverged from the Bloomberg series since then, which reflects in part the counterintuitive behaviour of the Bloomberg spreads between 2009 and 2011.[26] The new credit spread measures presented herein have a number of advantages. First, the method of the construction is more transparent. Second, the sample is larger due to the inclusion of bonds issued in foreign currencies. Third, the method used is relatively robust, allowing for the estimation of spreads at longer maturities than are available elsewhere.

The Gaussian kernel estimates generally track the movement of spreads in global credit markets, in terms of both the timing and severity of their reaction to episodes of financial stress. The levels of the Gaussian kernel estimates of Australian NFC spreads have diverged from their US equivalents since mid 2011, with US credit spreads declining even further than Australian NFC spreads since then. Despite this divergence in levels, the co-movement between Australian NFC spreads estimated with the Gaussian kernel and the corresponding US spreads has remained high.

Conclusion

This article presents a method for estimating aggregate credit spreads across tenors ranging up to 10 years for Australian NFCs. The estimation method is simple, transparent and robust in small samples. The Bank will commence publishing monthly

26 The Bloomberg Australian dollar fair value curve appears to be overly smooth between early 2009 and late 2010. These measures did not increase as much as could be expected in early 2009, given that the global financial crisis was at its most severe at that time, and as was observed in other measures of Australian and foreign corporate bond spreads. Moreover, the Bloomberg spread measures remained elevated for an extended period of time between early 2009 and 2010, while credit spreads globally declined sharply following the introduction of extraordinary policy measures; this was especially true of BBB-rated bond spreads.

credit spreads estimates from December 2013. The newly constructed credit spread measures will provide richer information than is currently available publicly, allowing the public – researchers, investors, regulators and others – to examine developments in the Australian credit market in more detail.

Appendix A: Hedging Foreign Currency Bond Spreads

To provide comparability within the sample between bonds denominated in different currencies, the analysis converts spreads of foreign currency bonds into their Australian dollar equivalent. This is consistent with corporate bond investors taking a view on credit and interest rate risk only and fully hedging the foreign exchange risk associated with holding foreign currency bonds using derivatives. Moreover, constructing estimates that assume all borrowers hedge in a consistent way allows the analysis to abstract from differences in the methods of hedging (including the use of natural hedges) and the extent of the coverage of hedging. The conversion to Australian dollar equivalent spreads relies on the existence of a well-functioning cross-currency swap market, which is the case for Australia.

Estimating the cost of hedging

Estimating the cost of hedging foreign-issued bonds into their Australian dollar equivalent spread involves a number of stages. This process is only intended as an approximation of the material costs involved. Briefly, these are:

- **Cross-currency basis swap:** used to convert foreign currency payments into Australian dollars. This is generally the most significant hedging cost.
- **Interest rate swap:** a basis swap is used to hedge between semiannual coupon payments and the 3-month foreign currency interbank rate, which is typically used as the benchmark for cross-currency basis swap contracts. A basis swap is also used to convert the resulting 3-month Australian dollar equivalent spread to a 6-month equivalent spread for comparability with the semiannual coupons on Australian dollar bonds.
- **Conversion factor:** adjusts for interest rate differentials when calculating the spread between benchmarks denominated in different currencies. The conversion factor is the ratio of price sensitivities, which translates the relative value of a one basis point change in the interest rate of one currency into the change in another.[27]

The impact of hedging foreign currency bonds

The Australian dollar cross-currency basis swap accounts for most of the foreign currency hedging cost. However, since 2008 the cost of receiving a 3-month foreign currency interbank rate in exchange for a 6-month interbank rate has become a larger component of total hedging costs. To illustrate the evolution of hedging costs, a hypothetical 10-year constant maturity foreign currency bond trading at a foreign currency swap spread of 100 basis points, is hedged from both US dollars and euros. The total hedging cost has been relatively stable since 2010 at around 50 basis points for a theoretical US dollar-denominated bond (Graph A1) and 70 basis points for a euro-denominated bond (not shown).[28]

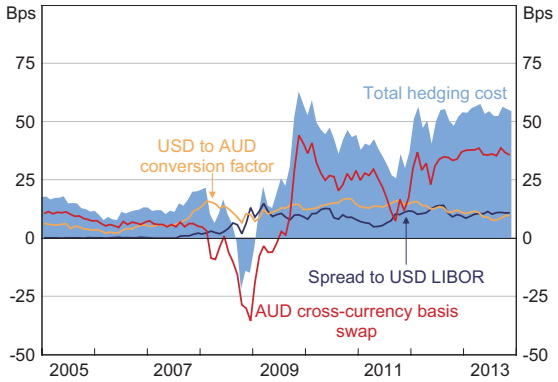
Comparing a selection of bonds also indicates that hedging foreign currency bonds into their Australian dollar equivalent tends to align the spreads more closely with those of comparable Australian dollar bonds. There are only a few instances of comparable pairs of (matched) bonds from the same borrower: bonds with similar residual maturities and issued in a foreign currency and Australian dollars. Despite the small number of bonds in the sample available for comparison, the available observations suggest that the difference between the Australian dollar

27 The conversion factor is approximated by the ratio of changes in present value from a one basis point shift in the swap curve at a given tenor for each currency. This approximation, also known as the PV01 (the present value of a one basis point shift in the swap curve), is commonly used by market participants in practice.

28 The analysis assumes that hedging a euro-denominated bond into Australian dollars first requires euro-denominated cash flows to be converted into US dollar cash flows (incorporating the three factors outlined above), from which Australian dollar equivalent spreads can be estimated. The additional stage reflects the fact that cross-currency basis swaps not involving a US dollar leg tend to be illiquid, and market practice is to hedge first into US dollar cash flows.

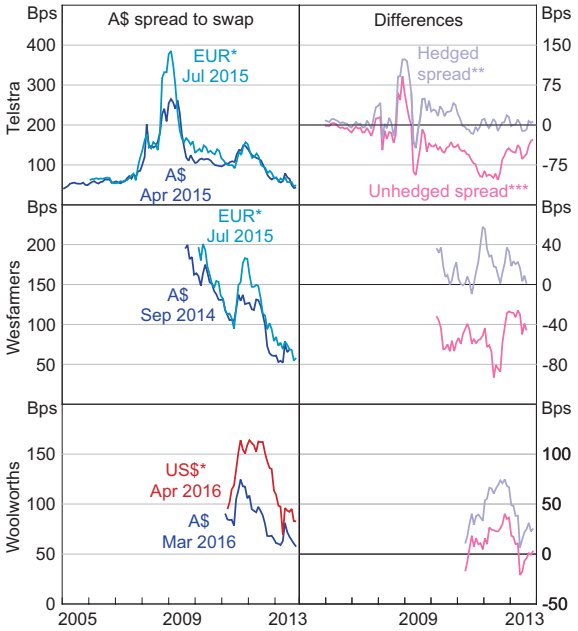
bond spreads and the hedged foreign currency spreads on comparable bonds tends to be smaller than the difference if the foreign currency bond was unhedged (Graph A2).

Graph A1
Decomposition of Hedging Adjustment*
Theoretical US dollar-denominated bond



* Theoretical 10 year constant maturity bond; assumes constant foreign currency spread to swap of 100 basis points
Sources: Bloomberg; RBA

Graph A2
Comparison of Bond Pairs
Matched bonds



* Australian dollar equivalent spread of the foreign currency bond
** Difference between the spread of the Australian dollar bond and the hedged spread on the foreign currency bond
*** Difference between the spread of the Australian dollar bond and the unhedged spread on the foreign currency bond
Sources: Bloomberg; RBA

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A Model for Stress Testing Household Lending in Australia

Tom Bilston and David Rodgers*

Stress testing can be a useful tool for authorities to assess the resilience of their banking systems to various shocks, including those that result in more borrowers being unable to repay their debts. This article outlines a model that simulates household loan defaults and losses using data from a survey of Australian households. The model generates plausible results in response to shocks to interest rates, the unemployment rate and asset prices. It also provides a useful starting point for the Bank's development of a more holistic stress-testing framework for the Australian banking system.

Introduction

Stress tests, in their most common form, attempt to quantify the impact of adverse scenarios, such as recessions and serious financial shocks, on financial institutions. The output of these stress tests provides an indication of whether financial institutions are adequately capitalised and/or sufficiently liquid to withstand a 'stress' scenario. Stress tests are used by private financial institutions as part of their internal risk management, as well as by prudential supervisors and other authorities to assess vulnerabilities facing individual financial institutions or the financial system as a whole.[1]

Stress testing of banking systems has become more prominent since the onset of the global financial crisis, partly because authorities have wanted to make more forward-looking assessments of financial system resilience. Increasingly, central banks have undertaken stress tests (driven, in some cases, by experiences of banking sector distress during the global financial crisis), and a majority of advanced economy central banks now regularly stress test their banking systems (see 'Box A: Central Bank Stress-testing Practices' for an overview). Most central banks stress test credit risk – the risk that borrowers will not repay their debts – given its central role in past episodes of financial instability. Beyond that, they have adopted a wide range of stress-testing practices, with significant differences in coverage of other types of risk and modelling techniques. This diversity of approaches reflects the different prioritisation of risks in each jurisdiction, as well as differences in resources and data availability.

While the Reserve Bank has not historically conducted stress tests of the Australian financial system, it has contributed to stress tests of Australian banks undertaken by the Australian Prudential Regulation Authority (APRA) since the early 2000s.[2] The Bank also assisted with the stress tests undertaken by the International Monetary Fund (IMF) during its 2006 and 2012 Australian Financial Sector Assessment Programs (FSAPs) (IMF 2006, 2012). Following an IMF recommendation made after the 2012 FSAP, the Bank has decided to develop an in-house stress-testing framework for the banking system that is appropriate for Australia and accords with its financial stability mandate. Many considerations are influencing this process, including the structure of the Australian financial system, how best to complement APRA's

* The authors are from Financial Stability Department.

1 A discussion of the different types of stress testing used by financial institutions and prudential supervisors can be found in APRA (2010).

2 See Laker (2010, 2012) for more information.

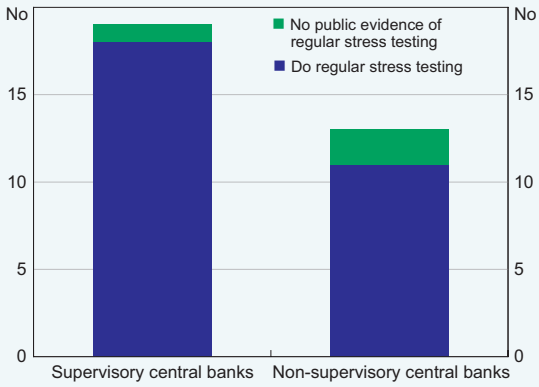
ongoing program of supervisory stress tests of Australian banks, and data availability.

Stress testing of household loan portfolios is one component of a stress-testing framework that is relatively important in Australia, given that household loans account for around two-thirds of banks' lending, and a sizeable share of banks' balance sheets. However, as household indebtedness and gearing have risen considerably since Australia's last severe economic downturn in the early 1990s, results from standard econometric stress-testing methods based on historical aggregate data could give a misleading picture of the resilience of banks to household credit risk. The Bank has developed an alternative approach involving a simulation-based stress-testing model that relies on reported household financial characteristics, and should therefore capture developments in household balance sheets over recent history. The model uses household- and individual-level data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey and was developed for research purposes (see Bilston and Johnson (forthcoming)). With refinement, it may also form part of the Bank's overall stress-testing framework.

Box A
Central Bank Stress-testing Practices

Most central banks in sizeable advanced economies now conduct regular stress tests of their banking systems (Graph A1).[1] This includes most of the central banks that do not directly supervise private banks. Some began to develop stress-testing frameworks in the early 2000s, but many began doing so during or after the global financial crisis. Almost all stress-testing central banks undertake their tests in-house, although some supervisory central banks carry out tests that require analysis to be done by the banks being tested. Stress scenarios chosen by central banks generally revolve around recessions, but often also capture other shocks such as sharp declines in property prices. Apart from these commonalities, central bank stress-testing practices diverge considerably and, as they are (understandably) still very much under development, continue to change over time.

Graph A1
Stress Testing at Advanced Economy Central Banks*

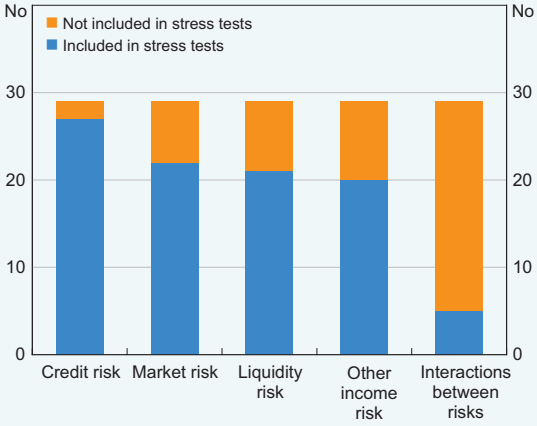


* IMF advanced economies with populations > 1 million
Sources: IMF Financial Sector Assessment Program; central bank publications

1 This box is based on public information and covers the practices of central banks of IMF advanced economies with populations greater than one million (including both the European Central Bank and national central banks for relevant euro area countries). It does not cover crisis-time stress testing, and stress testing that is required by current prudential standards.

Credit risk is tested by almost all central banks, but coverage of other risks varies (Graph A2). Some central banks cover market risk, while liquidity risk is increasingly being incorporated into stress-testing frameworks.[2] Risks to the other elements of banks' income, such as net interest income, non-interest income and operating expenses, are covered less frequently. The complexity of the models central banks use also varies: several, such as the Bank of England's Risk Assessment Model for Systemic Institutions (RAMSI), comprehensively model the interactions between different risks (such as credit and liquidity), while others, such as those published by the Sveriges Riksbank in its *Financial Stability Report*, are largely stand-alone tests of individual risks.

Graph A2
Risks Included in Central Bank Stress Tests*



* 29 central banks of IMF advanced economies with populations > 1 million that do regular stress tests
Sources: IMF Financial Sector Assessment Program; central bank publications

Methodologies also differ within approaches to individual risks, with credit risk a prime example. Most central banks take an econometric approach to modelling credit risk: they use historical data to estimate the relationship between defaults/losses and the economic cycle, and use this relationship to predict losses under stress scenarios. Some, such as the Federal Reserve, estimate models using loan-level data, while others, such as the Bank of England, do their modelling with a small number of aggregated portfolios (corporate, secured household, unsecured household). Corporate bankruptcy and equity price data are used as proxies in jurisdictions where reliable historical default data are not available. The main alternative to historical modelling is simulation using data on individual households and businesses. The Bank of Canada (see Farqui, Liu and Roberts (2012)) employs a model for household credit risk based on a survey of households similar to the HILDA Survey used in the model presented in this article. Norges Bank (see Andersen *et al* (2008)) uses micro-simulation models for both business and household credit risk, with the latter based on tax return data covering all Norwegian households.

A majority of the central banks that undertake regular stress tests publish the results, generally in their regular financial stability reports. Most results are disclosed at the system level or as a range of bank outcomes. For the supervisory central banks, stress-test results often become an input into assessments of the capital adequacy of supervised institutions; in the case of the Federal Reserve, stress-test results are now the main criteria for the acceptance of a bank's future capital management plan. The Bank of England (2013) has recently proposed a framework for formally incorporating stress testing into its assessments of systemic risk.

2 Market risk is the risk of adverse movements in market prices that require revaluations of banks' assets. Liquidity risk is the risk that a bank will be unable to satisfy its cash flow requirements or will incur losses to do so.

Household Micro-simulation Models

Simulations based on cross-sections of household-level data (household micro-simulations) have become increasingly popular tools for assessing household credit risk. Two typical approaches to household micro-simulations are the 'financial margin' and the 'threshold' approaches. Under the former approach, each household is assigned a financial margin, usually the difference between each household's income and minimum expenses (including debt-servicing expenses).[3] Households with negative financial margins are presumed to default on their debts. Combining this information with household assets and debt allows expected defaults and loan losses to be estimated, at both the individual household and aggregate levels. Shocks to macroeconomic variables can then be applied to estimate their impact on expected defaults and loan losses. Alternatively, the 'threshold' approach assumes that each household defaults when a certain threshold is breached – for example, when total debt-servicing costs exceed 40 per cent of income.[4] While this method requires fewer assumptions than the financial margin approach, it may be inappropriate to assume that all households with high debt-servicing costs will default. Indeed, higher-income households are more likely to be able to bear higher debt-servicing ratios than lower-income households. The model in this article is based on a financial margin approach and shares many features in common with a model based on Austrian households by Albacete and Fessler (2010).

3 For examples of financial margin-type household micro-simulation models, see Johansson and Persson (2007) for Sweden, Andersen *et al* (2008) for Norway, and Albacete and Fessler (2010) for Austria. These types of models have also been constructed for household sectors in a range of other countries, including Croatia, Finland, Hungary and Latvia.

4 Threshold-type household micro-simulation models have been built for the household sectors of Canada (Farqui, Liu and Roberts 2012), Chile (Fuenzalida and Ruiz-Tagle 2009) and Korea (Karasulu 2008), among others.

Methodology

Most variables in the simulation are from the HILDA Survey. This is a nationally representative panel survey of household characteristics and finances that has been collected annually since 2001. Special modules providing additional information on household wealth are available at four-year intervals (2002, 2006 and 2010), and this information is used extensively in the simulation.

The steps involved in the simulation are as follows (Figure 1):[5]

1. Initially, a pre-stress baseline is established. For each household, a financial margin is calculated as disposable income less rental payments, estimated minimum consumption expenditure and estimated minimum debt-servicing costs on all debt owed to financial institutions.[6]
2. Households with financial margins below zero are assigned a probability of default (PD) of one, and other households a PD of zero. For the purposes of the model, households with negative financial margins are expected to default in the period under consideration.
3. Each household's PD is combined with its assets and debt enabling the calculation of total household sector weighted-average PD and loss given default (LGD) rates. The weighted-average PD is the proportion of total household debt held by households expected to default. The weighted-average LGD is the share of debt in default that is not covered by collateral.
4. The debt-at-risk rate is a measure of expected household loan losses as a proportion of household loans (calculated as the product of the weighted-average PD and LGD rates). Debt at risk can be analysed as total household debt or separated into its components of housing debt, credit card debt and other personal debt.

5 For further details, see Appendix A.

6 Minimum consumption estimates are taken from the Henderson Poverty Line (HPL). The HPL is designed to be a minimum income level required to avoid a situation of poverty for a range of family sizes and circumstances. Some lenders use this measure of household living expenses in their assessments of loan serviceability for new borrowers.

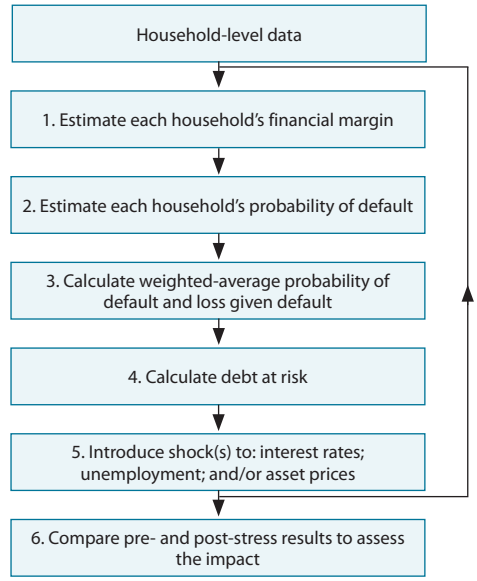
5. Once pre-stress results are established, macroeconomic shocks – to interest rates, the unemployment rate and asset prices – can be applied individually or in combination. The interest rate shock raises households' debt-servicing burden. The unemployment rate shock lowers income for affected households by reducing the income of individuals that become unemployed to an estimate of the unemployment benefits for which they would qualify. Each individual's probability of becoming unemployed depends on their characteristics. A Monte Carlo simulation with 1 000 trials is used and results are presented as the average value from these trials.[7] The asset price shock reduces collateral values, and thus raises LGDs, but does not affect PDs.[8]
6. The impact of the stress scenario is assessed as the difference between the pre- and post-stress share of households with negative financial margins and debt-at-risk rates. The difference between pre- and post-stress debt-at-risk rates can, for example, be scaled by bank capital in order to evaluate the banking system's exposure to shocks.

The process is repeated for the 2002, 2006 and 2010 surveys. The model does not have a time dimension, to the extent that everything takes place during the one period under consideration. In effect, applied shocks and default occur instantly. As a result, weighted-average PD, LGD and debt-at-risk rates (and other outputs of the model) cannot be interpreted as stemming from real-world shocks, such as high unemployment lasting a number of periods.

7 Monte Carlo simulation is a technique used to approximate the probability of different outcomes by running multiple trials, using quasi-random numbers.

8 The model does not incorporate second-round effects. For example, a shock to the aggregate unemployment rate is likely to have broader effects on household income than assumed in the model, such as through reduced available hours of work or wages.

Figure 1
Methodology



Source: RBA

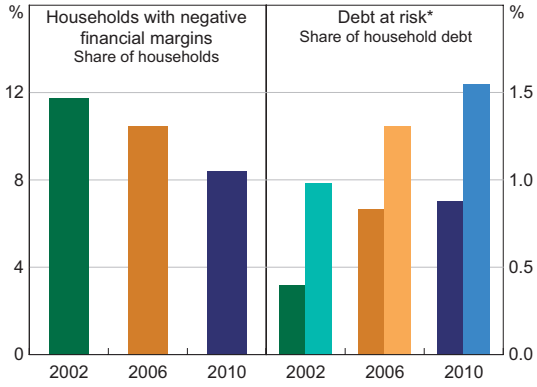
Pre-stress Results

Reviewing the output of the simulation before applying shocks gives a measure of household financial resilience and banks' exposure over the 2000s. The share of households with negative financial margins declined from around 12 per cent in 2002 to 8½ per cent in 2010, despite similar interest rates in each period (Graph 1, left panel). This difference largely reflects the strong growth of real household disposable income over this period, which eased the burden of basic expenses and debt repayments. Most of the households that the model suggests had negative financial margins did not actually default, as many had other assets that they could draw on, and so were actually in sound financial positions.[9] As a reference point, personal bankruptcies and other administrations as a share of the adult population averaged 0.2 per cent per year in the 2000s.

9 This issue is discussed further in the 'Limitations of the Model' and 'Potential Future Work' sections.

Banks' exposure to households with negative financial margins appears to have been limited, with the aggregate debt at risk as a share of household debt generally staying below 1½ per cent throughout the 2000s (Graph 1, right panel). The size of debt at risk depends on the security for the loan that is assumed to be recoverable by the lender in the event of default: if collateral is defined as just housing assets, the debt-at-risk rate (shown in the lighter shades) is about 0.5 percentage points higher than when collateral is defined as total household assets less non-retirees' superannuation and life insurance assets (shown in darker shades).[10] The debt-at-risk rate rose between the 2002 and 2010 survey years, reflecting increased weighted-average PD and LGD rates. In other words, even though the share of households with negative financial margins fell over this period, on average, these households held a larger share of debt and were less collateralised in each successive survey year.

Graph 1
Pre-stress – Model Results

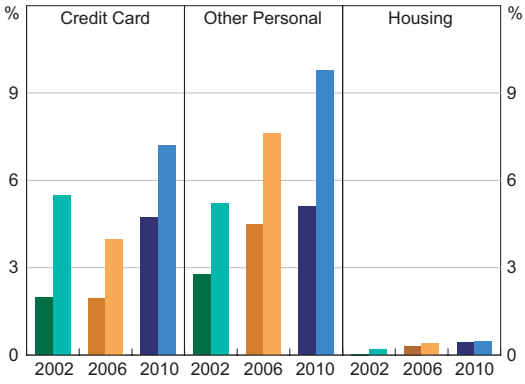


* Darker colours are based on including most household assets as eligible collateral; lighter colours are based on including only housing assets as eligible collateral

Sources: HILDA Release 10.0; Melbourne Institute; RBA; authors' calculations

The rise in expected losses between 2002 and 2010 is primarily driven by credit card and other personal loans (Graph 2). Relatively high expected losses for these types of loans are consistent with their largely unsecured nature; weighted-average LGD rates on credit card and other personal loans reached up to 50 per cent and 25 per cent, respectively. It is important to note though, that credit card and other personal loans only account for about 10 per cent of household debt.

Graph 2
Pre-stress Debt at Risk – Model Results*
Share of debt by product type



* Darker colours are based on including most household assets as eligible collateral; lighter colours are based on including only housing assets as eligible colateral

Sources: HILDA Release 10.0; Melbourne Institute; RBA; authors' calculations

Debt at risk as a share of housing debt was similar in each survey, reaching a maximum 0.5 per cent in 2010. This is an indication of how well-collateralised housing loans tend to be in Australia, particularly for primary mortgages on homes, where the weighted-average LGD rate is estimated to be close to zero in each survey year. Indeed, around 4.5 per cent of owner-occupier mortgagors reported having housing loans larger than the self-assessed value of their property in the 2000s and less than 15 per cent had estimated housing loan-to-valuation ratios (LVRs) above 80 per cent. This high level of collateralisation among mortgagors is partly related to the strong growth in housing prices through the 1990s and early 2000s, but also reflects the tendency for Australian households to prepay their mortgages (for example, see RBA (2012)).

10 In Australia, residential mortgages are typically full recourse, so lenders have the option of making claims on assets other than the mortgaged property owned by the borrower. In practice, lenders do not always exercise this option. Non-retirees' superannuation assets and life insurance assets are generally protected from creditors in bankruptcy.

The *relative* levels of losses by product type modelled for 2010 compare well with the relative levels of actual product type losses experienced by three of the four major banks over the same period (one major bank does not publish comparable data). Annualised net write-off rates reported by these major banks averaged 3 per cent over 2010 to 2012 for both credit card and other personal lending, while the annualised net write-off rate on housing lending was much lower, at 0.04 per cent. However, the total values of modelled losses for each product type in 2010 exceed reported (annual) levels substantially. This is unsurprising and may partly reflect the simple nature of the model: in contrast to the default assumption in the model, households with negative financial margins may be able to avoid default by drawing down on liquid asset reserves, selling other assets or securing new employment (and income) within the household.

Sensitivity Analysis

Applying each macroeconomic shock in isolation gives a sense of its differing effect on household credit risk in the model, although these shocks would not typically occur in isolation in a real-world scenario.[11] Table 1 presents the estimated impact – the change relative to the pre-stress results – for 2010, and results for other years are similar:

- *Interest rate shock:* a 1 percentage point rise in interest rates for all types of borrowing causes the share of households with negative financial margins to rise by 0.6 percentage points, because of the rise in these households' debt-servicing costs. It has a limited impact on the debt-at-risk rate (up by a maximum of 0.2 percentage points) since households whose financial margins are reduced below zero by the shock tend to be well collateralised. That is, the households whose debt-servicing burdens increase the most tend to have lower LVRs.
- *Unemployment rate shock:* a 1 percentage point increase in the unemployment rate causes the share of households with negative financial margins to rise by 0.3 percentage points, but has little effect on the debt-at-risk rate. The limited impact on debt at risk largely reflects the strong financial position of most Australian households. In addition, it is also influenced by the smaller amount of debt typically held by the households most likely to become unemployed; each individual's probability of becoming unemployed in the model depends on their characteristics. Some households affected by the unemployment rate shock also already have negative financial margins in the model.
- *Asset price shock:* a 10 per cent fall in asset prices does not affect household financial margins, but

Table 1: Sensitivity Analysis – Model Results
Change relative to pre-stress results, 2010, percentage points

	Isolated shocks to:		
	Interest rates	Unemployment rate	Asset prices
	1 percentage point rise	1 percentage point rise	10 per cent fall
Share of households with negative financial margins	0.6	0.3	na
Debt-at-risk rate:			
Using household assets	0.1	*	0.3
Using housing assets	0.2	*	0.4

* Small positive effect
Sources: HILDA Release 10.0; Melbourne Institute; RBA; authors' calculations

11 In addition, the effect of the individual shocks may be larger or smaller if second-round effects are taken into account.

causes the debt-at-risk rate to rise by a maximum of 0.4 percentage points. This occurs because a fall in asset prices in the model causes the value of security that could be claimed by the lender in the event of default to fall, thereby raising the weighted-average LGD rate.

A Stress Scenario

Applying a scenario that incorporates simultaneous shocks to the model gives some insights into household credit risk under more plausible stress situations. To demonstrate this, a hypothetical stress scenario similar to the one described in Laker (2010) is used. In this scenario, a significant deterioration in global economic conditions is assumed to cause an economic downturn in Australia that is worse than that experienced in the early 1990s, and:

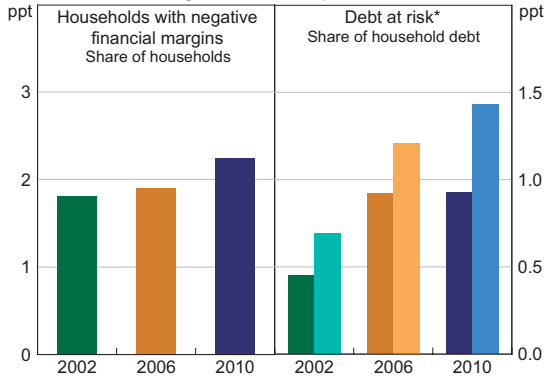
- all asset prices fall by 25 per cent;
- the unemployment rate rises by 6 percentage points; and
- there is no reduction in interest rates.

The results should be interpreted as giving an indication of the broad magnitude of the effects of a stress scenario on household financial resilience and how these have changed over the 2000s, taking into account the assumptions made in the model. As noted above, there are many factors that are not considered in the current model, but could be important if the model forms a part of the Bank's more holistic stress-testing framework.

Under the stress scenario, the share of households expected to default rises around 2 percentage points above the pre-stress results (in each survey year; Graph 3), which brings the total shares expected to default to between 10½ and 14 per cent. This increase relative to the pre-stress also rises slightly between each survey year. Similarly, the increase in the debt-at-risk rate is larger in each survey year; the largest increase is about 1½ percentage points in 2010, resulting in a doubling of the household debt-at-risk rate in this year to 3 per cent.

The increased debt at risk under the stress scenario relative to the pre-stress is largely driven by an

Graph 3
Post-stress – Model Results
Changes relative to pre-stress



* Darker colours are based on including most household assets as eligible collateral; lighter colours are based on including only housing assets as eligible collateral

Sources: HILDA Release 10.0; Melbourne Institute; RBA; authors' calculations

increase of 8 percentage points in weighted-average LGD rates that flows from the fall in asset prices. Weighted-average PD rates rose by around 2 percentage points in each survey year, a similar sized rise to that in the share of households with negative financial margins reflecting that these newly defaulting households tend to have average levels of debt.

By product type, the rise in the household debt-at-risk rate is largely because of increases in expected losses on credit card and other personal debt, which increase by up to 3 percentage points and 10 percentage points, respectively. By comparison, the estimated increase in the debt-at-risk rate on housing loans is fairly small, largely because of the strong collateralisation of housing loans in Australia, as well as modelling assumptions.[12] Regardless, given housing loans make up a sizeable share of banks' household and total lending, housing loans are an important component of household debt at risk.

The results from the stress scenario suggest that households were quite resilient during the 2000s and were well placed to withstand a shock to

12 For example, LGDs on housing loans in the model do not include legal or property possession costs. In addition, falls in housing values are modelled to be the same for all households, whereas evidence suggests that changes in house prices vary considerably across households in actual downturns. For further examples, see the 'Limitations of the Model' and 'Potential Future Work' sections.

economic conditions. The next step in the stress-testing framework would be to compare the results with bank capital to understand the flow-on effects to the banking sector. Rough calculations suggest that the losses implied from this model account for a small, but non-trivial, amount of banking system capital, although this analysis can be more appropriately undertaken once further refinements to the model are made.

Limitations of the Model

As with all stress-testing models, the simulations described in this article have some limitations that are critical to their interpretation:

- The one period nature of the model means that the results can only provide a broad indication of the magnitude of the effect of an economic shock. For example, a 6 percentage point increase in the unemployment rate in the model means that 6 per cent of individuals in the labour force (on top of those already unemployed) become unemployed in that period. Within this extra 6 per cent, any household whose financial margin falls below zero is assumed to default within the same period. By contrast, in a real-world downturn involving many periods of high unemployment, a certain proportion of the individuals that become unemployed would find jobs prior to defaulting.
- Calculating financial margins requires assumptions about minimum consumption, interest rates and loan terms, which may not be appropriate for all households. For example, minimum consumption estimates in the model are obtained from the HPL, which is not adjusted for the household's location or their income.
- Household surveys may not be ideal to capture household financial resilience. This is because households tend to overstate their self-assessed housing values, and understate their debt and income.[13] Although efforts are made to ensure that the HILDA Survey sample is representative, households with precarious finances often do not disclose their financial position, while higher-income households are less likely to remain in the sample over time.
- Household micro-simulations are relatively untested in actually capturing and predicting stress. While these models have been developed in a number of countries, none of these countries have had crises that emanated from the household sector.[14]

13 For example, see Watson and Wooden (2004) and Melser (2013).

Potential Future Work

There are a number of advancements that could be made to the model, including:

- Adding an explicit time dimension and allowing for other more complex behaviours would allow more realistic scenarios to be incorporated into the model, including downturns over multiple years. For example, in the current model, households with negative financial margins are assumed to default regardless of their asset position. However, it is estimated that around one-third of households with negative financial margins had sufficient liquid assets – including deposits, equities and trusts – to avoid default for at least one year. If households could also sell assets to avoid default, then over three-quarters of households with negative financial margins may be able to avoid default for over a year. This change would be likely to lower modelled losses slightly, but adding other dynamics where shocks are amplified over time could well increase them, so the losses predicted by a more complex model may be larger or smaller than those shown in this article.
- In common with other large household surveys, the HILDA Survey is released 12 to 15 months after the survey is undertaken. By making some basic assumptions, these values could be updated to make inferences about the possible impact of future shocks. The advantage of these forward-looking approaches would be tempered by the additional uncertainty in the data.

14 The US household sector could be a useful case study to test this. Micro-data surveys, such as the Federal Reserve's Survey of Consumer Finances, contain many of the required variables to run such an experiment.

Nevertheless, the model provides a useful starting point for developing a holistic stress-testing framework for the Australian banking system. Stress tests based on historical data, including from the early 1990s recession and the global financial crisis, can be used to examine losses arising from business loans or a decline in income more generally. Measuring and modelling liquidity stress is difficult, given that liquidity stress events have been infrequent and often curtailed by public sector intervention. Any such stress tests are likely to be based on judgement and international experiences, but are nonetheless critical given the central role of liquidity in the global financial crisis.

Appendix A

This appendix sets out the technical details of the model used in the simulations in this paper, with each step illustrated in Figure 1. The first step is to calculate the financial margin:

$$FM_i = Y_i - R_i - MC_i - DS_i \tag{A1}$$

where Y is disposable income, R is rental payments (if any), MC is minimum consumption expenditure, DS is estimated minimum debt-servicing costs (if any) and i denotes each household. All measures are provided on an annual basis or annualised before inclusion. Disposable income and rental payments are self-reported and sourced directly from the HILDA Survey. Minimum consumption information for each household is unavailable in the HILDA Survey, so Henderson Poverty Line (HPL) data, excluding housing costs, are mapped for each household using its characteristics.[15] Minimum debt-servicing costs are estimated as:

$$DS_i = PM_i + SM_i + P_i + C_i \tag{A2}$$

where PM is the estimated minimum primary mortgage repayment, SM is the usual repayment on second mortgages, and P and C are estimated interest payments on personal and credit card debt. Primary mortgage repayments are estimated using a credit-foncier model – a standard financial formula used to estimate mortgage repayments on amortising loans – assuming that all households have a standard variable rate mortgage and a loan tenure of 25 years. The HILDA Survey provides information on usual repayments on primary mortgages but this overstates minimum repayments because around half of Australian households pay more than required on their mortgages. Interest payments on personal and credit card debt are calculated as the multiple of (annualised) current interest rates and the self-reported amounts of each loan outstanding. All interest rates are assumed to be variable.

The second step uses the financial margin to calculate each household's probability of default:

$$PD_i = \begin{cases} 1 \text{ if } FM_i < 0 \\ 0 \text{ if } FM_i \geq 0. \end{cases} \tag{A3}$$

Households with financial margins below zero are assigned a probability of default of one and zero otherwise.

The third step combines households' probabilities of default with household assets and debt, allowing the household sector's weighted-average probability of default and loss given default to be calculated. The weighted-average probability of default is:

$$WPD = \frac{\sum_i^N PD_i D_i}{\sum_i^N D_i} x\ 100 \tag{A4}$$

where D is each household's debt, and N is the total number of households.

The weighted-average loss given default is the amount that lenders are likely to be unable to recover on loans in default:

$$LGD = \frac{\sum_i^N PD_i M_i}{\sum_i^N PD_i D_i} x100 \tag{A5}$$

15 In recent years, many lenders have moved to another measure, the Household Expenditure Measure (HEM), to assess household living expenses. Compared with the HPL, the HEM suggests that living expenses are higher for couples and lower for singles.

where $M_i = \text{Max}(D_i - A_i, 0)$ is the dollar value likely to be lost as a result of a household defaulting, and A is the value of a household's eligible collateral. Because there is uncertainty over the collateral or assets lenders would be able to make a claim on, we present upper (where eligible collateral A is assumed to be housing assets) and lower (where eligible collateral A is assumed to be household assets less non-retirees' superannuation and life insurance assets) limits for LGD. The LGD by product type is also affected by loss precedence; losses are assumed to be borne by products in the order of credit cards, other personal loans and mortgages.

The WPD and LGD rates can be combined to estimate the weighted-average debt-at-risk rate; that is, the expected share of loans that will not be recovered by the banking system:

$$DAR = WPD \times LGD = \frac{\sum_i^N PD_i M_i}{\sum_i^N D_i} \times 100. \quad \text{(A6)}$$

Shocks to interest rates, the unemployment rate and asset prices can then be applied and the process repeated for 2002, 2006 and 2010. The most complex shock, that to the unemployment rate, is modelled through a Monte Carlo simulation with 1 000 trials. The probability of each individual attached to the labour force becoming unemployed is estimated by scaling the results from three separate logit regressions (one for each survey) to match the population-weighted unemployment rate plus the desired shock size.[16] In each trial, every individual is assigned a quasi-random number between zero and one; individuals in the labour force are assumed to become unemployed when this number is less than their probability of becoming unemployed.

16 The initial variables in each logit model were similar to Buddelmeyer, Lee and Wooden (2009).

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Recovery and Resolution of Central Counterparties

Matt Gibson*

The increasing importance of central counterparties (CCPs) to financial stability has prompted regulators to take steps to ensure that critical CCP services can continue in circumstances of financial distress. These steps include ensuring that CCPs have robust plans for recovery to return them to viability, and that authorities have the ability to resolve a CCP if required. This article discusses the key components that are expected to form part of CCPs' recovery plans, including the power of a CCP to apply 'haircuts' to variation margin payments. The article also notes the potential elements that may form part of a resolution regime for CCPs.

Introduction

CCPs play a key role in managing post-trade risks in financial markets. A CCP stands between the counterparties to a financial market trade and performs the obligations that each has to the other under the terms of that trade. This means that participants in markets that are centrally cleared by a CCP do not have credit or liquidity exposures to other participants in those markets; instead, participants are exposed to the CCP alone. Since all trades are against a common counterparty, long and short positions may be offset, reducing participants' gross exposures and economising on associated collateral needs (Jackson and Manning 2007; Duffie and Zhu 2011). Further, as counterparty to both sides of each transaction, the CCP maintains a 'matched book' that minimises its exposure to market risk, and by maintaining a specialist risk management function it may be better able to manage and control exposures to individual market participants. Finally, given its central position, the CCP is able to coordinate actions in the event of a participant default.[1]

The benefits of central clearing in reducing counterparty risk and interconnectedness between financial institutions are well recognised by policymakers (FSB 2010). In response to the global financial crisis, G20 leaders committed to expanding the use of CCPs in over-the-counter (OTC) derivatives trades and many jurisdictions, including Australia, have passed legislation that provides for mandatory central clearing of certain derivatives products.[2] However, widespread central clearing of OTC derivatives will increase market participants' dependence on CCPs and further increase both CCPs' importance to the stability of the financial system and regulators' interest in their capacity to withstand financial stress. Furthermore, where the use of CCPs is mandatory, rather than a private choice, the official sector has a responsibility to clarify how it would deal with a situation of CCP distress. Although robust risk management standards significantly reduce the likelihood of a CCP failure, the possibility of such a

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1 The benefits of central clearing are discussed further in Rehlon and Nixon (2013).

2 The Leaders' Statement at the 2009 Pittsburgh Summit of the G20 committed that all '… standardized OTC derivative contracts should be traded on exchanges or electronic trading platforms, where appropriate, and cleared through central counterparties by end-2012 at the latest' (G20 2009). While this time line has not been met, significant progress has been made in the clearing of OTC derivatives and this continues to be a priority for regulators internationally.

failure cannot be eliminated entirely.[3] Regulators and international standard-setting bodies are therefore taking steps to ensure that CCPs can continue to provide their critical services to participants in circumstances of financial distress. The alternative would see failed CCPs enter into general insolvency, thereby posing a risk to financial stability.

This article focuses on the recovery plans of CCPs that are seen as central to the continuity of critical CCP services in circumstances of extreme stress. Recovery planning is the process by which CCPs prepare for potential threats to their viability, and establish tools and powers within the rules that govern their operations. Although recovery plans should be comprehensive and robust to very extreme circumstances, authorities internationally are also developing special 'resolution' arrangements for CCPs and other financial market infrastructures (FMIs) outside of the general insolvency regime. These arrangements will involve empowering a resolution authority to intervene directly should circumstances prevent a CCP from carrying out its recovery plans satisfactorily. Such intervention would be likely to be most effective and least disruptive if the resolution authority could simply complete the actions contemplated in the CCP's own recovery plan. Therefore, while recovery planning is primarily the responsibility of the CCP, such plans also need to be consistent with the framework for resolution.

International Standards

CCPs and other FMIs performed well during the global financial crisis, which has in part led international regulators and the G20 to encourage the central clearing of OTC derivatives. Since this policy stance implies greater dependence on CCPs, new international standards have been introduced to enhance the resilience and robustness of CCPs (and other FMIs) and ensure that, should a CCP face financial difficulties, critical clearing services can continue to be provided to market participants. Two developments are particularly relevant:

- In April 2012, the Committee on Payment and Settlement Systems (CPSS) and the International Organization of Securities Commissions (IOSCO) published a comprehensive set of updated standards that cover the risk management and recovery arrangements of a broad range of FMIs. Among other things, the CPSS-IOSCO *Principles for Financial Market Infrastructures* (the Principles; CPSS-IOSCO 2012) require that CCPs establish risk controls and default management plans to enable them to deal effectively with the default of one or more participants. These risk controls include the exchange of variation margin to regularly mark participants' positions to market, and the collection of initial margin to cover potential future adverse price moves.[4] CCPs are also required to maintain a prefunded buffer of pooled financial resources to cover additional losses that could arise if a large participant were to default in stressed market conditions.[5]
- In November 2011, the Financial Stability Board (FSB) published the *Key Attributes of Effective Resolution Regimes for Financial Institutions* (Key Attributes; FSB 2011). The Key Attributes set out the legal and institutional arrangements a jurisdiction should put in place to deal with a distressed financial institution. The scope of the Key Attributes extends to all systemically important financial institutions. While the primary focus to date has been on how to deal with a bank failure, the FSB recently released for consultation a

3 Fortunately, CCP failures are extremely rare. There are, however, examples of such failures in the 1970s and 1980s, including in France and Malaysia, as well as some reported 'near misses' (Hills, Rule and Parkinson 1999; Pirrong 2011). The most recent failure, and the most widely cited, was in Hong Kong in October 1987, when sharp declines in the Hang Seng index futures contract threatened large-scale participant defaults and losses in excess of the resources of the CCP. This prompted a joint government and private sector rescue. Ultimately, a new CCP was established with significant enhancements to its operating and risk management framework.

4 Variation margin payments are exchanged between CCPs and their participants on a regular basis to manage their current credit exposures to one another. In addition, CCPs collect initial margin from participants to cover potential losses on a participant's portfolio during the time it would take to liquidate the participant's portfolio if the participant were to default.

5 Under the Principles, all CCPs must hold sufficient financial resources to cover the joint default of any one participant and its affiliates in extreme but plausible market conditions. CCPs that are systemically important in multiple jurisdictions or that clear complex products such as credit default swaps must hold additional financial resources to cover the default of any two participants (plus their affiliates).

set of draft Annexes to the Key Attributes covering specific features of resolution arrangements for systemically important non-banks, including FMIs (FSB 2013). While the Annex that addresses FMIs applies generically to all FMI types, many aspects are most relevant to the resolution of a CCP, and in particular how a CCP might allocate losses arising from the default of a participant and replenish its financial resources.

Prefunded financial resource requirements under the Principles should ensure that a CCP could withstand even an extreme financial shock. However, given the potentially severe disruption that the insolvency of a CCP could have on the financial system, the Principles also require that CCPs maintain comprehensive and robust plans to recover from a threat to solvency that could not be managed solely using prefunded financial resources. Following the release of the Principles, CPSS and IOSCO have consulted on draft guidance on recovery planning for CCPs and other FMIs, discussing possible recovery tools that an FMI might consider (CPSS-IOSCO 2013).

In the Australian context, in December 2012 the Reserve Bank determined new Financial Stability Standards (FSS) for Australian licensed CCPs (RBA 2012a), aligned with requirements under the Principles.[6] In recognition of the ongoing CPSS-IOSCO work on recovery planning, CCPs were granted transitional relief from recovery-related requirements of the FSS until 31 March 2014. In parallel, the government is considering its response to a Council of Financial Regulators (CFR) recommendation to the Treasurer in February 2012 that the Australian Securities and Investments Commission and the Reserve Bank be given the power to appoint a statutory manager to a troubled FMI (CFR 2012). In its recommendation, the CFR further noted that 'the absence of a specialised resolution regime for FMIs represents a gap in the current regulatory framework' (CFR 2012, p 5). The Key Attributes, including the adaptations for FMIs set out in the draft Annex, provide a template for how such a regime could be developed.

6 Similar standards were also determined for facilities responsible for the settlement of securities transactions (RBA 2012b).

Recovery Planning

The risk management standards required of CCPs under the FSS are designed to ensure that CCPs have prefunded financial resources sufficient to withstand a participant default, even in extreme but plausible circumstances. Nevertheless, CCPs will be required to articulate how they would deal with any losses that exceeded the level of prefunded resources (unfunded losses), and also how they would then replenish their prefunded resources. In addition, CCPs must plan for losses that are not related to a participant default, including general business losses.

A comprehensive and robust CCP recovery plan will be expected to contain the following elements (CPSS-IOSCO 2013):

- Identification of critical services offered by the CCP. These are services that are critical to ensure financial stability or the smooth functioning of markets. The recovery plan should address how the continuity of critical services can be maintained, and identify how any non-critical services can be wound down in an orderly manner.
- Identification of stress scenarios that may threaten the continued provision of the CCP's critical services. These may include credit losses or shortfalls of liquidity caused by a participant default, or the realisation of non-default losses. The recovery plan should also define criteria that would trigger the implementation of recovery actions.
- A range of tools to fully and effectively address threats to the CCP's viability. These include tools to address losses associated with the default of a participant (discussed in more detail below), tools to address other losses, and tools to address structural weaknesses in governance or risk management that may have contributed to the losses suffered by the CCP.[7]

7 While CCPs are required to hold capital against non-default losses, the magnitude of these losses may in practice be difficult to predict in advance. This article does not examine the tools that a CCP may use to allocate non-default losses and replenish related capital holdings, but the development of such tools remains an important element of ongoing work on recovery planning for CCPs, both in Australia and internationally.

Recovery Tools

The tools that a CCP could use to recover from financial stress arising from a participant default fall into three categories: tools used to allocate unfunded losses; the termination of contracts; and tools used to re-establish financial resources.

Tools to allocate unfunded losses

A CCP will need to invoke its recovery plans to deal with unfunded losses only if the default of a participant has given rise to a loss in excess of available prefunded financial resources. These resources comprise the defaulted participant's initial margin and contributions to the CCP's prefunded pooled financial resources, as well as the remainder of these pooled resources.

In normal circumstances, a CCP maintains a matched book of positions by taking on both buy and sell sides of each transaction that it clears. This means that any losses on one side of a transaction cleared by the CCP are fully offset by gains on the other side of the transaction. A CCP typically marks positions to market at least daily and collects variation margin payments from its 'losing' counterparties that are then paid out to 'winning' counterparties. In the example shown in the left panel of Figure 1, the CCP collects variation margin to cover mark-to-market losses by participants C and D, and uses these funds to pay variation margin to participants A and B.

In the event of a participant default, the CCP would no longer have a matched book, yet it would have to continue to meet its obligations to non-defaulting participants on the other side of the defaulted participant's positions. In the example shown in the right panel of Figure 1, the default of participant D would mean that the CCP would receive variation margin of only 5 units, while its variation margin payment obligations remained at 15 units. For as long as it had an unmatched book, the CCP would be required to meet any variation margin payment obligations on the defaulted participant's portfolio out of available prefunded financial resources. Through its default management process, the CCP would attempt to eliminate this market risk by closing out its unmatched positions, generally via on-market trades or, for less liquid or OTC products, via auction to surviving participants.

However, there remain several scenarios in which a CCP may be unable to re-establish a matched book using only its prefunded financial resources (ISDA 2013):

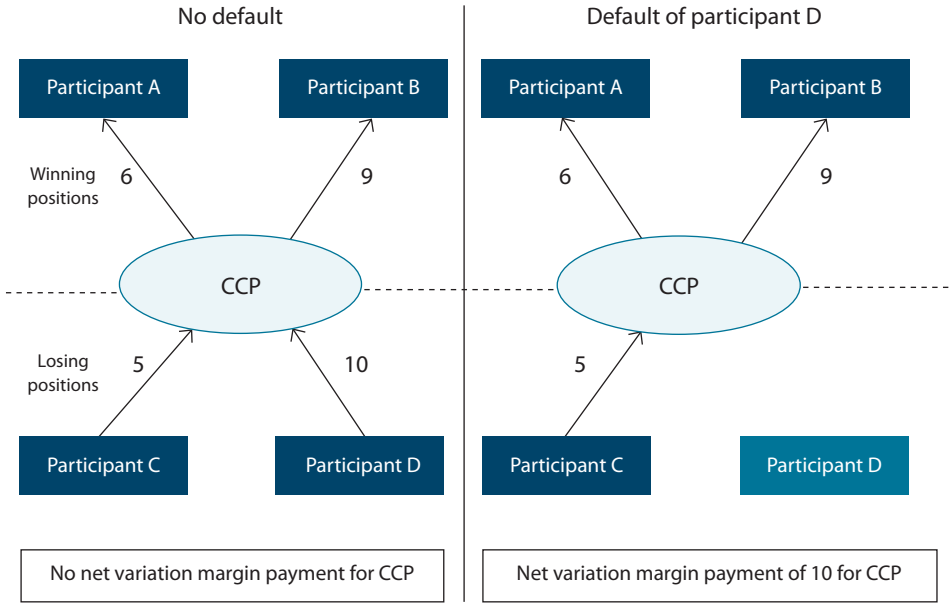
1. If mark-to-market losses on the defaulted participant's portfolio, and therefore the CCP's corresponding variation margin obligations, exceeded the financial resources available to the CCP before unmatched positions could be closed out. This could occur, for instance, in situations where it took some time to arrange an auction for these positions.
2. If the defaulted participant's portfolio could only be closed out at a price that crystallised losses for the CCP in excess of its remaining financial resources.
3. If the CCP could not close out the defaulted participant's portfolio, due to a loss of market liquidity or the failure of a participant auction to determine a market-clearing price.

In scenarios (1) and (2), the CCP would be left with insufficient financial resources to meet its variation margin obligations to non-defaulting participants in full. Scenario (3) could also lead to this situation given that the CCP would remain exposed to market risk on its unmatched book.

Assuming that the CCP had no other creditors, and without a mechanism to allocate its unfunded losses to participants, the CCP would enter insolvency and each non-defaulting participant would receive a claim on the CCP's estate proportional to any variation margin it was owed by the CCP.[8] After receiving distributions from the CCP's estate, participants that were still owed variation margin at the point of insolvency would suffer losses in proportion to their mark-to-market gains at that

8 This discussion also assumes that initial margin was not exposed to insolvency losses, and that the CCP would not be governed by a special insolvency or resolution regime that managed the CCP's insolvency in a non-standard manner.

Figure 1
Variation Margin Payments



Source: RBA

point. Participants that had suffered mark-to-market losses would be obliged to pay variation margin to the CCP. As a result, they would not have a claim on the CCP's estate that could be exposed to additional losses through the insolvency process.

Some CCPs already have some provisions in their rules to address unfunded losses. Most commonly, these take the form of a power to call for additional contributions from participants: a so-called assessment power. To the extent that potential assessments are pre-agreed, participants may be better able to plan in advance and understand their contingent liabilities. Indeed, in many cases prudential regulators of CCP participants will require that assessment powers be subject to caps.[9] However, an obvious limitation of capped assessments is that the capped amount could prove insufficient. In addition, since assessment powers rely on participants transferring funds to the CCP in circumstances in which they may have lost confidence in the CCP, they may have an incentive to 'walk away' rather than fulfil their contractual obligation when due.[10] A CCP's recovery plans may therefore have to supplement assessment powers with other tools, some of which, while unpalatable, may need to be available in the most severe circumstances. Nevertheless, even a capped assessment power would reduce the likelihood that such tools needed to be utilised.

Consistent with resolution principles for banks, international work on the resolution of CCPs has sought to ensure that creditors of a CCP would be no worse off than in a general insolvency (FSB 2011, 2013). Since consistency with resolution regimes is an important consideration in the development of CCP recovery plans, this 'insolvency counterfactual' is relevant for analysing the implications of alternative recovery tools (CPSS-IOSCO 2013). 'Variation margin gains haircutting' (VMGH) is one such tool that has received particular attention in international industry

9 This is not the case in all jurisdictions. For example, some CCPs in Japan have uncapped assessment powers.

10 While a participant could not walk away from its contractual obligations as such, it could refuse to meet these obligations on a timely basis. The failure of a participant to meet an assessment call when due would be likely to constitute an event of default under the CCP's rules. However, it is unlikely that legal action by the CCP could succeed in recovering such funds within the time frame necessary to deal with an unfunded loss.

and regulatory discussions of recovery planning, and mirrors the outcomes under general insolvency (CPSS-IOSCO 2013; Elliott 2013; ISDA 2013).[11] This tool has already been adopted by a number of overseas CCPs (see 'Foreign examples of recovery tools' below).

Variation margin gains haircutting

Where a CCP regularly marks participants' positions to market, VMGH has been identified as a practical method for allocating unfunded losses to the creditors of the CCP in a manner similar to loss allocation under general insolvency. VMGH involves the CCP applying a haircut to its variation margin payments to participants with mark-to-market gains, while requiring that participants with mark-to-market losses continue to pay variation margin to the CCP in full. This outcome is equivalent to that which would be expected in insolvency, provided that the participants were the major creditors of the CCP and initial margin was not exposed to insolvency losses. It does, however, avoid the costs and delays associated with insolvency proceedings.

Figure 2 compares the outcomes under insolvency (left panel) and VMGH (right panel) for the numerical example discussed earlier, assuming that all other prefunded resources of the CCP and any (capped) assessments had already been exhausted. In this example, the default of participant D leaves the CCP with incoming variation margin of 5 units to meet outgoing variation margin obligations of 15 units. A VMGH of two-thirds would replicate the pro rata distribution of incoming variation margin to participants A and B in proportion to their hypothetical claims on the CCP's estate.

In addition to the conceptual appeal of VMGH in replicating insolvency outcomes, VMGH would, where available, generally be expected to be a comprehensive and effective means of allocating unfunded losses to participants. VMGH would directly address the variation margin obligations that arose from the mark-to-market losses sustained on a CCP's unmatched book. If there were no limits on a CCP's ability to haircut variation margin payments to participants, it should always be able to reduce its variation margin obligations to a level that could be met from incoming variation margin payments.

There are, however, some practical limitations to relying solely on VMGH for allocating unfunded losses. These include:

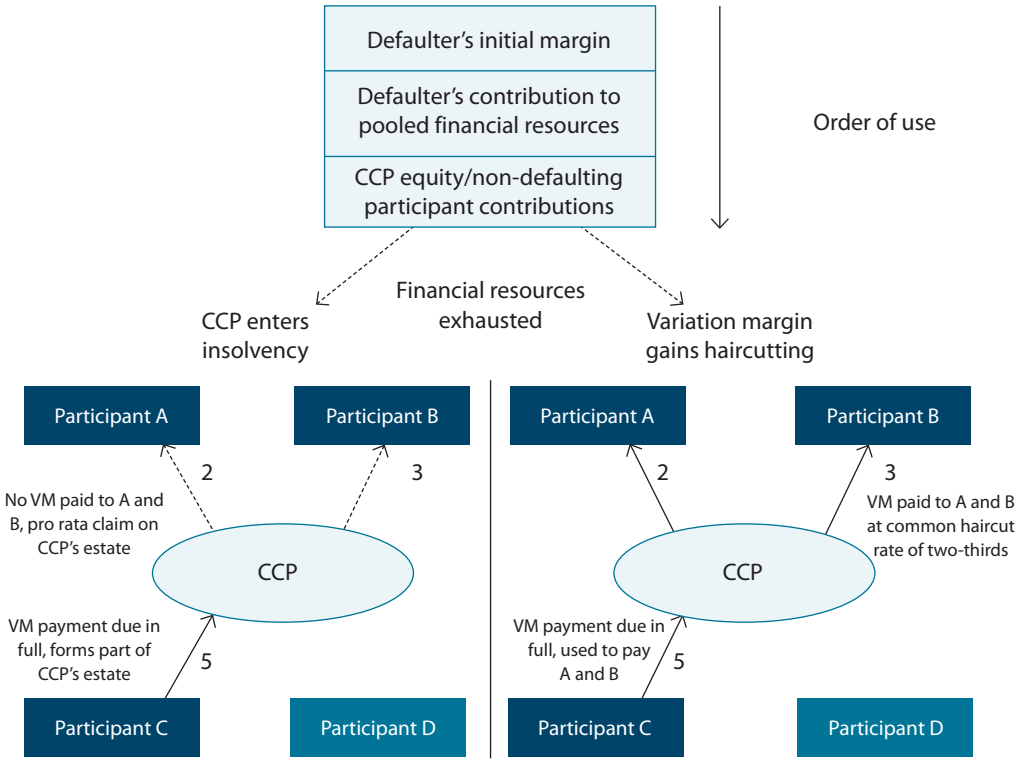
- While VMGH would be expected to be effective on the day of a default, continued reliance on this tool to meet future obligations could create uncertainty for participants. This could in turn create an incentive to exit the CCP in favour of alternative clearing arrangements, including bilateral arrangements.
- In some exceptional circumstances, VMGH may not be adequate to deal with unfunded losses. If the source of a loss was a mark-to-market price move, then VMGH would by definition always be adequate to cover the loss. However, if the loss arose in closing out the defaulted participant's portfolio it might exceed the amount that could be addressed through VMGH. This could occur, for example, if participants were only willing to take on the defaulted participant's positions at a significant price discount. Other tools, such as a (further) round of assessments on participants or, in the extreme, the termination of contracts, would therefore be required (see below).

In developing rules to support VMGH, a CCP will need to consider how the tool would be used in practice. In this regard, the international debate has highlighted the potential for the cost of VMGH to fall disproportionately on users of CCPs that hold unbalanced (or 'directional') portfolios.[12] While

11 The haircutting of initial margin held by the CCP is another possible tool for allocating losses. However, this is a particularly undesirable measure for a number of reasons. For instance, since participants currently expect their initial margin to be protected from the insolvency of the CCP, mutualisation of initial margin could ultimately reduce the incentive to clear centrally. Use of initial margin in this way would also leave the CCP temporarily under-collateralised on exposures to its remaining participants. A less drastic measure may be to use initial margin as a source of temporary liquidity until other resources (such as assessment calls) become available.

12 The question of how or whether participants that share in losses through VMGH should be compensated has also been raised in international debate. One possibility could be for these participants to become creditors of the CCP, to be repaid from the CCP's future revenue stream should the CCP recover successfully. Another could be for these participants to be given an equity stake, although there may be legal or regulatory obstacles to some participants accepting such a stake.

Figure 2
Correspondence between Variation Margin Gains Haircutting and Insolvency



Source: RBA

most dealer firms and some buy-side firms typically attempt to minimise unintended directional positions, other buy-side firms may hold highly directional open positions with a CCP.[13] These may reflect the hedging of exposures held outside of the CCP. As a result, such firms may be more likely to experience significant variation margin gains and losses. Buy-side firms do not typically access CCPs directly; instead they become clients of direct participants. Although VMGH would only directly affect the latter, direct participants could elect to pass through any haircuts on variation margin imposed by the CCP on their buy-side clients' positions.

13 Broadly speaking, buy-side firms are those that invest to meet an underlying demand for a portfolio with particular characteristics (e.g. a fund manager or superannuation fund).

Termination of contracts

Circumstances may be so extreme that a CCP cannot fully close out or auction a defaulted participant's portfolio, or cannot do so without incurring a loss that exceeds its remaining financial resources (e.g. the case of an auction clearing price that is at a significant discount to the mark-to-market price). The CCP may therefore have no option but to terminate (tear up) open contracts in order to restore a matched book. A CCP may choose to reserve a portion of its power to make assessment calls to fund such a shortfall. If this proved inadequate, and if it had the power to do so, the CCP would have to forcibly allocate positions to surviving participants. In many cases, however, forced allocation may be unacceptable to CCP participants or their regulators due to the unpredictable impact that the use of this power may have on their exposures. The debate

among both regulators and industry participants has therefore settled on the termination or tearing up of open contracts as a 'last resort' tool (CPSS-IOSCO 2013; Elliott 2013; ISDA 2013).

This tearing up of open contracts may be either 'complete' or 'partial':

- A complete tearing up would involve termination of all open contracts covered by the clearing service, across all participants, essentially closing the service. This would clearly be an extreme measure, obliging market participants to re-establish all of their positions under alternative or restructured clearing arrangements, and assume any losses associated with establishing such replacements. Nevertheless, a complete termination of contracts would mirror what would otherwise occur under general insolvency. Given the severe consequences of complete termination, the threat of such action in the event of a failed auction could prove sufficient to encourage competitive bidding at auction or the voluntary partial termination of positions (see below).
- A partial tearing up would involve the termination of only the defaulted participant's contracts. However, as in the case of forced allocation, a partial termination could have a significant and unpredictable impact on the net exposures of individual participants (ISDA 2013). These concerns could be addressed by allowing participants to nominate positions to be terminated voluntarily, or to carefully select sets of contracts for termination that avoid disturbing netting arrangements. However, there is no guarantee that the number of contracts that could be identified for tearing up would be sufficient to ensure that the CCP's matched book could be re-established. This suggests that CCPs may nevertheless need to have the power to effect a complete termination to ensure that they would be able to re-establish a matched book in all circumstances.

Tools to re-establish financial resources

Loss allocation tools and tearing up contracts would be used only where a CCP's prefunded financial resources had been fully depleted. However, for a CCP's participants and its regulators to be confident that the CCP remains 'fit for purpose', it must have the capacity to replenish its financial resources rapidly and to a level sufficient to be able to withstand any future participant default.[14]

Other things being equal, the replenishment of a CCP's financial resources should seek to restore the coverage levels in place prior to the default, but should take into account changes in circumstances following the default. One possible mechanism to replenish participant contributions to pooled resources is an assessment power (see above). The CCP would also need to have arrangements in place to raise additional funds as needed to restore its own contribution to pooled financial resources.

In the event that a CCP experienced a shock so severe that it fully depleted both the defaulted participant's initial margin and the CCP's entire pool of prefunded financial resources, there would be a significant risk that participants would lose their confidence in that CCP. This would be revealed when participants were called upon to replenish financial resources: some participants may not be prepared to commit further funds to the CCP without significant changes to its ownership or governance structure; some may contemplate exiting the CCP altogether. If the CCP's services were considered critical to financial system stability, the CCP or its regulators would need to take steps to address participants' concerns rapidly, so as to ensure that the CCP could continue to operate as a going concern.

Foreign examples of recovery tools

As international thinking on recovery planning for CCPs has evolved, CCPs in several jurisdictions have taken steps to introduce some of these recovery tools. The Japan Securities Clearing Corporation

14 Rapid replenishment would be required even where a CCP had drawn on, but not completely exhausted, its prefunded financial resources.

(JSCC), the UK-based LCH.Clearnet Ltd (LCH.C Ltd) and CME Clearing Europe, and the French-based LCH.Clearnet SA (LCH.C SA) each have rules allowing for VMGH and the complete tearing up of open contracts where prefunded financial resources have been exhausted by the default of a participant.[15]

In the case of LCH.C Ltd's clearing services for interest rate swaps and non-deliverable foreign exchange forwards, the haircut that may be applied to variation margin payments is capped. The applicable haircut is capped at the higher of 100 per cent of that participant's contribution to prefunded financial resources, or a fixed amount of either £100 million (for interest rate swaps) or US$100 million (for foreign exchange forwards). LCH.C Ltd would apply VMGH only after prefunded financial resources and participant assessments had been exhausted. If remaining losses could not be addressed fully through VMGH, and participants did not unanimously agree to extend VMGH beyond the level of the cap, LCH.C Ltd would proceed to tear up contracts and close the relevant clearing service. LCH.C SA applies a similar approach to LCH.C Ltd in respect of its clearing service for credit default swaps, but neither JSCC nor CME Clearing Europe apply caps to the level of VMGH allowed under their rules.

Resolution

Even well-crafted recovery plans could prove difficult to implement effectively in practice. For example, the management of a CCP might be reluctant to take extreme recovery actions such as to completely tear up contracts. Alternatively, participants could choose to 'walk away' from the CCP rather than fulfil their financial obligations in loss allocation or replenishment when due. Although authorities could take actions, such as the issuance of directions, to support recovery measures, there could be circumstances in which the CCP failed to recover nevertheless.

In such circumstances, it would be desirable for a resolution authority to have appropriate powers to enforce the rules-based recovery measures that the CCP was itself unable to complete. The intention would be that actions taken by the resolution authority in accordance with the plan restored critical services to viability, while allowing any non-critical services to be wound down in an orderly manner. The power to implement recovery measures should be supported by ancillary powers that provide flexibility to pursue alternative means of maintaining continuity of service (such as via a transfer of operations), or to effect a change in governance where necessary to restore the confidence of participants in a CCP.

Consistent with this, the Key Attributes and the recommendations of the CFR's 2011–2012 review of FMI regulation suggest that the main elements of a resolution regime for CCPs should include:

- the designation of an appropriate resolution authority for CCPs
- a description of the conditions governing the entry of a CCP into resolution
- statutory objectives for resolution, which are focused on financial stability and the continuity of critical services
- the power to appoint a statutory manager to administer a distressed CCP
- the power to facilitate the transfer of the operations of a distressed CCP to a third party or bridge institution
- enhanced powers of direction over a CCP, including to support recovery and resolution.

Next Steps

In March 2014, the requirements of the FSS relevant to recovery planning will come into force, and Australian licensed CCPs will be required to develop and maintain comprehensive and effective recovery plans. The most direct impact of these requirements will be on the two ASX-operated CCPs for which the Bank is the regulator responsible for matters related to financial stability: ASX Clear, which clears ASX-listed equities and equity derivatives; and ASX

15 These rules do not necessarily apply to all product classes cleared by these CCPs; see Elliott (2013) for a breakdown of recovery measures by product type.

Clear (Futures), which clears derivatives traded on the ASX 24 market and OTC interest rate swaps.[16]

The Bank's *2012/13 Assessment of ASX Clearing and Settlement Facilities* set out the steps that it expects ASX Clear and ASX Clear (Futures) to take in order to meet the new recovery planning requirements (RBA 2013). Each ASX CCP will need to prepare an appropriate recovery plan addressing very extreme scenarios under which the CCP's financial resources were insufficient to cover credit losses and/or payment obligations following a participant default. The plan would be expected to include the use of a selection of the tools discussed in this article and should be consistent with CPSS-IOSCO guidance on recovery planning (CPSS-IOSCO 2013).

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16 As noted above, the only other CCP currently licensed in Australia, LCH.C Ltd, has already introduced VMGH in a limited form. The Bank will be liaising with LCH.C Ltd's home jurisdiction regulator, the Bank of England, in assessing the compliance of LCH.C Ltd with the recovery planning requirements of the FSS.

Foreign Currency Exposure and Hedging in Australia

Anthony Rush, Dena Sadeghian and Michelle Wright*

The 2013 Australian Bureau of Statistics (ABS) Foreign Currency Exposure survey confirms that Australian entities' financial asset and liability positions remain well hedged against a depreciation of the Australian dollar, either through the use of foreign currency hedging derivatives or through offsetting foreign currency asset and liability positions. Even before taking into account the use of hedging derivatives, Australian entities as a whole have a net foreign currency asset position with the rest of the world. After accounting for hedging derivatives, this overall net foreign currency asset position increases slightly. This is primarily because the banking sector hedges all of its net foreign currency liability exposure, although this is partly offset by other financial corporations hedging part of their overall net foreign currency asset exposure. As a result of this net foreign currency asset position, the Australian economy's net overall foreign liability position would not in itself be a source of vulnerability in the event of a sudden depreciation of the Australian dollar.

Introduction

Since the float of the Australian dollar 30 years ago, Australia's flexible exchange rate has played an important role in cushioning the economy from external shocks and smoothing fluctuations in the business cycle.[1] Yet for individual entities with foreign currency assets, liabilities or trade exposures, fluctuations in the exchange rate can lead to changes in the Australian dollar value of their balance sheet positions and cash flows. Depending on the distribution of these foreign currency exposures across individual sectors, there could be flow-on effects for financial stability and the real economy. It is therefore important to understand how these foreign currency exposures are distributed throughout the economy and the extent to which they are hedged.

In terms of balance sheet exposures, Australian entities have traditionally had an overall net liability position with the rest of the world. This net foreign liability position reflects ongoing capital inflows – which are the counterpart to sustained current account deficits – and has fluctuated between 55 and 60 per cent of GDP for a number of years.[2] While the size of this liability position could potentially be a cause for concern, the majority of Australian entities' foreign liabilities are denominated in Australian dollars, whereas most foreign assets are denominated in foreign currencies. As a result, Australia has consistently had a net foreign currency *asset* position, with the net overall liability position reflecting liabilities that are denominated in Australian dollars.

This net foreign currency asset position means that a depreciation of the Australian dollar reduces the size of Australian entities' overall net foreign liability

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1 For a discussion of the significance of Australia's floating exchange rate regime in allowing monetary policy to operate effectively and fostering real economic adjustment, see Stevens (2013).

2 For a history of Australia's current account, see Belkar, Cockerell and Kent (2007).

position by increasing the Australian dollar value of foreign currency assets relative to foreign currency liabilities (the converse is true for an appreciation). This is true even before any hedging of these foreign currency positions is taken into account.

Notwithstanding the net foreign currency asset position for the economy as a whole, some individual entities – particularly in the banking sector – have net foreign currency liability positions. Unless these firms' net foreign currency liabilities are hedged, a depreciation of the Australian dollar could result in a deterioration of their balance sheet positions – by increasing the Australian dollar value of their liabilities relative to their assets.

In addition, as nearly 80 per cent of Australian merchandise trade is denominated in foreign currency, movements in the exchange rate can also affect the cash flows of trade-exposed firms by altering the Australian dollar value of their trade payments and receipts. Australian dollar depreciation will tend to reduce profits for net importers, while supporting the profitability of net exporters and import-competing firms – and vice versa for an appreciation – unless these foreign currency exposures are hedged.

In view of this, the Reserve Bank initiated and has provided funding for the ABS to undertake a survey of firms' foreign currency exposures – and their use of foreign currency derivatives to hedge these exposures – every four years since 2001. The most recent survey of Foreign Currency Exposure (FCE) was conducted as at the end of March 2013.[3] Compared with previous surveys, the 2013 results include more direct information about respondents' use of derivatives for hedging purposes, particularly for foreign currency debt security liabilities. However, owing to data limitations, the 2013 survey contains less information than previous surveys on the extent to which firms hedge their expected trade payments and receipts. As a result, the remainder of this article focuses on the hedging of balance sheet exposures only.[4]

It should also be noted that while the FCE survey quantifies the extent to which derivatives are used to hedge foreign currency risk, it does not *directly* account for 'natural hedges'. Natural hedges are created by payment obligations and/or receipts that have at least partially offsetting foreign currency risk; for example, a bank's use of a US dollar deposit to fund the purchase of an interest-bearing US dollar asset, or a superannuation fund's investment in a foreign currency asset that has a price that tends to be negatively correlated with movements in the relevant exchange rate. While the survey *indirectly* accounts for natural hedges that are created by netting foreign currency asset and liability positions against each other, no account is taken of other forms of natural hedging, such as those that are based on historical relationships between exchange rate movements and the foreign currency price of the underlying exposures.[5]

Aggregate Results

As at the end of March 2013, international investment position (IIP) data indicated that Australian entities overall had a net foreign currency asset position equivalent to 27 per cent of GDP before taking into account the use of derivatives for hedging purposes (ABS 2013a).[6] This is because most foreign liabilities are denominated in Australian dollars while most foreign assets are denominated in foreign currencies

3 See ABS (2013b) for the primary source of this information. The results from the 2009 survey are discussed in D'Arcy, Shah Idil and Davis (2009).

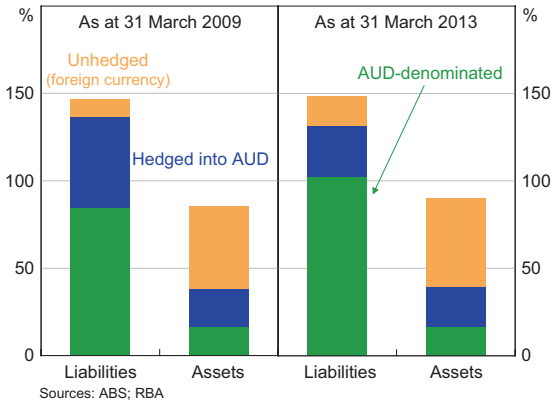
4 For non-financial firms, foreign currency exposures arising from expected trade payments and receipts are similar in size to, albeit less certain than, their foreign currency assets and liabilities (the equivalent of around 30 per cent of GDP).

5 Also, the FCE survey does not necessarily capture the full extent of derivatives-based hedging by Australian entities. For example, if multinational companies with Australian operations manage their exposures centrally – rather than arranging hedging for their Australian subsidiary separately to other operations – these hedges will not be captured.

6 The FCE survey indicates a slightly smaller net foreign currency asset position, as there are a number of small conceptual differences between the FCE survey and the IIP data. However, these differences do not materially affect the findings presented in this article.

(Graph 1). This net foreign currency asset position before hedging has increased from 7 per cent of GDP from the end of March 2009, driven by a decline in the value of foreign currency denominated liabilities. This in turn reflected a compositional shift towards equity liabilities (which are denominated almost entirely in Australian dollars) and away from debt liabilities (some of which are denominated in foreign currencies).

Graph 1
Currency Composition of Australia's External Position
Per cent of GDP



Sources: ABS; RBA

About 70 per cent of foreign liabilities were denominated in Australian dollars as at the end of March 2013 – equivalent to about 100 per cent of GDP. Within this, equity liabilities equated to around 50 per cent of GDP, while the banking sector's Australian dollar-denominated foreign debt liabilities and foreign holdings of Commonwealth Government securities (CGS) were each equivalent to a little less than 15 per cent of GDP. In contrast, 80 per cent of Australian entities' foreign assets were denominated in foreign currencies – or the equivalent of around 75 per cent of GDP.[7] Within this, foreign equity investments and foreign currency denominated debt assets equated to around 45 per cent and 30 per cent of GDP, respectively.

Information from the latest FCE survey indicates that, after accounting for derivatives used to hedge foreign currency exposures, Australia's *effective* net foreign currency asset position was equivalent to a little more than 30 per cent of GDP as at the end of March 2013. This is because a greater share of foreign currency liabilities were hedged compared with foreign currency assets (with hedging ratios of around 60 per cent and around 30 per cent, respectively).[8] The higher overall net foreign currency asset position after hedging primarily reflects the fact that, in aggregate, the banking sector reported that it hedged virtually all of its net foreign currency liability position using derivatives. For other sectors – discussed in more detail below – hedging via derivatives was reported to reduce the foreign currency asset position of 'other financial' corporations, but to increase the foreign currency asset position of private non-financial firms (which are referred to as 'other residents' in the FCE survey) a little.

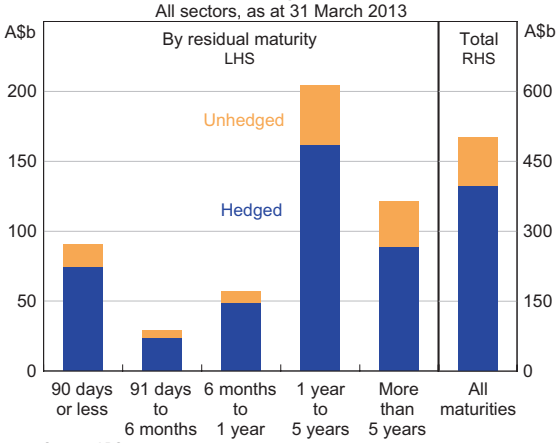
Debt securities account for a bit more than two-thirds of Australia's foreign currency debt liabilities. In recognition of this, the 2013 FCE survey collected additional data on foreign currency denominated debt security liabilities, the use of foreign currency derivatives to hedge these and the extent to which the maturity of these hedges are matched to the maturities of underlying exposures. With complete hedging, maturity matching ensures that an entity will not be exposed to foreign currency risk for the entire duration of the underlying exposure and can avoid rollover risk that might otherwise be associated with maintaining its hedges. These data

7 Examples of Australian dollar-denominated foreign assets include resident holdings of Australian dollar-denominated bonds issued by non-residents in the domestic market ('Kangaroo' bonds), Australian dollar-denominated loans made to non-residents by Australian banks and Australian banks' Australian dollar deposits with non-residents (including those related to intragroup funding transactions).

8 While the 2009 FCE survey indicated a slightly higher net foreign currency asset position after taking into account the use of derivatives-based hedging (38 per cent of GDP), the data are not directly comparable owing to a number of survey design changes. In particular, the 2009 data were based on information collected about a sample of firms' usual hedging policies, whereas the 2013 data were based on information collected specifically about the actual use of derivatives for hedging purposes.

indicate that, in aggregate, around 80 per cent of the value of foreign currency denominated debt security liabilities were hedged using derivatives, reflecting a hedging ratio of 84 per cent for short-term debt liabilities and 77 per cent for long-term debt securities, on a residual maturity basis (Graph 2).[9] Also, around 95 per cent of these foreign currency derivative hedges were maturity matched.

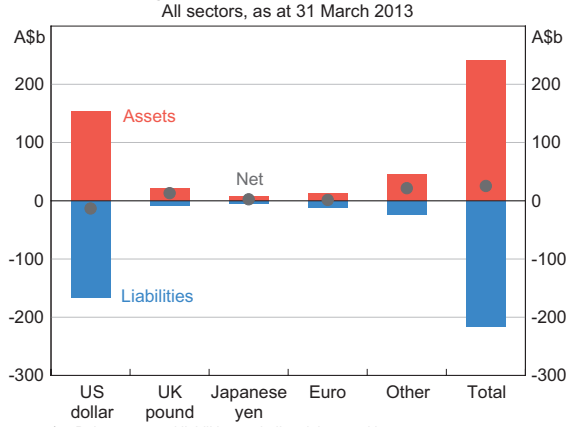
Graph 2
Hedging of Foreign Currency Debt Security Liabilities
All sectors, as at 31 March 2013



Source: ABS

'Other' debt liabilities, which consist primarily of loans and deposits, account for the remaining one-third of Australia's gross foreign currency debt liability exposures. The FCE survey indicates that around a quarter of these other debt liabilities were hedged using derivatives as at the end of March 2013. This relatively low derivatives-based hedging ratio may reflect the prevalence of natural hedging for other debt liabilities – in particular, through offsetting foreign currency asset positions. For the Australian economy as a whole, the FCE survey reveals that holdings of other foreign debt assets largely offset other foreign debt liabilities across a range of currencies (Graph 3). This feature is also evident across individual sectors.

Graph 3
Currency Composition of 'Other Debt'*
All sectors, as at 31 March 2013



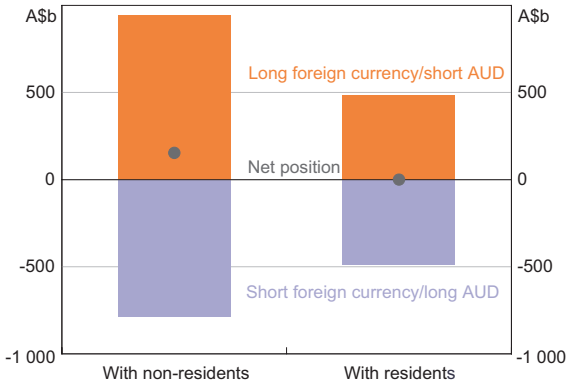
* Debt assets and liabilities excluding debt securities
Sources: ABS; RBA

Further to providing information about the nature of Australian entities' foreign currency exposures, the FCE survey also contains detailed information on the notional amount of foreign currency derivative holdings as at the end of March 2013. Consistent with the finding that the use of derivatives increases the effective size of the Australian economy's net foreign currency asset position, the survey reveals that Australian entities had a net long foreign currency derivative position vis-à-vis non-residents (Graph 4).[10] In addition to derivatives used for hedging purposes, this notional amount includes foreign currency derivatives used for other purposes, such as trading derivative positions which are held for the purpose of *gaining* exposure to particular foreign currency markets. Non-resident counterparties to Australian residents' long foreign currency derivative positions include foreign entities that issue Australian dollar bonds in the domestic market (known as Kangaroo bonds). To the extent that Kangaroo bond issuers seek to hedge their Australian dollar liabilities, they are natural counterparties for Australian entities wishing to hedge their foreign currency debt liabilities (Arsov *et al* 2013). In addition, a sizeable share of non-resident counterparties are foreign

9 Short-term liabilities are defined as those with a residual maturity of one year or less.

10 A long position in a foreign currency derivative is one that would profit from a depreciation of the Australian dollar against that foreign currency.

Graph 4
Foreign Currency Derivative Positions*
Notional amount held by residents, as at 31 March 2013



* Derivatives involving the Australian dollar
Source: ABS

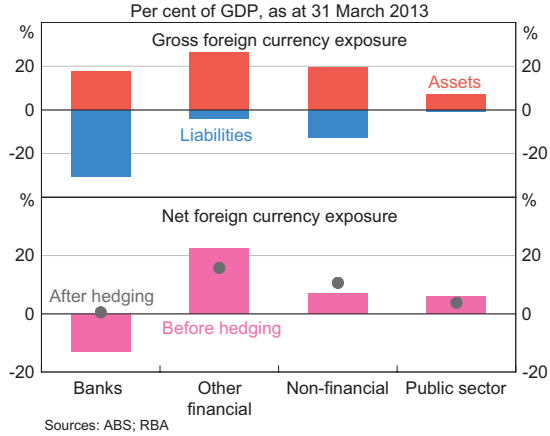
investors seeking to gain (rather than hedge) Australian dollar exposure via derivative markets.

By type of instrument, cross-currency swaps accounted for around two-thirds of the total notional amount of long foreign currency derivative positions and close to half of short foreign currency derivative positions.[11] This represents a substantial increase in the use of cross-currency swaps since the 2009 FCE survey. At that time, these instruments accounted for around 40 and 30 per cent of long and short foreign currency derivative contracts, respectively, with foreign exchange forward contracts being the dominant instrument. The increased use of cross-currency basis swaps is attributable to the banking sector and is consistent with a lengthening in the average maturity of banks' new offshore wholesale funding over the 2009–2013 period. Arsov *et al* (2013) explain that cross-currency swaps are better suited to hedging longer-term foreign currency risk compared with forward contracts, which are generally used to hedge shorter maturities.

Sectoral Results

The sectoral results for the 2013 survey indicate that Australia's aggregate net foreign currency asset position was held principally by non-bank private financial corporations (other financial corporations), with non-financial corporations and the public sector (including the Future Fund and the Reserve Bank) also holding small net foreign currency asset exposures (Graph 5). In contrast, the banking sector had a net foreign currency liability position before taking into account the use of derivatives for hedging purposes and a net foreign currency asset position of close to zero after accounting for the use of hedging derivatives.

Graph 5
Foreign Currency Exposure by Sector
Per cent of GDP, as at 31 March 2013



Sources: ABS; RBA

Banks

The 2013 FCE survey shows that, before taking account of the use of hedging derivatives, the banking sector had a net foreign currency liability position equivalent to 13 per cent of GDP, reflecting a foreign currency asset position of 18 per cent of GDP and a foreign currency liability position of 31 per cent of GDP (Table 1). The net foreign currency liability position for the banking sector reflects the fact that Australian banks have historically sourced a sizeable share of their wholesale funding from offshore markets.[12] Unless hedged, this net foreign currency liability position could have financial stability implications in the event of a sharp depreciation

11 Cross-currency swaps involve the exchange of principal in different currencies as well as the payment of interest in one currency and the receipt of interest in another currency at a fixed exchange rate determined at the contract's initiation. See Arsov *et al* (2013) for more information.

12 Offshore wholesale debt securities currently account for around 15 per cent of total banking sector liabilities. For more information about developments in the composition of Australian banks' funding, see RBA (2012).

Table 1: Private Sector Foreign Currency Exposures
As at 31 March 2013

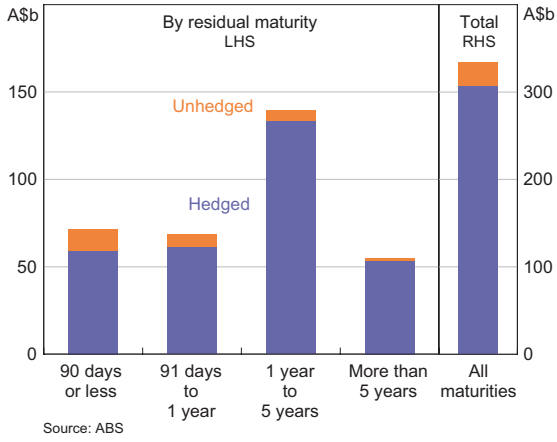
	Banks		Other financial corporations		Non-financial corporations	
	Before hedging	After hedging	Before hedging	After hedging	Before hedging	After hedging
A$ billion						
Assets	265	117	395	259	294	291
Liabilities	459	110	58	23	189	132
Net balance sheet exposure	**–194**	**8**	**337**	**236**	**104**	**160**
Per cent of GDP						
Assets	18	8	26	17	20	19
Liabilities	31	7	4	2	13	9
Net balance sheet exposure	**–13**	**1**	**22**	**16**	**7**	**11**

Sources: ABS; RBA

of the Australian dollar. Yet, by allowing banks to effectively fix the Australian dollar cost of accessing these markets, hedging provides an opportunity for Australian banks to diversify their funding bases, while avoiding exposure to exchange rate risk. After taking the use of hedging derivatives into account, the banking sector had a small net foreign currency asset position at the end of March 2013.

Debt security liabilities are the main source of foreign currency exposure for the banking sector, accounting for roughly three-quarters of the sector's foreign currency liabilities and almost half of Australia's total foreign currency liabilities. However, the data show that more than 90 per cent of these exposures were hedged using derivatives, reflecting a hedging ratio of around 85 per cent for short-term debt liabilities and around 95 per cent for long-term debt securities, on a residual maturity basis (Graph 6). Consequently, the banking sector's unhedged foreign currency debt security liabilities were equivalent to less than 1 per cent of its total financial assets. Further, the survey shows that for the banking sector, the maturities of the derivatives used to hedge against foreign currency risk were matched to the maturities of the underlying debt securities.

Graph 6
Banks' Hedging of Foreign Currency Debt Security Liabilities
As at 31 March 2013



Source: ABS

Other foreign currency debt liabilities – largely loans and deposits – account for the remainder of the banking sector's foreign currency liabilities. The FCE data suggest that around one-third of these liabilities were hedged using derivatives. However, the data also suggest that a sizeable share of the banking sector's other foreign currency debt liabilities had natural hedges, as the size and currency composition of its other foreign currency debt assets were closely matched to that of these liabilities.

Other financial corporations

The other financial corporations category covers a range of non-bank financial corporations, including superannuation and pension funds, insurance corporations and fund managers. These entities' foreign currency exposures generally arise from overseas investments, which are typically undertaken in an attempt to achieve higher risk-adjusted returns on their investment portfolios. In line with this, the FCE survey indicates that at the end of March 2013, this group of firms had a net foreign currency asset position equivalent to 22 per cent of GDP before taking into account the use of hedging derivatives, largely reflecting holdings of foreign equity assets. This net foreign currency asset position has risen modestly as a share of GDP since 2009 (from 18 per cent of GDP), owing to a reduction in these firms' foreign currency denominated debt liabilities over this period.

After accounting for the use of hedging derivatives, the FCE survey indicates that the overall net foreign currency asset position of other financial corporations was equivalent to 16 per cent of GDP, with a hedging ratio of around 35 per cent for foreign currency assets and 60 per cent for foreign currency liabilities (Table 1). The 2013 survey also suggests that hedging ratios for foreign equity assets were lower than those of foreign debt assets, which is also consistent with the results of the 2013 National Australia Bank Superannuation FX Survey (NAB Survey; NAB 2013).

The 2013 FCE survey results also suggest that the aggregate foreign currency asset hedging ratio for other financial corporations is likely to have declined over the four-year period (the 2009 results indicated that this group of firms *usually* hedged a little over 40 per cent of the value of their foreign currency assets) although this may in part reflect the timing of the surveys. In particular, the Australian dollar appreciated by around 40 per cent on a trade-weighted basis over the four-year period to be close to its post-float peak at the time of the 2013 survey, which may have increased some firms' expectations of future depreciation. The decline in the sector's hedging ratio is also broadly consistent with the results of the NAB Survey, which showed that hedging ratios for superannuation funds declined by 5–10 percentage points across most asset classes between 2011 and 2013. The NAB Survey suggests that fund managers have increasingly adopted a portfolio approach to managing their foreign currency risk, which involves accounting for correlations between exchange rates and underlying foreign currency asset prices in choosing an 'optimal hedging ratio' for the portfolio as a whole. This is in contrast to an asset-based approach, in which foreign currency risk is managed separately for each asset class. By accounting for natural hedges that may arise from correlations between movements in the price of different asset classes and/or exchange rates, a portfolio-based approach could be expected to result in lower derivatives-based hedging ratios than an asset-based approach.

Non-financial corporations

Non-financial corporations also had an overall net foreign currency asset position (before taking into account the use of hedging derivatives) equivalent to 7 per cent of GDP as at the end of March 2013 (Table 1). This net position in turn consisted of foreign currency asset holdings equivalent to about 20 per cent of GDP, with more than three-quarters of this in the form of equity investment (including direct investment by multinational companies in their offshore operations). In contrast to banks and other financial corporations, the non-financial sector's foreign currency liabilities have risen since 2009, consistent with an increase in borrowings in foreign debt markets by larger corporations (particularly in the mining sector).

The FCE survey indicates that around one-third of non-financial corporations' aggregate foreign currency liability exposures were hedged using derivatives, but only a negligible share of the sector's foreign currency assets were hedged using derivatives. As a result, non-financial corporations

had a larger overall net foreign currency asset position, after taking into account the use of hedging derivatives. Although non-financial corporations' unhedged foreign currency assets accounted for 40 per cent of Australia's total unhedged foreign currency assets, these exposures represented less than 10 per cent of the sector's total assets. This suggests that, in aggregate, non-financial corporations' foreign currency assets and liabilities do not pose a large risk to the real economy.

The survey also suggests that there has been a reduction in the non-financial sector's hedging ratios for both assets and liabilities since 2009. Consistent with this, the notional amount of the sector's long Australian dollar (short foreign currency) derivative holdings more than halved over this period, while the notional amount of the sector's short Australian dollar (long foreign currency) derivatives fell modestly. As with the other financial corporations sector, the decline in the foreign currency asset hedging ratio may partly reflect expectations for the Australian dollar to depreciate, given that it was at a very high level at the time of the survey. The decrease in the liability hedging ratio could also reflect increased use of natural hedging; for example, firms with foreign currency payment obligations may have offsetting foreign currency receipts.

Public sector

The general government sector – which consists of national, state and local governments – had a net foreign currency asset position equivalent to around 3 per cent of GDP as at the end of March 2013, before taking into account the use of derivatives for hedging purposes (Table 2). The sector held foreign currency assets equivalent to about 4 per cent of GDP, with the majority of these likely to reflect investments by the Australian Government's Future Fund. Overall, the government sector is reported to have hedged about 70 per cent of its foreign currency asset exposure using derivatives.[13] The government sector had negligible foreign currency liabilities (equivalent to less than 1 per cent of GDP), which were mostly accounted for by liabilities of state borrowing authorities and were hedged almost entirely using derivatives.

As at the end of March 2013, the Reserve Bank had a foreign currency asset position of $39 billion, equivalent to 3 per cent of GDP, which was denominated in US dollars, euros, Japanese yen and Canadian dollars. This position consisted primarily of net reserves acquired on an outright basis, which are not hedged as these assets are held primarily to facilitate policy operations in the foreign exchange

Table 2: Public Sector Foreign Currency Exposures
As at 31 March 2013

	General Government		Reserve Bank of Australia	
	Before hedging	After hedging	Before hedging	After hedging
A$ billion				
Assets	65	19	39	39
Liabilities	13	0	0	0
Net balance sheet exposure	**52**	**19**	**39**	**39**
Per cent of GDP				
Assets	4	1	3	3
Liabilities	1	0	0	0
Net balance sheet exposure	**3**	**1**	**3**	**3**

Sources: ABS; RBA

13 This is broadly in line with the level of hedging implied by the Future Fund's 2012/13 annual report (Future Fund 2013).

market. For this reason, the Bank holds the minimum level of reserves that it assesses will allow it to meet expected policy requirements.[14]

Summary

The Australian economy has historically been a net recipient of capital flows, which is reflected in its net foreign liability position. However, as most foreign liabilities are denominated in Australian dollars and the majority of foreign assets are denominated in foreign currencies, Australia has a net foreign currency asset position. This position increases in size after accounting for derivatives-based hedging. Australia's foreign currency asset position primarily reflects foreign equity holdings by non-bank financial corporations and the non-financial sector. The banking sector's foreign currency debt liabilities – and in particular its debt *security* liabilities – account for the bulk of Australia's foreign currency liabilities. At face value, this could raise concerns about the banking sector's ability to service these liabilities in the event of sudden depreciation of the Australian dollar. However, the FCE survey shows that the banking sector almost completely hedges its gross foreign currency debt security liability exposure using derivatives, and that the remaining foreign currency exposure is offset by natural hedges created by foreign currency asset holdings (e.g. payments and receipts generated by banks' offshore assets and liabilities with offsetting foreign currency risk). Overall, information from the 2013 FCE survey confirms that the use of foreign currency derivative contracts and the issuance of Australian dollar-denominated liabilities means that the Australian economy's net overall foreign liability position would not in itself be a source of vulnerability in the event of a sudden depreciation of the Australian dollar.

14 For a discussion of the RBA's foreign exchange reserves, see Vallence (2012).

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Developments in Foreign Exchange and OTC Derivatives Markets

Matthew Brooks, Cameron Deans, Peter Wallis, Benjamin Watson and Mark Wyrzykowski*

Global activity in foreign exchange and over-the-counter (OTC) derivatives markets continued to increase over the three years to April 2013. The increase in foreign exchange turnover was mostly driven by growth in the United Kingdom. Turnover in Australia declined slightly, even though global turnover of the Australian dollar increased markedly. Globally, the notional amount of OTC derivatives outstanding increased modestly over the three years to the end of June 2013, while the increase was more pronounced in the Australian market.

Background

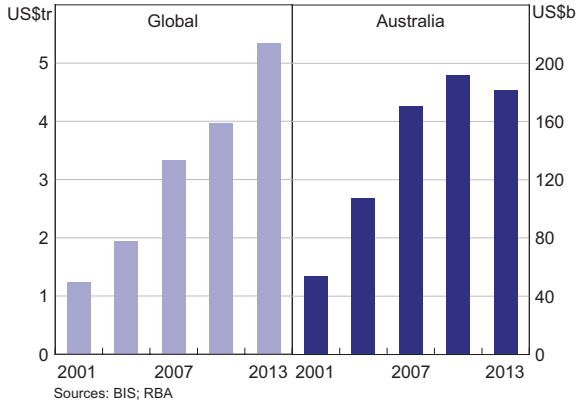
The 2013 Triennial Central Bank Survey of Foreign Exchange and OTC Derivatives Markets Activity (Triennial Survey) provides a comprehensive and unique source of information about the activity and structure of these markets.[1] The 2013 Triennial Survey was conducted in two parts: the turnover portion of the survey measured activity in foreign exchange and single-currency interest rate derivatives markets in the month of April, while the outstandings portion of the survey measured the amount of OTC derivatives outstanding as at the end of June.

This article discusses the key results from the survey on foreign exchange turnover and examines some of the broad drivers of foreign exchange market activity both globally and in Australia. It also provides an overview of developments in the size of OTC derivatives markets as measured by the amounts outstanding.[2]

Foreign Exchange Turnover

Global foreign exchange turnover grew by 35 per cent over the three years to April 2013, to reach an average of US$5.3 trillion per day (Graph 1).[3] The rate of growth exceeded that over the previous three years and coincided with a 25 per cent increase in the value of international trade over the same period. In contrast, global cross-border lending and investment, which are also key sources of transaction

Graph 1
Foreign Exchange Turnover
Daily average by location, April



Sources: BIS; RBA

* The authors are from Financial Markets Group.

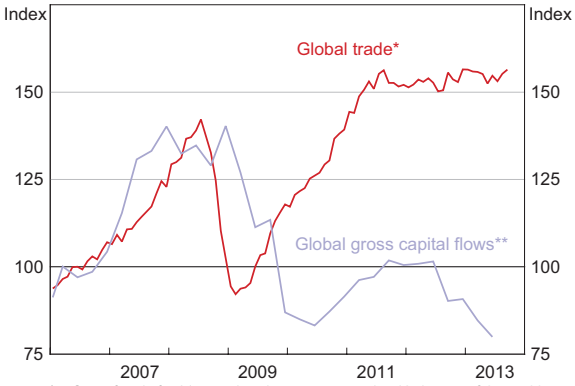
1 The 2013 Triennial Survey was coordinated by the Bank for International Settlements (BIS). The turnover portion was conducted by central banks and other authorities across 53 jurisdictions while the outstandings portion covered 47 jurisdictions.

2 For an analysis of the results of the 2013 Triennial Survey by the BIS, see BIS (2013).

3 All data are expressed at current exchange rates. At constant exchange rates, global turnover also increased by 35 per cent over the three years to April 2013.

demand for foreign exchange, have been little changed over the three-year period (Graph 2). Part of the growth in global turnover over the measured three-year period appears to have reflected increased short-term trading activity that took place in the month of April, when the survey was conducted, primarily in response to the decision by the Bank of Japan (BoJ) to substantially expand its asset purchase program. This announcement triggered a large increase in volatility – and turnover – in the Japanese yen, with the growth in turnover most noticeable in the United Kingdom and between 'reporting dealers' and 'other financial institutions'.[4]

Graph 2
Global Trade and Gross Capital Flows
US dollar terms, 2006 average = 100



* Sum of trade for 21 countries plus euro area trade with the rest of the world
** Excluding official reserve flows; rolling four-quarter sum for 62 countries
Sources: CEIC Data; IMF; RBA; Thomson Reuters

In contrast to the strong growth recorded globally, turnover in the Australian foreign exchange market declined by 5 per cent over the three-year period to an average of US$182 billion per day, primarily reflecting a significant decline in turnover in the euro.[5] In the Australian market, turnover in the Japanese yen and the Australian dollar increased by much less than the global rate of growth and only partially offset the decline in euro turnover. Given the volatility in foreign exchange markets around the time of the survey, the relatively modest increases in turnover in the Australian dollar and Japanese yen in Australia could be partly explained by the fact that hedge funds and proprietary trading firms have a smaller presence in the domestic market compared with other major financial centres, particularly the United Kingdom.

Turnover by jurisdiction

The global foreign exchange market became more geographically concentrated over the three years to April 2013, with the United Kingdom's position as the largest centre further reinforced by a 4 percentage point increase in its market share, to just over 40 per cent (Table 1, Graph 3). As the major global foreign exchange centre, and the market with the greatest liquidity, the United Kingdom has a relatively high concentration of market participants that tend to be associated with speculative and/or high-frequency trading activity – including hedge funds and proprietary trading firms. As such, the marked increase in turnover in the United Kingdom appears to be partly the result of increased speculative activity in April in response to the BoJ policy announcement. However, it is also consistent with the longer-term trend towards an increased share of global activity in London: the United Kingdom's market share has increased by 9 percentage points since the 2004 survey.

The United States remained the second largest centre, followed by Singapore, Japan and Hong Kong. Collectively, these four markets accounted for a little less than 35 per cent of global turnover, which is little changed from the 2010 survey. In contrast, smaller markets tended to lose market share over the three-year period, continuing a trend that has been evident since 2007. Within this group of smaller markets, Switzerland and Australia recorded the largest declines in market share over the three years to April 2013.

4 'Reporting dealers' include commercial and investment banks, securities houses and other entities that actively participate in the foreign exchange market and submit data to the survey.

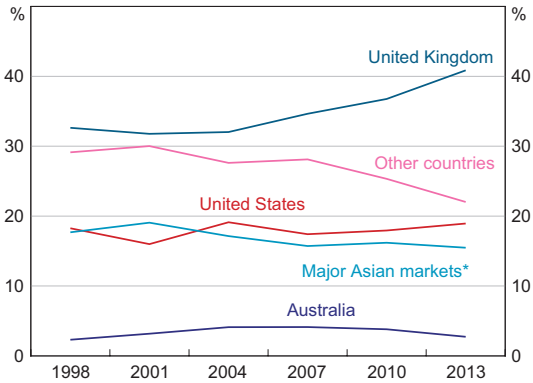
5 At constant exchange rates, turnover in the Australian market fell by 16 per cent. Unless otherwise stated, global turnover figures are adjusted for interdealer double counting at both the local and global level. Country subtotals are adjusted for interdealer double counting at the local level only.

Table 1: Global Foreign Exchange Turnover by Jurisdiction[(a)]

	Daily average, April 2013	Change over 2010–2013	Market share	
			April 2010	April 2013
	US$ billion	Per cent	Per cent	Per cent
Total	**5 345**	**35**	**na**	**na**
United Kingdom	2 726	47	36.8	40.9
United States	1 263	40	17.9	18.9
Singapore	383	44	5.3	5.7
Japan	374	20	6.2	5.6
Hong Kong	275	16	4.7	4.1
Switzerland	216	–13	4.9	3.2
France	190	25	3.0	2.8
Australia	182	–5	3.8	2.7
Other countries	1 063	21	17.4	15.9

(a) The sum of the country subtotals exceeds the global total as country subtotals are not adjusted for cross-border double counting
Source: BIS

Graph 3
Geographical Distribution of Foreign Exchange Turnover
Per cent of global turnover



* Hong Kong, Japan and Singapore
Sources: BIS; RBA

The share of cross-border transactions fell to 58 per cent of global turnover in April 2013, down from 65 per cent in April 2010. This is the lowest proportion of cross-border activity since 2001 and is consistent with the increased geographical concentration of the global foreign exchange market. The decline could also reflect a reduction in cross-border lending and investment by banks in some large regions (e.g. the United Kingdom and Europe). The share of cross-border transactions is higher in smaller financial centres – including Australia at 75 per cent – although the share reported by Australian dealers also declined over the three-year period (from almost 80 per cent in 2010).

Turnover by currency

The earlier expectation and subsequent announcement of a change in policy by the BoJ in April 2013 contributed to a 63 per cent increase in global turnover in the Japanese yen over the three years to April 2013 (Table 2). The increase was concentrated in the USD/JPY currency pair, with turnover in this pair increasing by 72 per cent over the three-year period. Evidence from semiannual surveys conducted in six of the largest foreign exchange markets indicates that a significant part of the increase occurred in the six months leading up to April 2013.[6]

6 Semiannual surveys are conducted by central banks and other authorities in Australia, Canada, Japan, Singapore, the United Kingdom and the United States. These centres now account for around 75 per cent of the global foreign exchange market. However, the results are not directly comparable to the Triennial Survey due to some differences in the collection and attribution of turnover. Australia's results for the semiannual survey are available on the Australian Foreign Exchange Committee website at <http://www.rba.gov.au/AFXC/Statistics/FXTurnoverReports/>. Quarterly data for the Australian market are also available at <http://www.rba.gov.au/statistics/tables/> (Tables F9 and F10).

Table 2: Foreign Exchange Turnover By Currency

	Global		Australia	
	Daily average, April 2013	Change over 2010–2013	Daily average, April 2013	Change over 2010–2013
	US$ billion	Per cent	US$ billion	Per cent
Total	**5 345**	**35**	**182**	**–5**
Currency[(a)]				
USD	4 652	38	164	–5
EUR	1 786	15	27	–43
JPY	1 231	63	26	4
GBP	631	23	13	–26
AUD	462	53	91	6
Other currencies	1 927	34	42	20
Currency pair				
EUR/USD	1 289	17	21	–46
USD/JPY	978	72	21	11
GBP/USD	472	31	9	–36
AUD/USD	364	46	81	7
USD/CAD	200	10	4	–7
Other currency pairs	2 043	35	47	13

(a) The sum of the currency subtotals is divided by two as each transaction involves two currencies
Source: BIS

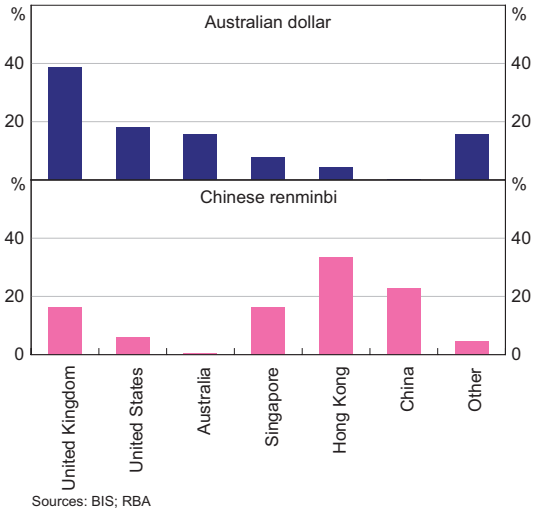
The exceptionally strong growth in global turnover in the USD/JPY currency pair also partly explains an almost 40 per cent increase in US dollar turnover over the period. However, the growth in US dollar turnover also reflects strong increases in turnover of a number of emerging market currencies – most notably, the Chinese renminbi (RMB) and Mexican peso – as these currencies tend to be more heavily traded against the US dollar than they are against the euro or Japanese yen (discussed below). The US dollar remains by far the most traded (and liquid) global currency and is now included in one side of 87 per cent of all transactions. The large share of US dollar activity reflects the US dollar's role as the primary global reserve currency and, relatedly, the fact that a large proportion of financial products and trade contracts are denominated in US dollars.

In contrast, the share of transactions that included the euro declined by 6 percentage points to 33 per cent over the three years to April 2013. Uncertainty surrounding the Greek sovereign debt crisis may have bolstered euro turnover at the time of the 2010 survey, with the subsequent decline in the euro's share of total turnover consistent with the more benign political environment in Europe more recently. In addition, the banking and fiscal problems in the euro area have been accompanied by a general reduction in cross-border investment and business lending activity by European residents, which is likely to have weighed on euro turnover over the period. In the Australian market, a sharp decline in turnover in the EUR/USD currency pair contributed to a decline in overall turnover.

Global turnover in the Australian dollar increased by 53 per cent over the three years to April 2013, and reflects growth of 84 per cent in the United Kingdom and 34 per cent on average in other jurisdictions. Overall, 84 per cent of global turnover in the Australian dollar now occurs outside of Australia (compared with around 60 per cent

in 2001). This is broadly consistent with the share of offshore turnover in other globally traded currencies (including the New Zealand dollar, Canadian dollar, Swiss franc and Japanese yen). Almost 40 per cent of Australian dollar turnover occurred in the United Kingdom in April 2013, which represents an increase of 7 percentage points from April 2010 (Graph 4). As discussed, the UK market tends to have a higher share of hedge funds and proprietary trading firms and after the Australian dollar reached its multi-year high in early April 2013, the subsequent depreciation over the rest of the month may have led to increased activity from these types of investors as they positioned their portfolios based on an expectation of a depreciation of the Australian dollar in the future.

Graph 4
Geographical Distribution of Foreign Exchange Turnover
Market share by currency, April 2013



Sources: BIS; RBA

Turnover of some emerging market currencies also increased significantly over the three years to April 2013, consistent with broader economic and financial market development in some of these countries. However, improved data collection may also have contributed to these gains. The Mexican peso is now the eighth most traded currency globally after turnover increased by around 170 per cent over the past three years, and the RMB is now the ninth most traded after turnover increased by 250 per cent.

The increase in RMB activity is consistent with China's ongoing progress in internationalising the RMB.[7] In April 2013, around 45 per cent of RMB turnover was recorded outside of Hong Kong and China and this could be expected to increase over coming years as other financial centres develop into RMB trading hubs and the use of RMB becomes more widely accepted – for example, as an invoicing currency for trade.

Turnover by counterparty

Reporting dealers in each jurisdiction provide information on their turnover with other reporting dealers (which makes up the interdealer market), with other financial institutions, and with non-financial institutions. Much of the increase in global turnover over the three-year period was driven by increased activity between reporting dealers and other financial institutions, including non-reporting banks, institutional investors, hedge funds and proprietary trading firms, as well as official sector institutions (such as central banks and sovereign wealth funds; Table 3). This is in contrast to the Australian market, where turnover between reporting dealers and other financial institutions was reported to have declined over the three-year period (Graph 5).[8]

A more detailed counterparty breakdown of the other financial institutions category was collected for the first time in 2013. The data reveal that, globally, non-reporting banks accounted for around 45 per cent of this sector's turnover with reporting dealers in April 2013, with institutional investors (e.g. pension funds) and hedge funds and proprietary trading firms together accounting for around 42 per cent. Given that some of these entities are likely to have been especially active in the period leading up to and following the BoJ policy announcement, it is possible that the April 2013 data overstates the

7 For a detailed discussion on developments in the internationalisation of the renminbi, see Ballantyne, Garner and Wright (2013).

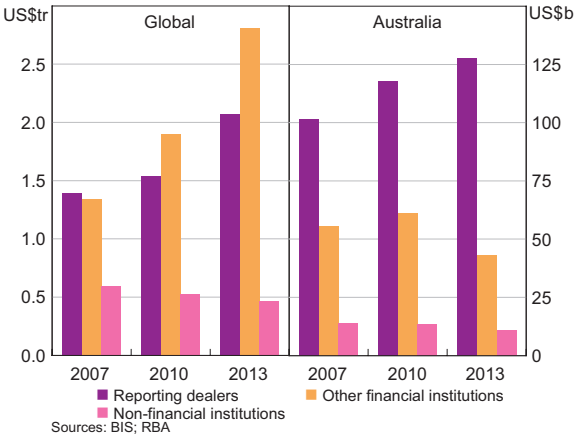
8 Some of the decline in turnover between reporting dealers and other financial institutions in the Australian market could be attributable to the effect of reclassification, as some previously non-reporting banks were reclassified as reporting dealers for the 2013 survey. Reclassifications could also affect the interpretation of the global results.

Table 3: Foreign Exchange Turnover by Counterparty[a]

	Global		Australia	
	Daily average, April 2013	Change over 2010–2013	Daily average, April 2013	Change over 2010–2013
	US$ billion	Per cent	US$ billion	Per cent
Reporting dealers	2 070	34	127	8
Other financial institutions	2 809	48	43	–29
Non-reporting banks	*1 278*	*na*	*19*	*na*
Institutional investors	*603*	*na*	*10*	*na*
Hedge funds, proprietary trading firms	*576*	*na*	*2*	*na*
Official sector financial institutions	*53*	*na*	*1*	*na*
Other/undistributed	*300*	*na*	*11*	*na*
Non-financial institutions	465	–13	11	–17

(a) All amounts represent transactions between reporting dealers and each counterparty type; transactions with other reporting dealers are often referred to as 'interdealer' transactions; a detailed breakdown of other financial institutions is not available for 2010
Source: BIS

Graph 5
Foreign Exchange Turnover
By counterparty



Sources: BIS; RBA

usual market shares of these institutions. However, the growth in turnover between reporting dealers and other financial institutions could also reflect a continued increase in the use of electronic trading methods, including algorithmic and high-frequency trading by these institutions. This is also consistent with the marked increase in turnover in the major trading centres, as algorithmic trading styles tend to be more prevalent in markets with greater liquidity and where execution delays are at a minimum (due to their proximity to the electronic platforms of 'market makers' executing the trades).[9]

The strong global growth in turnover between reporting dealers and other financial institutions over the three years to April 2013 was partly offset by a 13 per cent decline in turnover between reporting dealers and non-financial institutions. The decline in turnover with non-financial institutions was also evident in Australia, with this market segment now accounting for less than 10 per cent of turnover in both the domestic and global markets (compared with a global average of 15 per cent over the past five surveys). This is despite the 25 per cent increase in global trade over the three-year period, which is likely to be a key source of foreign exchange demand for non-financial institutions. The divergent outcomes for global trade and foreign exchange turnover with non-financial institutions could in part reflect ongoing changes to how non-financial institutions manage their foreign currency

9 Market makers provide liquidity to the foreign exchange market through the continuous quoting of prices to buy or sell foreign currency and committing to take the opposite side of customer transactions. For a discussion on high-frequency trading in the foreign exchange market, see BIS Markets Committee (2011).

exposures. These could include a reduced need for hedging products due to an increased use of 'natural hedging' – for example, as global supply chains have become more integrated – and a possible reduction in the extent to which multinational firms choose to repatriate their foreign currency receipts.[10]

Turnover between reporting dealers (i.e. in the interdealer market) increased in line with total global turnover over the three-year period, continuing to account for around 40 per cent of global turnover. In contrast, turnover between reporting dealers in Australia accounts for a much larger share of the local market (at around 70 per cent) and turnover between reporting dealers increased by 8 per cent over the three-year period.

The level of turnover between reporting dealers can be influenced by transactions between reporting dealers and other financial institutions, and between reporting dealers and non-financial institutions. This is because reporting dealers may enter into offsetting transactions with other reporting dealers in order to reduce the exchange rate risk that would otherwise be associated with being a counterparty to these transactions. In addition, some customers (generally classified as other financial institutions) make use of a prime brokerage relationship whereby they transact in the market, subject to credit limits, under the reporting dealer's (or prime broker's) name with a group of predetermined third-party banks. This prime brokerage turnover, which accounts for 16 per cent of global turnover but only 2 per cent of Australian activity, is recorded in the survey as two transactions: one between the reporting dealer (prime broker) and the customer, and one between the reporting dealer and the counterparty dealer.

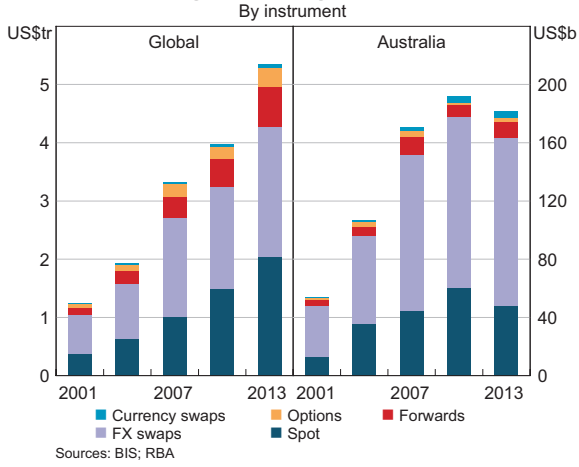
More generally, technological advances have influenced the way that reporting dealers manage the risk that arises from customer transactions. Over time, the subsequent turnover generated by each customer trade has probably fallen as technology has allowed reporting dealers to internalise these transactions more effectively. That is, they can match off transactions within their own institution without the need to trade with other reporting dealers, which would otherwise incur transaction costs.[11]

The recent survey also provided data on the share of turnover classified as 'retail-driven' and the type of execution method (by voice or electronically). Retail-driven transactions accounted for around 3 per cent of global turnover but are a relatively small part of the Australian market, at less than ½ per cent of turnover. Around 55 per cent of transactions globally were transacted via electronic methods compared with around 62 per cent for the Australian market.

Turnover by instrument

Global turnover increased across all types of foreign exchange instruments over the three years to April 2013, with foreign exchange (FX) swaps and spot transactions each continuing to account for around 40 per cent of total foreign exchange market activity (Graph 6).

Graph 6
Foreign Exchange Turnover
By instrument



Sources: BIS; RBA

In contrast to the global results, Australian turnover in both FX swaps and spot transactions declined over the three-year period. Nevertheless, turnover in FX swaps remained well above the average of the past decade and these transactions continued to account for a relatively high share of the Australian

10 For more information on hedging behaviour in Australia, see Rush, Sadeghian and Wright (2013).

11 For more information on developments in technology and the foreign exchange market, see Heath and Whitelaw (2011).

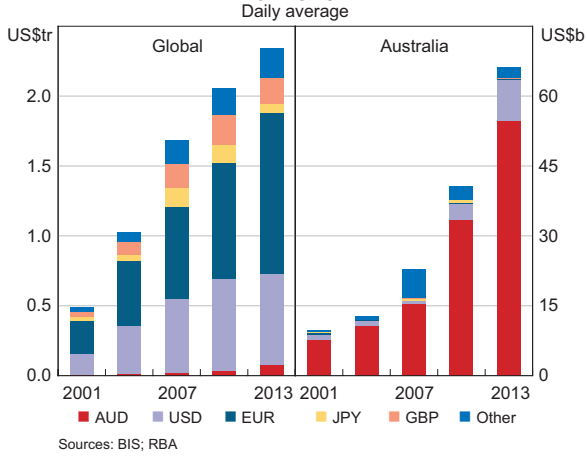
market, at around 63 per cent. Spot turnover in Australia also remained above the average of the past decade. The slight reduction in the use of FX swaps could reflect a change in hedging policy by Australian asset managers – which use FX swaps to hedge against the foreign exchange risk inherent in their holdings of foreign assets – particularly given the high level of the Australian dollar at the time of the survey.[12] Consistent with this, FX swap turnover with other financial institutions fell by 21 per cent over the three-year period, compared with a 2 per cent decline in FX swap turnover in the Australian market as a whole. In addition, a fall in demand for short-term foreign currency borrowing by Australian banks may have also contributed to reduced demand for FX swaps.

Meanwhile, turnover in cross-currency swaps was little changed over the three-year period. Australian financial institutions typically use cross-currency swaps to hedge the foreign exchange exposures associated with borrowing from global capital markets and, as a consequence, Australia accounts for a relatively high share of the global cross-currency swap market (around 7 per cent of turnover in April 2013, compared with 3 per cent of overall foreign exchange market turnover). However, in recent years Australian banks' foreign liabilities have not grown, as they have diversified their funding bases away from foreign debt markets.[13]

Single-currency Interest Rate Derivatives Turnover

Over the three years to April 2013, average daily global turnover in single-currency OTC interest rate derivatives increased by 14 per cent to US$2.3 trillion (Graph 7).[14] Turnover in euro-denominated instruments picked up considerably, partly reflecting a 7 per cent appreciation in the euro against the US dollar since April 2010. Australian dollar-denominated turnover increased markedly, both in the Australian market and offshore, with the share of global turnover accounted for by Australian dollar-denominated interest rate derivatives almost doubling over the three-year period to around 3 per cent. In the Australian market, turnover of interest rate derivatives increased by 62 per cent over the three years; this was mostly driven by growth in the turnover of Australian dollar-denominated instruments, although there was also a pronounced increase in the turnover of US dollar-denominated instruments.

Graph 7
Single-currency Interest Rate Derivatives Turnover
Daily average



Sources: BIS; RBA

OTC Derivatives Outstanding

In addition to measuring turnover in OTC derivatives markets, the Triennial Survey provides information on the aggregate outstanding positions in these markets. This part of the survey – which was conducted to reflect outstanding positions as at the end of June 2013 – measures the size of the market.[15] Outstanding positions can be measured in several ways.[16] The most common is the notional amounts,

12 Some entities hedge a portion or all of the foreign exchange risk that arises from holding assets and liabilities denominated in a foreign currency. This can generate ongoing demand for foreign exchange derivatives, particularly foreign exchange swaps and forwards, as hedge positions are set up and then maintained.

13 For more information on Australian bank funding, see Robertson and Rush (2013).

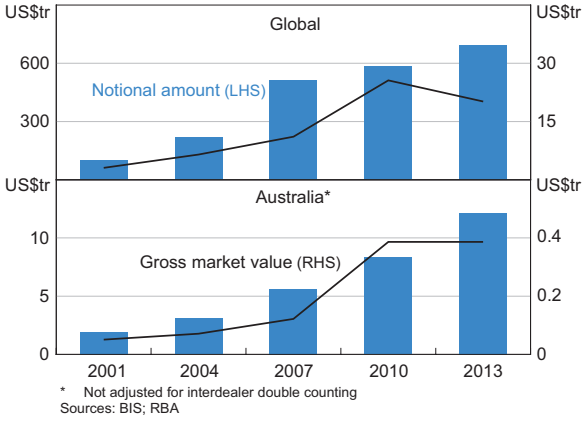
14 Single-currency interest rate derivatives include forward rate agreements, swaps and options.

15 The survey on turnover covers 25 reporting dealers in the Australian market while the survey of outstandings covers six major Australian banks.

16 See 'Box A: Understanding the Three Measures of Market Size' in Ahn, Matić and Vallence (2012) for a more detailed explanation.

which represent the reference amounts used to calculate payments made on derivatives contracts. By this measure, the size of the OTC derivatives market has grown substantially since 2001, both globally and domestically (Graph 8). The strong pace of growth in the Australian market has continued since 2010, with the notional amount of outstanding positions increasing by around 50 per cent, whereas the global market grew by approximately 20 per cent over this period.

Graph 8
OTC Derivatives Markets – Outstanding Positions



* Not adjusted for interdealer double counting
Sources: BIS; RBA

An alternative measure of the size of the derivatives market is the gross market value of outstanding positions, which measures the current replacement cost of a contract; that is, the gross cost to which a counterparty would be exposed if the open contracts were to be replaced. Gross market values are sensitive to changes in the underlying reference variable (i.e. the market price or interest rate), and therefore reflect both the quantity of derivatives contracts outstanding as well as observed fluctuations in market prices. In contrast to the increase in the notional amount of global OTC derivatives contracts, the gross market value of these instruments declined over the three years to June 2013. The gross market value of the Australian market was little changed at the equivalent of US$400 billion over this period, or around 2 per cent of global gross market value.

Much of the notional amounts outstanding and gross market values reflect the build-up of offsetting positions between counterparties. As such, these metrics are more useful indications of total activity in the market, rather than precisely measuring the build-up of risk. The decline in the gross market value of the global market over the past three years may in part reflect a reduction in offsetting positions, without affecting the net value of exposures. In particular, the increased focus on operational and counterparty risk management since the global financial crisis has encouraged greater use of trade compression services, which support the early termination of economically redundant derivatives positions.[17] For Australian institutions, the extent of trade compression may be limited by the one-directional nature of their foreign exchange contracts – reflecting their hedging of the currency risk on foreign borrowing. This would tend to reduce the incidence of redundant trades that can be terminated.

Single-currency interest rate derivatives account for the vast majority of outstanding OTC derivatives contracts globally (Table 4). These instruments are also prominent in the Australian market, although foreign exchange derivatives comprise a considerable share of the domestic market.[18] This partly reflects Australian banks' use of foreign exchange instruments to hedge the currency risk on their foreign borrowings (discussed above).[19]

Commodity, credit and equity derivatives represent a much smaller share of the OTC derivatives market, both globally and in Australia. Of these instruments, commodities derivatives are more prominent in Australia than they are globally, consistent with Australia's role as a key commodity producer.

17 Otherwise known as 'tear-ups', the process involves matching similar derivatives contracts and replacing those with contracts of a smaller notional value, without changing the overall risk profile of each position.

18 Foreign exchange derivatives are defined broadly in the Triennial Survey and include cross-currency basis swaps, FX swaps, forward contracts and currency options.

19 For further information on Australian banks' use of foreign exchange instruments to hedge the currency risk on their foreign borrowings, see Arsov *et al* (2013) and Rush *et al* (2013).

Table 4: OTC Derivatives Outstanding by Instrument
As at end June 2013, per cent[(a)]

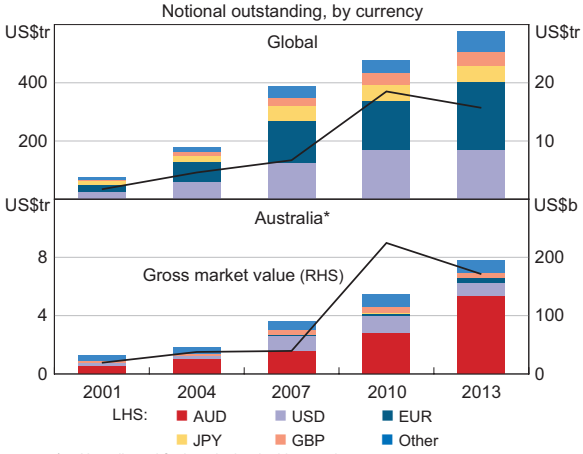
	Share of notional principal outstanding	
	Global	Australia
Single-currency interest rate	83	65
Foreign exchange	12	33
Credit	4	1
Equity	1	0
Commodity	0	1

(a) Values of 0 indicate a share of total outstanding less than 0.5 per cent
Sources: BIS; RBA

Single-currency interest rate OTC derivatives

Globally, there was a 20 per cent increase in the notional amount of single-currency interest rate derivatives outstanding to US$577 trillion over the three years to June 2013, largely reflecting an increase in the notional amounts of euro-denominated contracts (Graph 9). In the Australian market, the notional amount of single-currency interest rate derivatives rose by 42 per cent over this period, while the gross market value declined.

Graph 9
Single-currency Interest Rate Derivatives
Notional outstanding, by currency



* Not adjusted for interdealer double counting
Sources: BIS; RBA

The bulk of positions in interest rate derivatives are held by reporting dealers – typically banks – and other financial institutions; this partly reflects the use of these instruments by intermediaries to hedge the interest rate risk on their balance sheets. Non-financial counterparties accounted for only about 5 per cent of notional amounts outstanding in both the global and local markets (Graph 10). In Australia, the share of the market accounted for by non-financial institutions has declined considerably since 2001.

Graph 10
Single-currency Interest Rate Derivatives
Share of notional outstanding, by counterparty

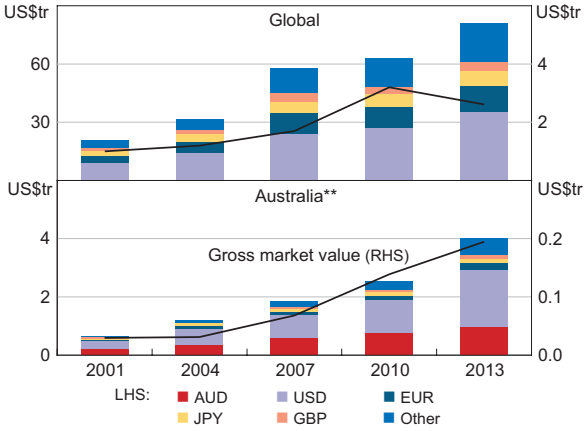
Sources: BIS; RBA

Foreign exchange OTC derivatives

The notional amounts of global foreign exchange OTC derivatives increased by 29 per cent over the three years to June 2013, whereas the gross market value declined (Graph 11); this may partly reflect the more subdued trading conditions for the currencies referenced in the majority of foreign exchange OTC derivatives contracts – the US dollar and the euro – compared with three years ago. The Australian

market grew strongly over this period, with notional amounts and the gross market value increasing by 60 per cent and 40 per cent, respectively.

Graph 11
Foreign Exchange Derivatives*
Notional outstanding, by currency

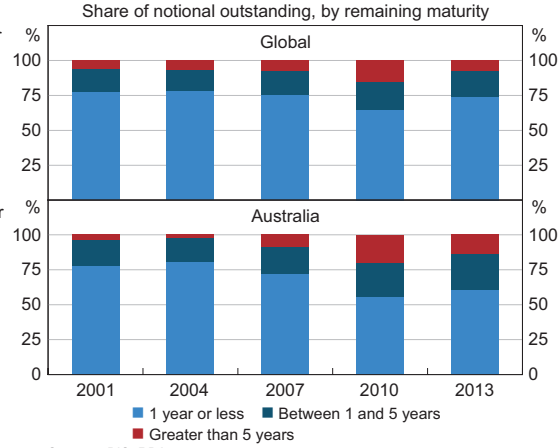


* The sum of each leg of the contracts is divided by two
** Not adjusted for interdealer double counting
Sources: BIS; RBA

Globally, the currency composition of outstanding foreign exchange OTC derivatives has remained little changed since June 2007. For the Australian market, however, there has been a noticeable rise in the share of foreign exchange derivatives contracts involving a US dollar leg. In addition, the share of positions involving an Asian currency has increased since 2007. In particular, the notional amounts of contracts referencing the Hong Kong dollar and Singapore dollar have risen considerably over the past six years.

The residual maturity of foreign exchange derivatives contracts is generally shorter than that of other derivatives instruments, with most contracts maturing in one year or less (Graph 12). Compared with global foreign exchange derivatives positions, the Australian market is characterised by a greater share of contracts with maturities of more than one year; this partly reflects the use of longer-dated instruments to hedge the currency risk associated with Australian banks' offshore funding. The past three years have seen a decline in the share of instruments with a maturity of greater than five years – both domestically and globally – although in Australia's case the current share of these longer-dated instruments remains well above its level in the early 2000s.

Graph 12
Foreign Exchange Derivatives
Share of notional outstanding, by remaining maturity



Sources: BIS; RBA

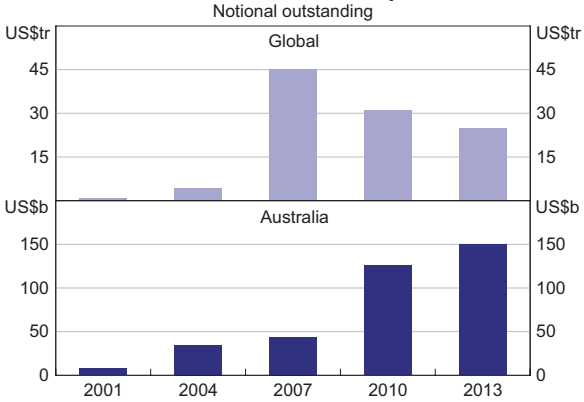
Credit default swaps

The notional amount of credit default swaps (CDS) outstanding increased by 20 per cent in the Australian market over the three years to June 2013, whereas the gross market value increased by 55 per cent. However, the Australian market remains small, with the notional amount outstanding equivalent to around 10 per cent of Australian GDP. By comparison, the notional amount of CDS outstanding globally is equivalent to 35 per cent of world GDP. The recent growth in the Australian market has been driven by contracts that reference more than one institution, which is consistent with the recent increase in the liquidity in these hedging instruments in Australia.

The notional amount of global CDS outstanding rose markedly leading up to the global financial crisis, from US$6 trillion in 2004 to US$45 trillion in June 2007 (Graph 13). The rapid expansion of the notional amount of CDS reflected, in part, the strong growth in underlying demand for these instruments. But this growth was also supported by the common practice among market participants of reducing an exposure by creating an offsetting position, rather than by closing the existing contract (IOSCO 2012).

Since 2007, it has become increasingly common for dealers to engage in portfolio compression, by replacing mostly offsetting contracts with a contract of smaller notional value and, as a result, the notional amount of global CDS outstanding has declined noticeably.[20]

Graph 13
Credit Default Swaps
Notional outstanding



Sources: BIS; RBA

Conclusion

Turnover in global foreign exchange and OTC derivatives markets continued to increase over the three years to April 2013. While the increase coincided with growth in international trade, both cross-border lending and investment flows were little changed over the period. The growth in global turnover in foreign exchange markets appears to have partly reflected an increase in short-term trading activity, particularly in response to the policy announcement by the BoJ, which occurred early in the month of the 2013 survey. Globally, growth in foreign exchange turnover was most noticeable in the United Kingdom, and between reporting dealers and other financial institutions. In contrast, foreign exchange turnover in the Australian market declined slightly over the three-year period, despite a marked increase in trading of the Australian dollar globally. The notional amount of outstanding OTC foreign exchange and interest rate derivatives contracts grew strongly over the three years to the end of June 2013, both globally and in the Australian market. However, the gross market value of global OTC derivatives declined over this period. This may partly reflect the more subdued trading conditions for the US dollar and the euro, which are the currencies referenced in the majority of OTC derivatives contracts.

20 See Fabbro (2011) for more information on global CDS outstanding.

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Financial Stability Review

These reviews, issued in March and September, assess the current condition of the financial system and potential risks to financial stability, and survey policy developments designed to improve financial stability.

Annual Reports

- *Reserve Bank of Australia Annual Report*
- *Payments System Board Annual Report*
- *Equity & Diversity Annual Report*

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- *Lessons from the Financial Turmoil of 2007 and 2008*, October 2008
- *The Structure and Resilience of the Financial System*, November 2007

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The Bank periodically produces other publications that may take the form of submissions to inquiries, surveys or consultation documents. Some recent examples include:

- *2013 Self-assessment of the Reserve Bank of Australia – Systemically Important Payment Systems*, December 2013
- *2013 Self-assessment of the Reserve Bank Information and Transfer System*, December 2013
- *Proposed Variations to the MasterCard and Visa Access Regimes: Consultation Document*, December 2013
- *Statement on the Conduct of Monetary Policy*, October 2013
- *2012/13 Assessment of ASX Clearing and Settlement Facilities*, September 2013
- *Report on the Australian OTC Derivatives Market*, July 2013
- *Australian Regulators' Statement on Assessing the Case for Mandatory Clearing Obligations*, May 2013

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HILDA

The following Disclaimer applies to data obtained from the HILDA Survey and reported in the article 'A Model for Stress Testing Household Lending in Australia' in this issue of the *Bulletin*.

Disclaimer

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