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The Sensitivity of Personal Income to GDP Growth

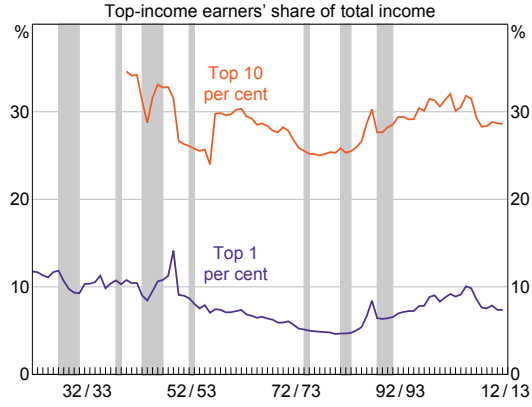
Tahlee Stone*

This article examines how the income of different individuals varies in response to changes in the state of the economy using individual-level data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. More specifically, the article explores which types of income earners (those in the top, middle or bottom of the income distribution) and which sources of income (labour or capital) are most affected by economic conditions. Results suggest that the incomes of bottom- and top-income earners are the most sensitive to the state of the economy, although for different reasons: during strong economic conditions, the labour income of bottom-income earners rises, due to lower unemployment, while the capital income of top-income earners also rises, due to higher dividend and interest earnings. The effect on bottom-income earners appears to be stronger than that on top-income earners, suggesting that income inequality declines when economic conditions are strong.

Introduction

Changes in the state of the economy can have different effects on earners in different parts of the income distribution and thus have the potential to affect income inequality. Historically, the relationship between economic activity and income inequality (as measured by the income shares of top earners) is somewhat unclear for Australia. A visual inspection of the long-run series of income inequality suggests that there is not a strong correlation between fluctuations in economic conditions and income inequality (Graph 1). During recessions in Australia, the income share of top earners has increased in some cases, while in others it has been steady or declined.[1]

Graph 1
Long-run Income Inequality*
Top-income earners' share of total income



* Shaded areas denote periods of economic recession
Sources: Alvaredo et al (2016); Butlin (1985)

This article uses longitudinal data from the HILDA Survey to further investigate the relationship between economic activity and income inequality in Australia. This work focuses on which income earners are most sensitive to fluctuations in economic conditions by tracking how different individuals' incomes vary with aggregate GDP growth. The correlation between personal income growth and aggregate GDP growth will be referred to as 'the cyclical sensitivity of income'.

* This work was completed within Economic Research Department.

1 A recession is defined prior to 1960 as one year of negative GDP growth using annual data from Butlin (1985). After 1960, the three recessions shaded in the graph are the ones identified by Gillitzer, Kearns and Richards (2005) using coincident indices.

The article also explores which components of income are driving this sensitivity and investigates two potential channels: the 'labour income' channel and the 'capital income' channel. In the literature, these channels are predicted to have offsetting effects on the distribution of income. During a period of strong economic growth:

- *'Labour income' channel* – bottom-income groups tend to experience larger increases in employment and larger wage increases than top-income groups, leading to *lower* income inequality.
- *'Capital income' channel* – a rise in income from business and financial assets will affect the incomes of top-income earners by more, as individuals in this group are more likely to derive a larger portion of their income from these capital sources. By itself, this will lead to *higher* income inequality.

The 'labour income' channel appears to be the most important channel in other countries, such as the United States (Coibion, Gorodnichenko, Kueng and Silvia 2012). The more even wealth distribution in Australia should weaken the effect of the 'capital income' channel making it likely that the 'labour income' channel is also the most important channel in Australia for influencing the income distribution.

Identifying whether individuals at the top, middle or bottom of the income distribution are more exposed to economic conditions, and through which channels, can help us to understand which groups in the economy are most affected by macroeconomic fluctuations.[2]

Examining how the distribution of income growth responds to changes in economic activity can also help improve our understanding of patterns in aggregate household spending.[3] For instance, cyclical (temporary) changes in income will have a larger effect on aggregate household spending if income growth is mostly concentrated among individuals whose spending is constrained by their current income. These 'liquidity-constrained' individuals typically have a relatively high marginal propensity to consume out of temporary income changes (Kaplan, Violante and Weidner 2014).[4] Such analysis is also useful for understanding the causes of short-term changes in income inequality. Previous Australian research has mainly focused on long-run trends in income inequality.[5]

Data

Individual-level data are obtained from the HILDA Survey and cover the period from 2001 to 2014. Two main samples are used for the analysis:

- an 'employed' sample – comprising all persons in the survey between the ages of 25 and 60 years who reported a positive wage income in the previous period
- a 'full' sample – containing all responding individuals in the survey.[6]

For both samples, the sensitivity of three key income variables to aggregate GDP growth is estimated: total annual income; 'labour' or wage & salary income; and 'capital' income. Capital income includes: business income, interest from savings & investments, dividends from shares, superannuation, rental income and royalties.[7]

2 A related literature looks at the distributional effects of changes in monetary policy. See Coibion *et al* (2012) and Hughson *et al* (2016), for example.

3 Recent studies also examine how income and consumption growth are affected by changes in the distribution of wealth caused by changing economic conditions, wtih particular focus on housing assets. See Mian and Sufi (2016) and Krueger, Mitman and Fabrizio (2016), for example.

4 Kaplan *et al* (2014) find that around 20 per cent of households in Australia are liquidity-constrained or 'hand to mouth' and spend all of the regular inflow of income they receive each pay period.

5 See, for example, Fletcher and Guttmann (2013); Greenville, Pobke and Rogers (2013); and Dollman, Kaplan, La Cava and Stone (2015).

6 An unbalanced panel allows for individuals to exit and re-enter the sample, but respondents must be present for at least two consecutive waves of the survey to be able to calculate growth rates for income.

7 A more complete definition of capital income might also include realised capital gains and net-imputed rent for owner-occupiers. While net-imputed rent can be approximated, neither of these variables are measured directly in the HILDA Survey.

Total income includes labour income, capital income, government payments and 'other' income.[8]

Following Mian and Sufi (2016), individuals in each sample are sorted into five income buckets or 'quintiles' according to their level of total annual income in the previous year, rather than the current year, so that an individual's position in the income distribution is measured before any growth in their income has occurred over the period.

Table 1 reports summary statistics on the key characteristics for the top and bottom income quintiles of the full sample. Compared with the bottom quintile, top-income earners are more likely to be male, have tertiary qualifications, be self-employed and hold financial assets, though labour income still represents the largest portion of their total income. By comparison, bottom-income earners are more likely to be employed casually or under a fixed-term arrangement. Individuals in this group derive most of their income from labour income and government payments, though capital income still accounts for around 14 per cent of total income.

It is instructive to examine how the incomes of top and bottom earners changed in response to the 2008–09 economic downturn. The response is measured by comparing how the different income components (labour, capital and government payments) contributed to the overall change in real total annual income for individuals in the top and bottom income quintiles over this period (Graph 2).

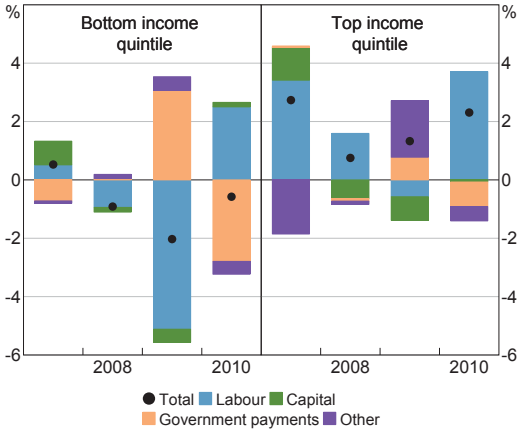
Table 1: Summary Statistics for the Full Sample[(a)]
2001 to 2014

	Bottom income quintile	Top income quintile	Total
Age (years, mean)	37	45	44
Male (%)	38	70	49
Tertiary education (%)	26	76	48
Self-employed (%)	5	17	9
Holds financial assets (%)	25	60	40
Casual or fixed-term contract (%)	24	11	17
Total annual income ($, mean)	13 000	111 000	47 000
Of which:			
Labour income (%)	41	78	55
Capital income	14	16	15
Business	3	7	5
Interest	4	2	3
Dividend	2	4	2
Other capital[(b)]	5	3	5
Government payments (%)	41	3	27
Other income (%)[(c)]	4	3	3

(a) All amounts are reported in September 2014 dollars; income groups are determined separately for each year
(b) Other capital income include superannuation, rental income and royalties
(c) 'Other' income includes private transfers, foreign pensions, child support payments, scholarships, workers compensation, inheritance and other irregular payments
Sources: Author's calculations; HILDA Release 14.0

8 All income variables are converted to real terms using the consumer price index. 'Other' income includes private transfers, foreign pensions, child support payments, scholarships, workers compensation, inheritance and other irregular payments. Government payments income is defined as the gross amount of pensions and allowances received, and is not reported net of taxes.

Graph 2
Income Sensitivity during the Financial Crisis
Full sample, contribution to real mean growth in total income



Sources: HILDA Release 14.0; RBA

Labour income decreased for the bottom income quintile in 2008 and 2009, although the fall in average labour income for this group was partially offset by government bonus payments received around this time. In contrast, labour income for individuals in the top income quintile experienced only a small decline in 2009. Growth in total annual income slowed, but remained positive, for the top income quintile over the 2008–09 period, although capital incomes did decline.

Together, these patterns provide evidence for both the 'labour income' and 'capital income' channel in Australia. The response of labour income is more important for those at the bottom of the income distribution, while income from other sources, such as capital assets, seems more responsive for top-income earners.

This is explored in the next section over a longer time period, using regression analysis to control for other determinants of personal income growth. The panel dimension of the HILDA Survey is used to account for compositional change in the individuals who represent the top and bottom income quintile each year.

Model Results

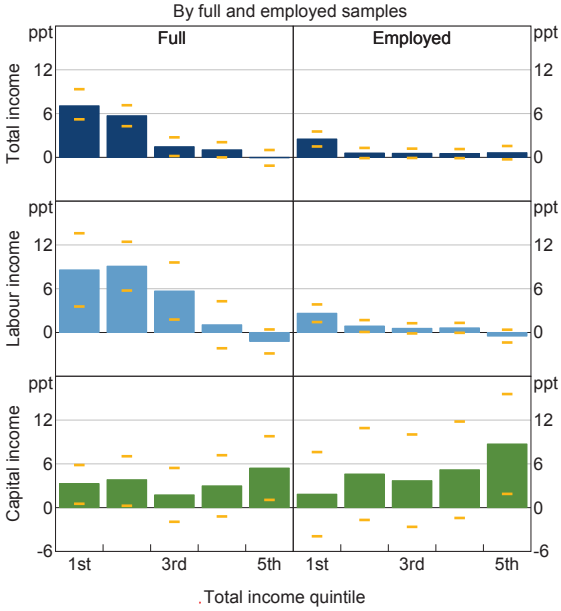
An econometric model is used to estimate the sensitivity of personal income growth to aggregate GDP growth across the different income quintiles, and to decompose the response into a 'labour income' and 'capital income' effect. The model, discussed in more detail in Appendix A, is estimated separately for total income, labour income and capital income on both the full and employed samples.

To test for the 'labour income' channel in Australia, the sensitivity of labour income to GDP growth is measured. The nature of the response is also considered. Labour income is affected by economic fluctuations through individual movements into or out of employment, through a change in hours worked by employed individuals or through changes in wage rates (Bishop and Plumb 2016). In particular, the response of labour income is compared for the full and employed samples, noting that the sensitivity of labour income for the employed sample will only show how much of the response occurs through an adjustment in wage rates or hours worked.

The existence of the 'capital income' channel for Australia is then assessed by examining how the sensitivity of capital income to GDP growth varies across income groups and by exploring which components of capital income are most sensitive. Assessing whether the labour or capital income response to GDP growth has a larger effect on the overall response of total income will provide evidence for which channel has a stronger effect in Australia.

Profiles of cyclical sensitivity are presented for each income variable for both the full and employed samples in Graph 3. These estimates represent the average response of individuals' income growth to a 1 percentage point change in the growth rate of GDP, for each income quintile. For example, for the bottom quintile in the full sample, a 1 percentage point increase in the growth rate of GDP is associated with a 7 percentage point increase in the growth rate of total income.

Graph 3
Sensitivity of Income Growth to GDP Growth*
By full and employed samples



* Estimated as the average response of individual income growth to a 1 percentage point change in the growth rate of GDP; yellow dashes show 95 per cent confidence intervals

Sources: HILDA Release 14.0; RBA

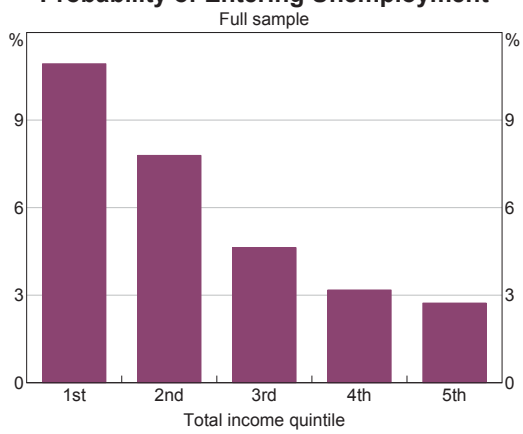
'Labour income' channel

For the full sample, there is a positive and statistically significant relationship between GDP growth and growth in total income and labour income for individuals in the bottom three income quintiles (Graph 3). Labour income is more responsive than total income for these groups, which suggests that insurance mechanisms such as government benefits and transfers play a role in offsetting some of the wage risk faced by bottom-income earners.

In contrast, the sensitivity of total and labour income for the bottom quintiles of the employed sample are more similar, suggesting that low-wage workers receive less of a buffer against aggregate shocks through government payments. More generally, the results for the employed sample show that total and labour incomes of individuals who remain employed from one year to the next in the second and middle quintiles are no longer as sensitive to GDP growth (Graph 3). However, some sensitivity remains for the lowest-income earners, with the bottom income quintile being the only quintile with a sensitivity estimate significantly different from zero.

This suggests that most of the sensitivity of income for the bottom- and middle-income groups of the full sample is likely to occur due to transitions into and out of employment, as individuals in these groups have a higher probability of entering into unemployment (Graph 4).[9] For these groups, a 1 percentage point increase in the growth rate of GDP is associated, on average, with a 5 percentage point increase in the growth rate of total income.

Graph 4
Probability of Entering Unemployment
Full sample



Sources: HILDA Release 14.0; RBA

For the employed sample, the higher sensitivity of labour and thus total income for the bottom quintile represents the response that occurs through an adjustment in wages or hours worked by individuals in this group. This result may reflect the fact that the bottom income quintile also has a higher share of individuals in casual, fixed-term or part-time employment. There is more scope to increase hours worked for these workers than for full-time workers. The estimates imply that 1 percentage point increase in the growth rate of

9 The probability of entering into unemployment is calculated by tracking individuals over time and calculating the share of individuals who were employed in each income quintile at time *t* and transitioned into unemployment at time *t* + 1.

GDP results in a 2 percentage point increase in the growth rate of total income, on average, for those in the bottom income quintile.

These results provide support for the 'labour income' channel in Australia. They suggest that labour income is most responsive to GDP growth for households at the bottom of the income distribution as individuals in bottom-income groups are more exposed to changes in employment status and to an adjustment in hours or wages.

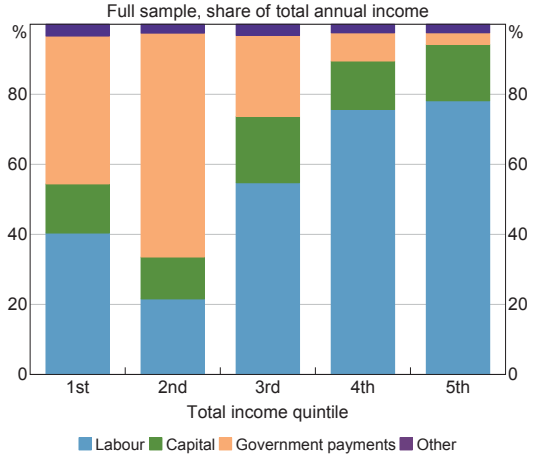
'Capital income' channel

For capital income, there is a positive and statistically significant relationship between income growth and GDP growth for the top quintile of both the full and employed samples (Graph 3). Capital income in the top quintile is slightly more sensitive to GDP growth in the employed sample, which could be because employed individuals are more willing to hold riskier, more sensitive assets than those at the extremes of the working life cycle.

The fact that the high sensitivity of capital income to GDP growth for top-income groups in both samples does not have a large effect on total income is likely to be because of the small share of capital income for most individuals in these groups, of around 13 per cent of total income (Graph 5). A closer look at the income composition of individuals in the top quintile suggests that the procyclical relationship for this group is driven by the highest-earning individuals, because the capital share of total income in the top quintile increases as income rises.

Capital income is also responsive to GDP growth for bottom-income earners in the full sample. The relationship is statistically significant for the lowest two income quintiles of the full sample, which reflects the fact that bottom-income individuals earn some interest income on savings accounts and that retirees derive more income from capital sources (retirees account for around 30 per cent of individuals in the bottom two income quintiles, compared with less than 10 per cent of the top three quintiles).

Graph 5
Income Composition
Full sample, share of total annual income



Sources: HILDA Release 14.0; RBA

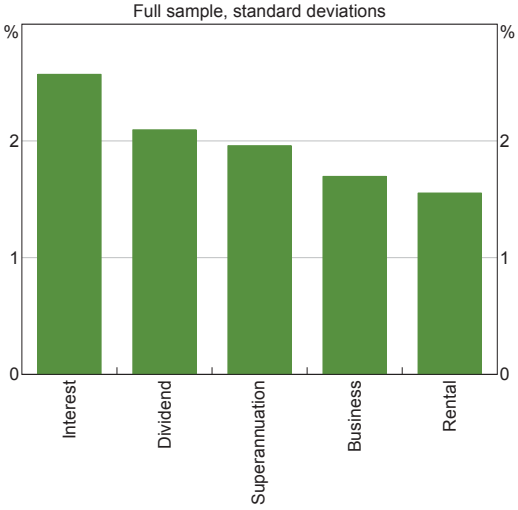
The sensitivity of capital income in the bottom two income quintiles is not significantly different from zero in the employed sample, suggesting that the sensitivity of retirees' capital income is a driver of the significant outcomes for the full sample.

To assess which components of capital income are driving the sensitivity for the top and bottom income quintiles, the average volatility of different capital income components are estimated. Based on this, it appears that interest and dividend earnings are the more volatile sources of income (Graph 6).

To explore this further, the econometric model is re-estimated for capital income, excluding a different capital income component each time. The model is estimated on the full sample to also understand what is driving the sensitivity of capital income that is observed for the bottom income quintiles in Graph 3. Results from estimating these models are shown in Table 2.

For the bottom income quintile, the responsiveness of capital income is most affected when the interest income component is excluded (Table 2, column 2). The coefficient on GDP growth decreases and is no longer statistically significant. There is also a large decrease in the coefficient for the second income

Graph 6
Average Volatility of Capital Income Components
Full sample, standard deviations



Sources: HILDA Release 14.0; RBA

quintile, which is the income group that contains the highest share of retired individuals. This suggests that the sensitivity of capital income for bottom-income earners may be driven by the high share of interest income in total capital income for retirees.

In contrast, it appears that all components of capital income contribute to the sensitivity for the top income quintile. This may be because individuals in this group tend to hold more diversified asset portfolios. However, the coefficient on GDP growth increases when business income is excluded, suggesting that most of the sensitivity to capital income for the top quintile occurs through income from financial assets, such as dividend and interest income.

These results provide evidence that the 'capital income' channel is operating in Australia, although somewhat differently than it does in the United States. Rather than capital income playing a role solely for top-earning individuals, capital income is procyclical at both the top and bottom of the income distribution in Australia. However, the response of capital income is much higher for the top-income group and is driven mainly by changing returns to financial assets, rather than by business or rental income.

Comparing the profiles of total, labour and capital income also shows that labour income appears to be the component of income driving the overall sensitivity for total income. This provides evidence that the 'labour income' channel is more potent for Australia.

Conclusion

This article examines how the effect of changing economic conditions on income growth varies across different income groups and different income components. Results suggest that labour income is most sensitive at the bottom of the income distribution as those households are more exposed to unemployment and to adjustments

Table 2: Regression Results for Components of Capital Income[(a)]
Coefficient on $\Delta \ln(GDP)$

Total income quintile	Total capital	Excluding:		
		Interest	Dividend	Business
Bottom	3.3***	0.5	3.1*	3.2**
2nd	3.8***	0.8	2.3**	3.5**
3rd	1.8	2.3	1.5	2.4
4th	3.0	0.4	1.0	4.9
Top	5.4****	5.1***	4.6**	5.8***
Observations	154 836	154 836	154 836	154 836

(a) *, ** and *** indicate statistical significance at the 10, 5 and 1 per cent levels, respectively; all regressions include a set of control variables for individuals' circumstances, as well as state and industry fixed effects
Sources: Author's calculations; HILDA Release 14.0

in hours worked and/or wages. Capital income is responsive to GDP growth for those in the top and bottom income quintiles; however, capital income is much more sensitive for the top income quintile and is driven mainly by changing returns to financial assets.

These effects provide evidence for both a 'labour income' channel and a 'capital income' channel in Australia. The two channels have partly offsetting effects on inequality, but the response of labour incomes appear to have the stronger effect for Australia. This suggests that changes in economic conditions will have a more pronounced effect on bottom-income groups, which implies that stronger economic conditions tend to reduce income inequality in Australia, and vice versa.

Appendix A: The Model

The econometric model used to estimate the sensitivity of personal income growth with respect to aggregate GDP growth is shown by Equation A1. The model chosen is based on the empirical models of Guvenen, Kaplan and Song (2014) and Cervini-Plá, López-Villacivencio and Silva (2015), and draws upon an extensive wage cyclicality literature. This model is estimated separately for total, labour and capital income on both the full and the employed samples. Individuals in each sample are grouped into five buckets (or quintiles) according to their level of income.

The model is specified as:

$$\Delta \ln\left(Y_{i,t}\right) = \sum_{q=1}^{5} \alpha_q D_{i,t-1}^{q} + \sum_{q=1}^{5} \beta_q D_{i,t-1}^{q} \Delta \ln\left(GDP_t\right) + \delta' CONTROLS_{i,t-1} + \varepsilon_{i,t} \quad \text{(A1)}$$

where $\Delta \ln (Y_{i,t})$ is the change in the log of the income variable of interest (total, labour and capital income) from year $t-1$ to t for individual i. The term $D_{i,t-1}^{q}$ is a dummy variable equal to one if individual i is in quintile q at year $t-1$. A dummy variable is included for each income quintile to control for differences in average income growth across quintiles.

The term $\Delta \ln (GDP_t)$ is the change in log GDP from $t-1$ to t. This variable is interacted with the income quintile dummies and the coefficients on these interaction terms β_q provide measures of the response of income growth to GDP growth for each income quintile.

The model also includes a set of variables that are likely to be important determinants of income growth rates across individuals. These 'control' variables ($CONTROLS_{i,t}$) include individual-level circumstances such as age (and age squared), gender, years of education, marital status and migrant status, as well as industry and state fixed effects. Like the income quintile groups, individuals' characteristics are measured at time $t-1$ so that their effect on subsequent income growth can be estimated.

The separate models for each income variable and for each sample are estimated using robust standard errors, clustered at the individual level. This accounts for possible heteroskedasticity and serial correlation of an individual's income shocks over time, but does not adjust for potential bias introduced by any cross-sectional correlation between the income shocks of different individuals in the same income quintile.

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Factors Affecting an Individual's Future Labour Market Status

Michelle van der Merwe*

This article examines the ways in which someone's characteristics and circumstances in one year affect their probability of being in a particular labour market state in the next year. People are more likely to be employed next year if they are currently employed and have tertiary qualifications. In contrast, they are more likely to be unemployed or outside the labour force if they have a long-term health condition, have not completed high school or are a migrant from a non-English-speaking background. Additionally, the article considers the changing importance of determinants over time, noting the role that changes in individual and household preferences as well as broader macroeconomic conditions are likely to have played.

Introduction

Underlying the changes in aggregate labour market outcomes there are much larger flows of individuals into and out of employment, unemployment and the labour force. Understanding the determinants of these flows can help to shed light on aggregate developments and refine an assessment of the degree of spare capacity in the labour market. For example, aggregate developments could reflect changes in the structure of the population or changes in the propensity of certain groups to participate in the labour market. An assessment could be made that the potential labour supply (as measured by the number of unemployed persons) may be smaller if the unemployed consists of individuals who are less likely to be matched to a job than others, given their characteristics. In contrast, if individuals outside the labour force, such as the marginally attached, display similar behaviour to those who are unemployed, then the potential supply of labour could be larger than otherwise (Gray, Heath and Hunter 2002).[1]

The purpose of this article is to understand how someone's characteristics and circumstances affect the probability of being in a particular labour market state in the next year. Previous Australian studies have typically focused on the experience of particular groups of individuals or particular types of labour market flows rather than the aggregate labour market flows from year to year. For example, in addition to Gray *et al* (2002), who focused on the behaviour of individuals that are marginally attached to the labour market, Haynes, Western and Spallek (2005) examine the characteristics that influence the employment status of Australian women, while Carrol and Poehl (2007) investigate whether certain groups of individuals are more likely to separate voluntarily or involuntarily from their employer.

The remainder of this article describes the features of the data, with a particular emphasis on the nature of the labour market changes observed, before moving to a more formal modelling approach that allows the relative importance of factors associated with an individual's future labour market status to be determined.

* The author is from Economic Analysis Department and is solely responsible for any errors. Thanks to Denzil Fiebig, Adam Gorajek and Gianni La Cava for their helpful comments and suggestions, including on earlier versions of this article.

1 Marginal attachment refers to the individuals who are not currently actively looking for work, but want to work and are available to take up employment.

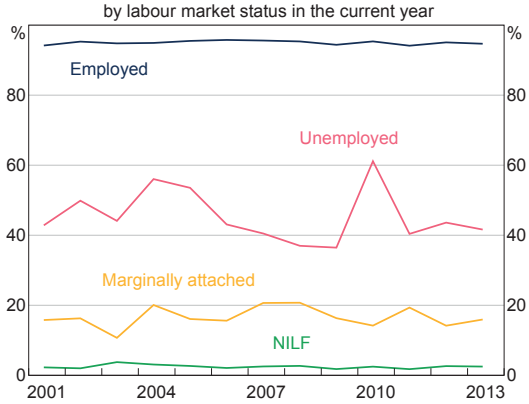
The Data

The Household, Income and Labour Dynamics in Australia (HILDA) Survey is a longitudinal household study that collects information from Australian individuals and households about economic and subjective wellbeing, labour market dynamics and family dynamics. The survey is conducted on an annual basis and is designed to be representative of the Australian resident population. It follows individuals and households over time.

The HILDA Survey provides a suitable dataset to answer the broader objectives of this article because it provides a detailed breakdown of an individual's labour market status each year as well as their individual characteristics. For the purpose of this article, four mutually exclusive labour market states are considered: employed; unemployed; marginally attached to the labour force; and not in the labour force (NILF) for reasons other than marginal attachment. Individuals who report their labour market status as self-employed or as participating in full-time study are excluded; the propensity for these individuals to transition between labour market states may reflect changes in very particular circumstances, such as business failure or the end of formal studies, both of which are outside the scope of this article. Further, individuals not present across two consecutive years of the survey are also excluded given the interest in labour market dynamics of this analysis.

The aggregate data in the HILDA Survey indicate that, in any given year, most individuals report their labour market status as employed or not in the labour force for reasons other than marginal attachment. A focus on the aggregate data, however, will not reveal information about what proportion of individuals change labour market status. One way to examine individual changes from year to year is to consider one-year-ahead transition probabilities. Graph 1, for example, shows that more than 40 per cent of individuals who were unemployed in one year typically became employed in the following year. Moreover, among those who were employed in each year, over 90 per cent remained in employment in the next year. The results for transitions into the other three labour market states also show that an individual's labour market status is unlikely to change from one year to the next.[2]

Graph 1
Transition Probabilities*
Per cent employed in the next year
by labour market status in the current year



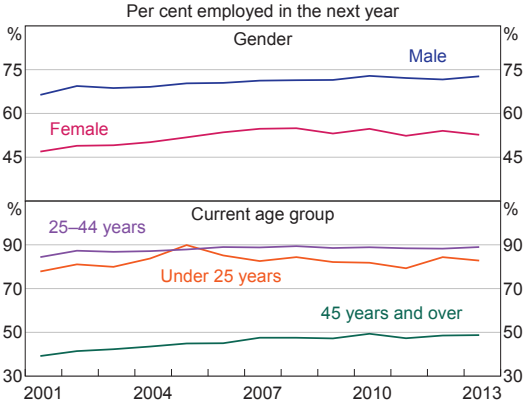
* Unconditional probability; population weighted; NILF is not in the labour force

Sources: HILDA Release 14.0; RBA

Transition probabilities can also be calculated by gender and age group. Graph 2 shows the percentage of individuals who were employed in the following year based only on their gender and age group in the current year. Consistent with the aggregate statistics, a higher proportion of males than females were employed in the next year. Similarly, a larger proportion of individuals in the younger two cohorts were employed in the next year compared to their older counterparts. Nevertheless, over the past decade or so, the proportion of females and older individuals moving into employment has gradually increased. For older individuals, there is evidence that they are more likely to be outside of the labour market than younger individuals, although the proportion has been gradually declining over the past decade (Graph 3).

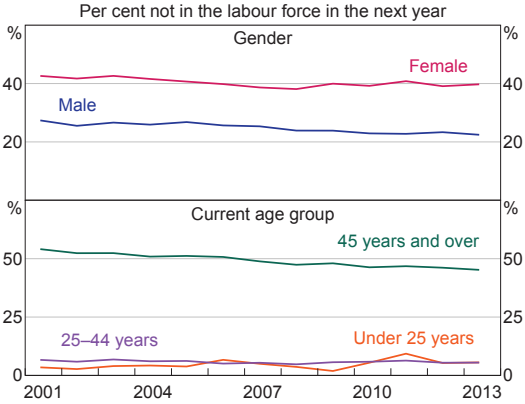
2 This type of persistence is known as state dependence.

Graph 2
Transition Probabilities*
Per cent employed in the next year



* Unconditional probability; population weighted
Sources: HILDA Release 14.0; RBA

Graph 3
Transition Probabilities*
Per cent not in the labour force in the next year



* Unconditional probability; population weighted
Sources: HILDA Release 14.0; RBA

Modelling Framework

To disentangle the relative importance of individual characteristics associated with an individual's future labour market status, a more formal modelling approach is required. As individuals can be in one of four mutually exclusive labour market states, a model that allows the dependent variable to take on multiple discrete values is required; a multinomial logit framework could be appropriate. Using this framework, Equation (1) expresses the probability that individual *i* will be in labour force state *j* in period $t+1$ given their individual characteristics and circumstances in period *t*.

$$\Pr\left(Y_{i,t+1}=j \middle| X_{i,t}, Y_{i,t}, Y_{i,1}\right)=\frac{\exp\left(X_{i,t}'\beta_j+Y_{i,t}'\gamma_j+Y_{i,1}'\theta_j\right)}{\sum_{k=1}^{4}\exp\begin{pmatrix}X_{i,t}'\beta_k+Y_{i,t}'\gamma_k\\+Y_{i,1}'\theta_k\end{pmatrix}} \quad (1)$$
$$j=1,2,3,4$$

In particular, $j=1$ refers to employed, 2 refers to unemployed, 3 refers to marginally attached and 4 refers to outside of the labour force for reasons other than marginal attachment. $X_{i,t}$ is a vector of exogenous explanatory variables of observable individual characteristics in period *t* and $Y_{i,t}$ is the labour market status of individual *i* in period *t*. These individual characteristics (outlined in more detail in the next section) include age, educational attainment, gender etc. Lastly, $Y_{i,1}$ is the first reported labour market status of individual *i* that is included to address the initial conditions problem.[3]

Another key consideration reflects the nature of the dataset, which consists of repeated observations on the same individuals over time. Given this, a more flexible multinomial logit framework is required than the standard framework to allow for correlations between unobservable factors and individual-specific heterogeneity. To meet these criteria, a mixed logit model is estimated, using maximum simulated likelihood.[4] In estimating the model, the labour market flows in the HILDA Survey that span 2001–14 are pooled together and, for the purpose of model identification, employment is set

3 The initial conditions problem reflects the fact that an individual's labour market status in the first period will depend on their labour market status in the previous period that we do not observe. But it is almost certain that the individual's previous unobserved labour market state was influenced by the same unobservable characteristics that influence their observed labour market states. Woolridge (2005) and Heckman (1981) propose two alternative solutions to control for this unobserved heterogeneity in dynamic non-linear panel models. This article uses the approach proposed by Wooldridge (2005).

4 The mixed logit model meets these criteria as it can: accommodate correlations between unobserved factors over time; allow for individual heterogeneity through the introduction of random parameters; and handle flexible substitution patterns. It also has strong theoretical support in the literature; McFadden and Train (2000) show that it can approximate any discrete choice model.

as the base category.[5] (See Appendix A for more details on the model specification and output.)

Explanatory variables

The earlier discussion of transition probabilities highlighted a number of factors that are likely to affect an individual's future labour market status and ought to be included as explanatory variables in the model. In line with almost all labour market status-related studies, age, gender, family structure, education and migrant status are considered as potential determinants.

Following Gray *et al* (2002), age is included to capture life-cycle effects and an age-squared term is included to allow for a potential nonlinear relationship. For example, it is intuitive that as an individual ages they are initially more likely to be employed or seek employment because of family responsibilities and the need to save for retirement; once they reach a certain age, however, the likelihood of still being employed or seeking out employment will decline and the likelihood of moving out of the labour force and into retirement increases.

Gender is included to capture differences associated with traditional gender roles related to work and family carer responsibilities that mean men have traditionally been more likely to participate in the labour market than women. Relatedly, family structure is also an important consideration for an individual's future labour market state. In an attempt to capture some of the more complex dynamics associated with family structure, gender is interacted with a dummy variable that denotes whether an individual is in a relationship (married or de facto) compared with being single. Furthermore, gender is also interacted with the presence of cohabiting dependent children under the age of 15 years.

5 The model is estimated with 250 Halton draws and stability is tested by re-estimating the specification with 500 Halton draws; the simulated log-likelihoods between the two models are little changed indicating that the model estimates are stable.

Educational attainment is included to allow for differences in human capital between individuals. The intuition is that regardless of an individual's current labour market state, those with higher levels of educational attainment are more likely to be employed in the next period than others. The degree of educational attainment is specified as a series of dummy variables that distinguish whether an individual has a degree (bachelor or higher) or diploma, vocational training or has not completed high school. The baseline for comparison is with someone who has finished high school but not studied beyond that.

The HILDA Survey identifies two broad types of migrant groups – those who are from a non-English-speaking background and those who are from an English-speaking background. Abstracting from other individual circumstances, a migrant from a non-English-speaking background is likely to face higher barriers to labour force participation and is thereby less likely to be employed in the next year compared with an individual who was born in Australia or is a native English speaker. The two migrant groups are distinguished in the model through a categorical variable, where the baseline for comparison is an individual born in Australia.

A dummy variable is included to denote whether or not an individual lives in a major city compared with a regional (including remote) area. The dummy variable acts as a proxy for greater employment opportunities in the city. An alternative approach could be to use local unemployment rates to capture these differences, although some studies have found that their inclusion adds little additional information to the specification because unemployment rates did not change much over the period considered (Gray *et al* 2002; Warren 2015).

Whether or not an individual has a long-term health condition is also likely to be an important determinant of their ability to find employment. A dummy variable is set equal to one if the individual reported in the HILDA Survey that they

had a long-term health condition, disability or impairment that restricted their everyday activities and could not be corrected by medication or medical aids.

Lastly, considerable attention in the literature has been devoted to the role of the current labour market state in explaining subsequent labour market outcomes (e.g. Prowse 2010). This so-called 'state dependence' is closely related to the scarring hypothesis of unemployment whereby there is a causal link between past and current unemployment. As Arulampalam, Booth and Taylor (2000, p 25) explain, state dependence is such that 'an individual who does not experience unemployment now will behave differently in the future to an otherwise identical individual currently experiencing unemployment'. Similarly, an individual who is currently employed is likely to be building up their stock of human capital, which in turn is likely to increase the probability of being employed in the future. To examine whether state dependence is a determinant of an individual's future labour force status, for which the preliminary analysis also found strong supporting evidence, a categorical dummy variable indicating their labour market status in the current period is included in the model.[6]

Results

As the coefficient estimates from the mixed logit model are not straightforward to interpret, average marginal effects are presented instead.[7] These effects describe the change in the predicted probability of a particular outcome when an explanatory variable changes by one unit or, in the case of a binary variable, the variable changes from zero to one, holding all other variables constant. As an individual can only be in one labour market state, the average marginal effects for each variable must sum to zero.

For the dummy variables in the model specification, the average marginal effect is calculated as the mean difference in the predicted probabilities of being in a given labour market state next year when the value of the variable is set to zero for all individuals in the sample, and when the variable is set to one for all individuals in the sample (holding all other explanatory variables constant). For the continuous variables, the average marginal effect is the mean change in the predicted probability when the value of the variable is increased by one unit and all other explanatory variables are held constant. The predicted probabilities under the different scenarios for the dummy and continuous variables are calculated through a series of simulation exercises that use the estimated mixed logit model; one consequence of this approach is that we are unable to comment on the statistical significance of the average marginal effects.[8]

All other things being equal, being female increases the probability of being outside the labour force in the next year by around 1.4 percentage points. The result is in line with the aggregate data that consistently show that a higher proportion of women are outside the labour force than men in any given year; for example, because of earlier retirement or family carer responsibilities (Graph 4).[9] In contrast, the probability of being employed in the next year is little different for females and males (that is the average marginal effect for females is close to zero), which is somewhat surprising given that men have historically had a higher propensity

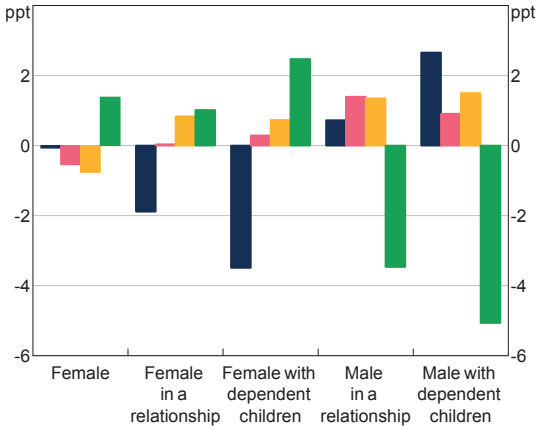
6 True state dependence is distinguished here from spurious dependence that stems from an individual's unobservable attributes; both are separately controlled for in the mixed logit modelling framework so that the coefficients and average marginal effects associated with the current labour market status can be interpreted as the effect of true state dependence.

7 The sign and statistical significance of the coefficient estimates from the mixed logit regression are meaningful to interpret but not the magnitude of the coefficients themselves.

8 To comment on whether the average marginal effect is statistically significant requires us to consider whether the corresponding regression coefficient in the mixed logit regression is statistically significant (refer to Appendix A).

9 In interpreting the average marginal effects associated with gender roles and family structure, the baseline comparison for females is males; the baseline comparison for females who are in a relationship is males and females who are not in a relationship; the baseline comparison for females with dependent children is males and females without dependent children; and so on.

Graph 4
Average Marginal Effects
Role of gender and family structure on predicted probability of labour market status in the next year



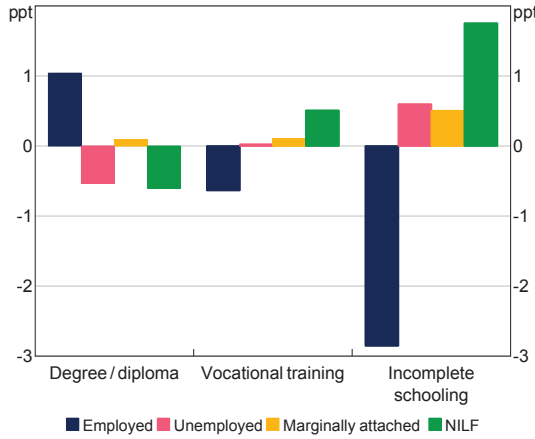
Sources: HILDA Release 14.0; RBA

to be in employment for factors related to traditional gender and family carer roles.

The other results associated with traditional gender and family career responsibilities are broadly consistent with the earlier hypotheses. The probability of being in employment in the next year falls by around 3½ percentage points if an individual is female and has dependent children under 15 years of age, irrespective of their relationship status and household income; while for males with dependent children the probability increases by around 2½ percentage points. Women with dependent children are more likely to be marginally attached or outside the labour force in the next year, while men with dependent children are less likely to be outside the labour force in the next year. Similarly, regardless of their labour market state in the current year, males in a relationship are less likely to be outside the labour force in the next year than others (the probability falls by 3½ percentage points) while women in a relationship are more likely to be outside the labour force for reasons other than marginal attachment in the next year (the probability increases by 1 percentage point).

Compared with finishing high school, having a degree or diploma increases the probability of being employed in the next year by around 1 percentage point and lowers the probability of being unemployed in the next year by around ½ percentage point (Graph 5). In contrast, incomplete schooling (compared with finishing high school) reduces the probability of becoming employed by almost 3 percentage points and increases the probability of becoming unemployed or moving out of the labour force in the next year. These results are consistent with the notion that higher levels of human capital accumulation increase the probability of being employed in the future.

Graph 5
Average Marginal Effects
Role of education on predicted probability of labour market status in the next year*

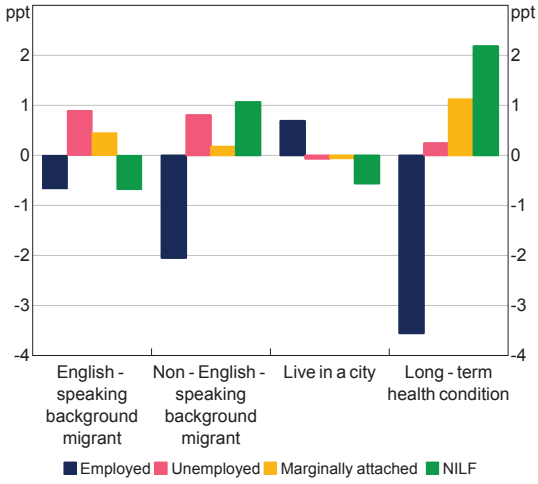


* Relative to completing high school

Sources: HILDA Release 14.0; RBA

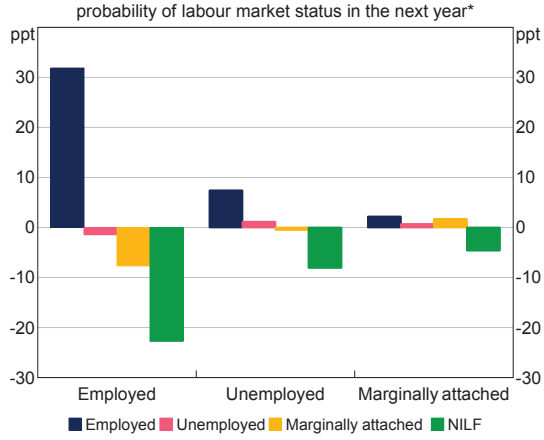
Compared with being born in Australia, being a migrant from a non-English-speaking background lowers the probability of being employed in the next year by 2 percentage points, regardless of the individual's current labour market state, while being a migrant from an English-speaking background reduces the probability by only 0.7 percentage points (Graph 6). This supports the earlier hypothesis that migrants from a non-English-speaking background are less likely to find employment owing to potential language barriers.

Graph 6
Average Marginal Effects
Role of other factors on predicted probability of labour market status in the next year



Sources: HILDA Release 14.0; RBA

Graph 7
Average Marginal Effects
Effect of existing labour market status on predicted probability of labour market status in the next year*



* Relative to an existing labour market status of NILF

Sources: HILDA Release 14.0; RBA

Meanwhile, living in a major city, compared with regional and rural areas, increases the probability of being employed in the next year by around ¾ percentage point and reduces the probability of being outside the labour force for other reasons in the next year by a similar magnitude. There is little meaningful effect on the probability of being unemployed or marginal attached in the next year from living in the city (the average marginal effect is close to zero).

The presence of a long-term health condition lowers the probability of being employed in the next year by around 3½ percentage points and increases the probability that the individual is not in the labour force in the next year by just over 2 percentage points. Of all the factors that have been considered, the presence of a long-term health condition has one of the largest negative effects on the probability of being employed in the next year.

Existing employment has by far the largest influence on the probability of being employed next year (Graph 7). For those currently employed, the probability of being employed in the next year is over 30 percentage points higher than if they are currently outside the labour force. The probability of being employed in the next year is 7½ percentage points higher if an individual is unemployed in the current year (compared with being outside the labour force in the current year). The probability of becoming unemployed, marginally attached or moving out of the labour force for reasons other than marginal attachment is considerably lower if the individual is currently employed. This is strong evidence in support of true state dependence for individuals who are currently employed. In contrast, the evidence is less compelling (but still significant) for the scarring hypothesis of unemployment; the probability of being unemployed next year is around 1 percentage point higher if the individual is currently unemployed, compared with ¾ percentage points higher for those who are currently marginally attached.

Changes over Time

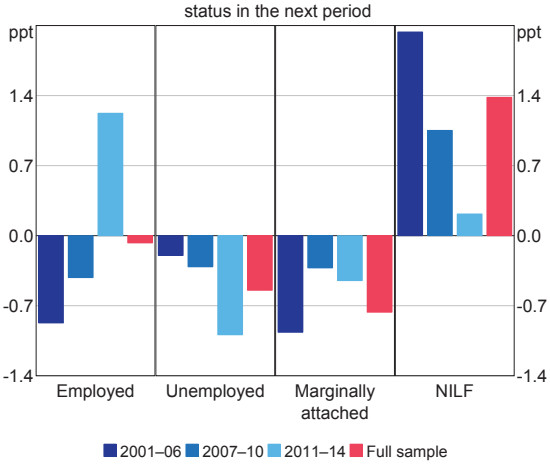
The previous section has highlighted a range of factors that, over the past decade or so, have been important determinants of being in a particular labour market state in the next year. It is also interesting to consider whether the importance of some of these determinants has changed over time

given the observed changes in the features of the labour market (such as the increased participation by females and older cohorts of Australians).

A simple way to explore this is to re-estimate the model outlined in the previous section over separate sub-samples (to allow for variation in the model coefficient estimates across each sample). Average marginal effects for variables of interest can then be calculated for each sub-sample and compared to one another to give an indication of how the effects have evolved over time. For this exercise, the model is estimated over three sub-samples: one over the period before the financial crisis (2001–06); one over the period during and immediately after the crisis (2007–10); and the last over the post-crisis period, which also coincides with the period after the mining investment and commodity price booms (2011–14). Particular attention is given here to gender, age (or more specifically, the effect of being one year older) and state dependence as the average marginal effects associated with these attributes have experienced some of the more notable changes over time.

The average marginal effects associated with being female show a distinct change in the probability of being employed in the next year over time. While the pre-crisis sample indicates that females were around 1 percentage point less likely than males to be employed in the next year, the post-crisis sample shows a complete reversal of this effect. Indeed, in the period after the crisis it has become more likely that a female will be employed in the next year than a male. Unsurprisingly then, there is also a noticeable and corresponding decline over time in the probabilities that a female would leave the labour force or become unemployed in the next year (Graph 8). These results could reflect a range of factors including the need to supplement household income because of negative shocks to wealth associated with the financial crisis, changes in preferences associated with how much time an individual wants to spend outside of the labour force and changes in traditional gender roles

Graph 8
Average Marginal Effects – Female*
Effect on predicted probability of labour market status in the next period

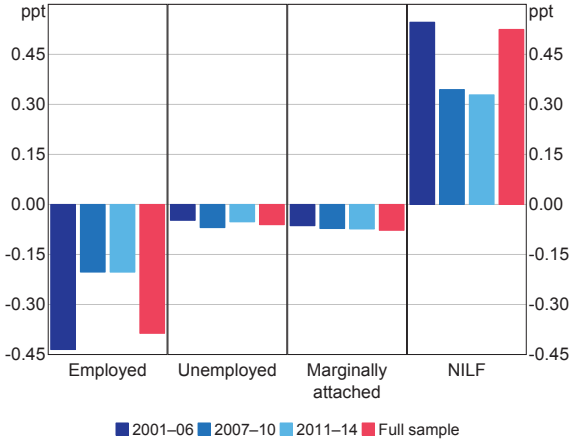


* Relative to being male
Sources: HILDA Release 14.0; RBA

associated with child rearing. At the same time, they might simply reflect the prevailing macroeconomic environment of the post-crisis period, where employment in largely male-dominated industries – such as manufacturing and mining-related construction – contracted owing to longer-run structural changes and the transition to the less labour intensive production phase of the mining boom.

In the period since the financial crisis, there is evidence that for someone who is older (by one year), the probability that they will not be employed has declined by around half and the probability of being outside the labour force has also diminished (Graph 9). As per the explanations offered for the evolution of the female average marginal effects, the decline could indicate an income-related factor or a change in preferences that has meant older individuals have become less likely to be outside the labour force in the next period than prior to crisis. Alternatively, with each generation having a higher propensity to participate in the labour force than the one preceding it, it could simply be that the working life of Australians has increased over time. However, these types of cohort effects are more gradual and

Graph 9
Average Marginal Effects – Age
Effect on predicted probability of labour market status in the next period

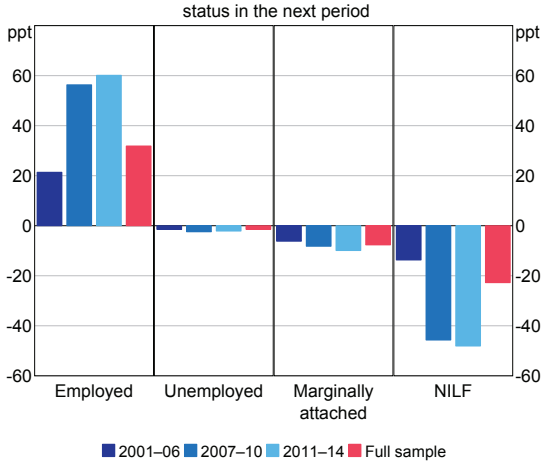


Sources: HILDA Release 14.0; RBA

longer term in nature and the distinct change that occurs around the time of the financial crisis suggests that other factors may also be at play.

Lastly, the importance of existing employment in increasing the probability of being employed in the following year has almost tripled since the financial crisis (Graph 10). The noticeable increase is likely to reflect the decline in voluntary separations and the increase in the average tenure of employment with a given employer over recent years, which together may reflect increased concerns associated with job security.

Graph 10
Average Marginal Effects – Existing Employment*
Effect on predicted probability of labour market status in the next period



* Relative to an existing labour market status of NILF
Sources: HILDA Release 14.0; RBA

Conclusion

This article explores the relative importance of individual characteristics and circumstances in one year in determining the probability of being in a particular labour market state the following year. The results indicate that the factors that are most important for increasing the probability of being employed in the year ahead are: being currently employed; having tertiary qualifications; and being a male who has dependent children (which is likely to be capturing the traditional gender and family carer responsibilities that have meant that males are more likely to be in employment than females). In contrast, the factors that weigh on the probability of being employed in the year ahead include being a female with dependent children, having a long-term health condition, not completing high school and being a migrant from a non-English-speaking background. The key factors increasing the probability of being outside the labour market in the next year are the presence of a long-term health condition, low levels of education and being a female with dependent children. Over the past decade, the average marginal effects associated with being female, being older and existing employment and being employed in the next year have changed considerably. This is likely to reflect a number of factors, including changes in preferences related to work and family, concerns over job security, as well as broader macroeconomic trends.

Appendix A: The Mixed Logit Model

The mixed logit model has economic foundations in random utility theory, where there is an unobservable latent variable (here denoted by $Y^*_{i,t+1}$) that represents the propensity that the observed outcome variable (here denoted by $Y_{i,t+1}$) will be equal to one for a given labour market state in the next period.

Recall, Equation (1) describes the probability that individual *i* will be in labour force state *j* in period $t+1$ given their individual characteristics and circumstances in period *t*.

$$\Pr\left(Y_{i,t+1}=j \middle| X_{i,t}, Y_{i,t}, Y_{i,1}\right)=\frac{\exp\left(X'_{i,t}\beta_j+Y'_{i,t}\gamma_j+Y'_{i,1}\theta_j\right)}{\sum_{k=1}^{4}\exp\begin{pmatrix}X'_{i,t}\beta_k+Y'_{i,t}\gamma_k\\+Y'_{i,1}\theta_k\end{pmatrix}} \quad (1)$$
$$j=1,2,3,4$$

Where $j=1$ refers to employed, 2 refers to unemployed, 3 refers to marginally attached and 4 refers to outside of the labour force for reasons other than marginal attachment. $X_{i,t}$ is a vector of exogenous explanatory variables of observable individual characteristics in period *t* and $Y_{i,t}$ is the labour market status of individual *i* in period *t*.

The mixed logit model estimates the latent propensity that individual *i* will be in labour force state *j* in period $t+1$ given their individual characteristics and circumstances in period *t* (Equation A1).

$$Y^*_{i,t+1}=\alpha_{i,2}d_2+\alpha_{i,3}d_3+\alpha_{i,4}d_4+\beta_j X_{i,t}+\gamma_j Y_{i,t}+\theta_j Y_{i,1}+\varepsilon_{i,j,t+1} \quad (A1)$$

In addition to the variables outlined in the body of the article, d_j are the alternative-specific constants (capturing the four alternative labour market states in period $t+1$) which have random coefficients $\alpha_{i,j}$, where:

$$\alpha_{i,j}=\overline{\alpha}_j+\mu_i \quad (A2)$$

For identification purposes $\alpha_{i,1}d_1$ is normalised to zero, making employed in period $t+1$ the base case. By allowing the alternative-specific coefficients to be random, potential correlation in the composite error terms is enabled as well as heteroskedasticity across the outcomes. The error term $\varepsilon_{i,j,t+1}$ is an unobserved random term that is independent and identically distributed and is distributed according to the extreme value distribution.

Table A1 shows the estimated coefficients from the mixed logit estimation with 250 Halton draws. The table only shows three sets of coefficient estimates because one labour market state had to be normalised to zero for identification purposes. The sign and statistical significance of the coefficients therefore need to be interpreted relative to the base case. For example, taking the coefficients associated with being female, compared with being employed in the next period, a female is less likely to be unemployed, but more likely to not be in the labour force in the next period, with both coefficients statistically significant at the 1 per cent level.

Table A1: Mixed Logit Regression Results
2001–14

	Labour market state in $t + 1$		
	Unemployed	Marginally attached	Not in labour force: other
Age	–0.088***	–0.168***	–0.238***
Age squared	0.001***	0.002***	0.004***
City (control = regional/rural)	–0.089	–0.121*	–0.182**
Gender and family structure (control = single male, no dependents)			
Female	–0.288***	–0.143	0.247***
Female with dependent children under 15 years	0.352***	0.730***	0.183*
Male with dependent children under 15 years	–0.095	–0.038	–0.731***
Female in a relationship	–0.580***	–0.236***	0.323***
Male in a relationship	–0.575***	–0.672***	–0.095
Education (control = finished high school)			
Degree/diploma	–0.362***	–0.109	–0.205*
Vocational training	0.063	0.125	0.169
Incomplete school	0.497***	0.515***	0.618***
Country of birth (control = Australian born)			
Migrant: English-speaking background	0.455***	0.153	–0.064
Migrant: Non-English-speaking background	0.513***	0.308***	0.394***
Long-term health condition (control = no condition)	0.387***	0.761***	0.781***
Current labour market status (control = NILF)			
Employed	–1.864***	–3.316***	–3.965***
Unemployed	–0.208	–1.610***	–2.739***
Marginally attached	0.164	–0.111	–1.144***
Initial labour market status (control = NILF)			
Employed	–1.473***	–1.939***	–3.034***
Unemployed	0.677***	–0.286*	–1.697***
Marginally attached	0.493***	0.391***	–0.868***
Constant	0.614	2.956***	5.032***

(a) ***, ** and * denote statistical significance and the 1, 5 and 10 per cent level; simulated log-likelihood: –20 212.935
Source: RBA

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Measures of Inflation Expectations in Australia

Angus Moore*

Inflation expectations have an important influence on wage growth and price inflation. Expectations differ across agents and time and, accordingly, the Reserve Bank monitors a range of measures. This article discusses why inflation expectations are important for inflation and economic activity, the measures that exist in Australia and various issues affecting their interpretation. The financial markets that are used to calculate some measures of inflation expectations are not particularly liquid in Australia, and the financial measures also include an inflation risk premium; these issues can affect the interpretation of movements in the series.

Introduction

Inflation expectations are important for a number of reasons. First, inflation expectations influence decisions such as wage negotiations or price setting, which typically occur infrequently.[1] As a result, inflation expectations have a self-referential component: if firms expect inflation to be low, they will set their prices accordingly, creating low actual inflation. This has implications for the ease with which the Reserve Bank of Australia (RBA) can achieve its inflation target.

Second, changes in both short- and long-term inflation expectations affect real interest rates (the difference between nominal interest rates and inflation expectations) and hence the stance of monetary policy. If inflation expectations decline, real interest rates become less accommodative if nominal interest rates are unchanged. In theory, higher real interest rates provide an incentive for households to consume less. This is because higher real rates make the return on savings more attractive and discourage firms from investing by raising borrowing costs.

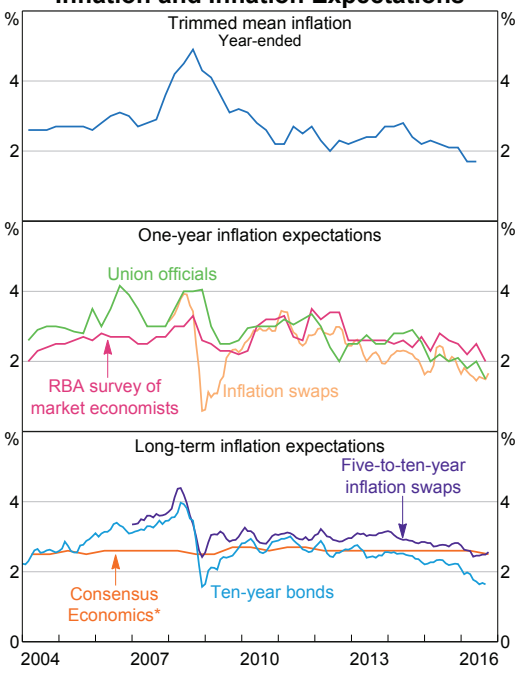
Finally, longer-term measures of expectations – particularly those that abstract from near-term inflation – might be informative about the credibility of the central bank's ability to achieve its inflation target. Large deviations in these measures from the inflation target could suggest that long-term inflation expectations have become unanchored, which makes it more difficult for monetary policy to stabilise inflation and output.

Given their importance, the RBA monitors a range of measures of inflation expectations (Graph 1). These measures have come under increased focus lately, as low inflation outcomes over the past year or so have been associated with declines in shorter-term measures of inflation expectations. Over the same period, financial market-based measures of long-term inflation expectations have also moved lower, but survey-based measures of long-term inflation expectations have moved by less. These developments have raised questions about how to measure inflation expectations, what they mean for understanding future inflation outcomes, and how to interpret movements in the market-based measures in particular. This article surveys the

* The author is from Economic Analysis Department.

1 Estimates for Australia suggest prices are reset, on average, once every three quarters (Jääskelä and Nimark 2011). Similarly, evidence from the RBA's liaison with firms found that a majority of firms reset prices once per year (Park, Rayner and D'Arcy 2010).

Graph 1
Inflation and Inflation Expectations



* Average over six to ten years in the future

Sources: ABS; Australian Council of Trade Unions; Bloomberg; Consensus Economics; Melbourne Institute of Applied Economic and Social Research; RBA; Workplace Research Centre; Yieldbroker

various measures of inflation expectations in Australia and discusses the issues that surround several of these measures. In particular, using a newly available transaction-level database on activity in the inflation swaps market, the article explores some challenges in interpreting market-based measures of inflation expectations.

Measures of Inflation Expectations

There are three broad types of commonly used measures of inflation expectations in Australia: surveys of professional forecasters; surveys of consumers and firms; and market-based measures.

Surveys of professional forecasters

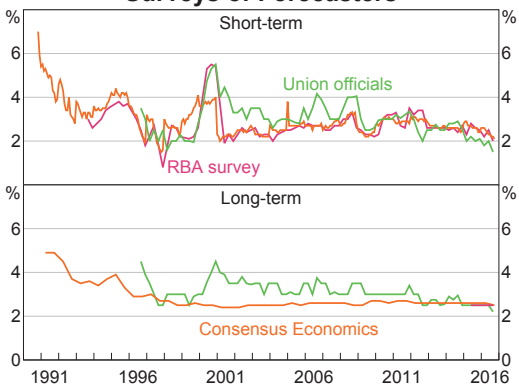
There are three key surveys of professional forecasters: the quarterly RBA survey of market economists; Consensus Economics' monthly survey; and the quarterly survey of union officials. All of these surveys ask for expectations for headline inflation, although questions for trimmed mean inflation were recently added to the RBA survey. The RBA and union surveys both ask participants for forecasts of year-ended inflation for the June and December quarters for the next two years. This permits the construction of one- and two-year expectations for year-ended inflation. In contrast, Consensus Economics asks for year-average inflation for the current calendar year and the next calendar year, which means that the survey horizon changes through the year: in January, forecasters are forecasting inflation one year ahead, but by December they are forecasting just one *month* ahead.[2] The RBA survey is run shortly after the release of the Consumer Price Index (CPI) and the results are published in the Reserve Bank's *Statement on Monetary Policy* a few weeks later.

The RBA also monitors surveys of longer-term expectations. The first is from the survey of union officials. It asks for expectations for medium-term inflation, defined as average annual inflation over the next five to ten years. An identical question was added to the RBA survey of market economists in mid 2015. The second is from Consensus Economics, which captures expectations of average inflation for between six and ten years. Because it abstracts from near-term influences on inflation, the measure is ideal for assessing anchoring of long-term inflation expectations. The drawback of the Consensus long-term measure is that the survey question is included only twice a year (in April and October).

Graph 2 suggests that the introduction of inflation targeting in 1993 established a strong anchor around 2½ per cent, although long-term expectations did not reach 2½ per cent until late 1998; given the previous experience with high inflation, this five-year lag is unsurprising and was expected at the time (Fraser 1994). Recently, all the survey measures have declined to around the levels seen in the late 1990s.

2 Consensus Economics also runs a quarterly survey that asks for year-ended growth for each of the quarters in the current and next calendar years. Unlike the monthly survey, Consensus Economics provides only the mean of the survey responses rather than all of the individual responses.

Graph 2
Surveys of Forecasters



Sources: Australian Council of Trade Unions; Consensus Economics; RBA; Workplace Research Centre

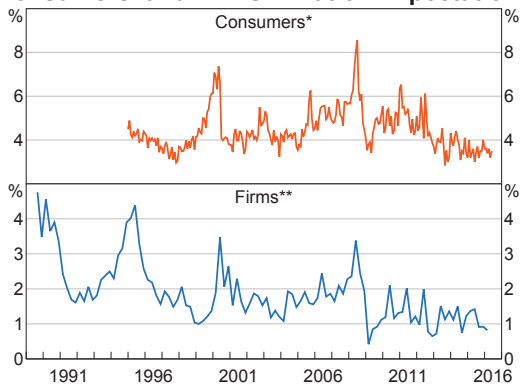
Low inflation expectations are consistent with low wage and consumer price inflation outcomes and the RBA's expectation that inflation will only return to more normal levels gradually.

There are two key advantages to these types of measures. First, because survey respondents are professional forecasters, respondents are well informed and invest substantial resources into forming their expectations for inflation. Second, the measures have long and consistent time series, which is useful for econometric modelling and permits examination of how the measures respond to past events. The main drawback of these measures is that, as theory tells us, it is the expectations of decision-makers in the economy – firms and households – whose expectations matter for wage and price setting decisions. There is little reason to believe that the relatively small number of survey respondents (typically 15–20) is representative of the broader population. This may be less of an issue with the union survey, since these officials may be involved in wage negotiations on behalf of a large number of their members.

Surveys of consumers and firms

The Melbourne Institute measure of inflation expectations is based on a survey of around 1 200 consumers run every month. Consumers are asked how they expect the 'prices of the things you buy' to change over the next year (Graph 3). The responses are weighted to ensure that the survey sample matches population characteristics for gender, age and location. In theory, consumers' inflation expectation should be highly relevant for inflation dynamics, since consumers are key decision-makers in the economy. In practice, research suggests that consumers' expectations do not line up well with actual inflation outcomes. Responses tend to be clustered around round numbers such as 5 or 10 per cent and overly responsive to movements in certain salient prices, such as petrol (Brischetto and de Brouwer 1999; Ballantyne, *et al* 2016). These problems make interpreting movements in the measure more difficult.

Graph 3
Consumers' and Firms' Inflation Expectations



* Expected change over the next year
** Annualised expected three-month change
Sources: Melbourne Institute of Applied Economic and Social Research; NAB

A survey of firms' inflation expectations with a long history is the National Australia Bank's survey of inflation expectations, which asks firms how they expect the price of their final goods to evolve over the next three months (Graph 3).[3] Much like the consumer survey measure, in theory these measures should be highly relevant – firms' expectations are what *should* feed in to price- and wage-setting decisions. However, as with the

3 Two other surveys of firms – the ACCI-Westpac and Dun & Bradstreet surveys – also ask firms about their expectations for their final prices. However, these surveys only ask for whether firms expect their prices to increase, decrease or stay the same.

consumers' expectations measure, research has typically found that firms' expectations do not line up well with actual inflation outcomes.

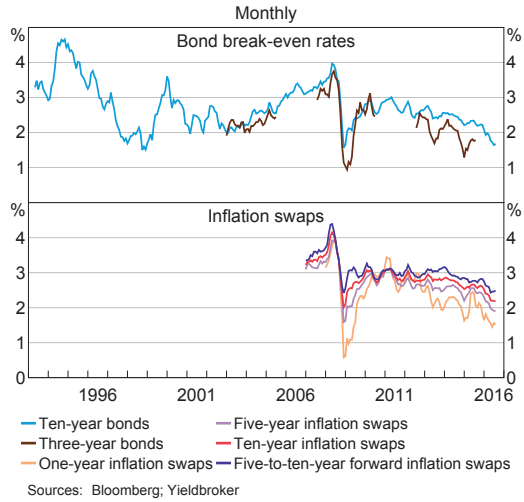
Market-based measures

There are two market-based measures of inflation expectations in Australia. The first is the fixed rate on inflation swaps, which are a type of over-the-counter (OTC) derivative. In an inflation swap, one party receives a payment indexed to inflation in exchange for a payment determined by a fixed rate, which is agreed on at initiation of the contract. Users of inflation swaps include pension funds (who use them to hedge long-dated inflation-linked obligations) and infrastructure project providers (who use them to hedge their inflation-linked assets or revenues). The second market-based measure of inflation expectations is derived from the difference in yields between nominal and inflation-indexed Australian Government Securities (AGS).[4] Because their face value is indexed to the CPI, the yield on inflation-indexed bonds is a real yield. Thus, the difference between the nominal and inflation-indexed AGS is the average rate of inflation over the next 10 years that equates the expected return on nominal AGS to the expected return on inflation-indexed AGS; this is often referred to as the 'break-even' inflation rate.

These measures are useful for a number of reasons. First, market participants have substantial financial resources at stake. This means that they have strong and direct incentives to form accurate expectations for inflation and, as a result, are likely to be well informed. Second, the inflation-indexed bond measure has a long time series, with monthly data from 1985 and daily data from 1993. This makes it well suited for econometric modelling. Third, for inflation swaps, prices are available at many tenors, which permits the construction of a 'term structure' of inflation expectations – for instance expected inflation between five and ten years into the future (Graph 4). These types of forward measures are a good way to assess longer-term anchoring of expectations because they abstract from temporary factors.

There are a few characteristics of these markets that may cloud the interpretation of both the level and the movements in inflation expectations.[5] The first is that, in Australia, markets for these instruments are not particularly active or liquid. For inflation-linked bonds, liquidity is low relative to nominal AGS and so investors who wish to hold highly liquid assets will have a preference for nominal AGS. As a result, investors may demand a higher yield on inflation-linked AGS, known as a 'liquidity premium', to compensate for the risk of market prices moving against the investor in a substantial way if they try to sell their position. This liquidity premium may downwardly bias the bond-based measure of inflation expectations. As derivatives, the supply of inflation swaps is not constrained, meaning that, in theory, inflation swap rates should be less affected by liquidity preference effects

Graph 4
Market-based Measures of Inflation Expectations



Sources: Bloomberg; Yieldbroker

4 Additional adjustments are also required to account for other factors such as the different coupon frequencies of nominal and inflation-indexed AGS and different maturities of the bonds. Finlay and Olivan (2012) discuss these issues.

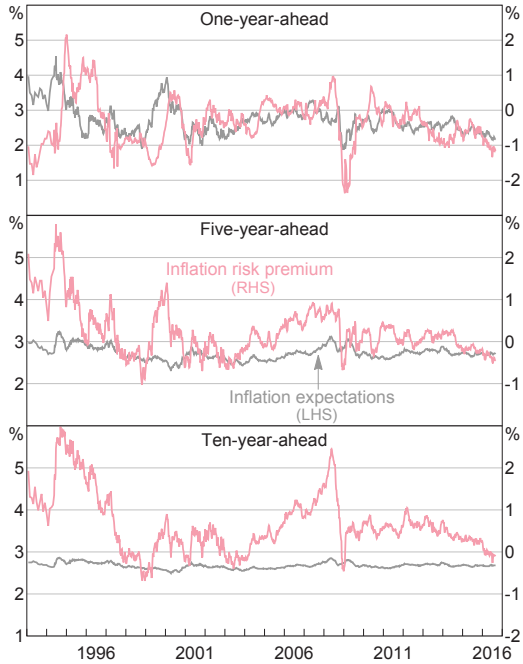
5 An additional concern with the bond-based measure is that there are relatively few inflation-linked AGS on issue. This means that the '10-year' rate is really an interpolated approximation, based on bonds with other maturities. This scarcity also means that it is difficult to reliably construct expectations other than 10-year. In the past, the RBA has constructed a three-year break-even rate; however, coverage is patchy because appropriate maturity bonds are not always available.

(Finlay and Olivan 2012). However, inflation swaps may be narrowly provided (due to balance sheet constraints) and reflect the views of just a small number of market makers. As outlined below, this is the case in Australia. This means that the inflation swaps measure of inflation expectations is not particularly representative. In which direction these concerns should bias the swaps measure of inflation expectations is unclear – it depends on which side of the transaction the market maker is on. Further work could try to assess and measure this bias.

The second concern is that these measures are *compensation* for bearing inflation risk. In addition to expectations, both market-based measures contain an *inflation risk premium*. This premium is the additional yield that investors demand to compensate for the risk of lower- or higher-than-expected inflation. The inflation risk premium means that the market-based measures of inflation expectations are biased upwards.

Moreover, there is evidence that the inflation risk premium varies over time.[6] This makes it difficult to interpret movements in the market-based measures, because movements could be either due to changes in expectations or changes to the inflation risk premium. Finlay and Wende (2011) use a structural model that incorporates data from inflation-linked AGS and the Consensus Economics survey of long-term inflation expectations to try to disentangle inflation expectations from the inflation risk premium.[7] They find that, at the one-year horizon, the two vary by similar magnitudes. At longer horizons, Finlay and Wende find much of the variation in the break-even inflation rate is due to changes in the inflation risk premium (Graph 5). Other estimates in the overseas literature differ in how much variation they attribute to the expectations versus the inflation risk premium, and the estimates can be sensitive to model specification. Nonetheless, much of the literature finds sizeable variation in the inflation risk premium. Estimates similar to Finlay and Wende's have not been done using inflation swaps data in Australia.

Graph 5
Inflation Expectations and Inflation Risk Premia
Annualised quarterly inflation rate at horizon



Source: Finlay and Wende (2011)

A Closer Look at the Effect of Liquidity and Activity on the Market-based Measures

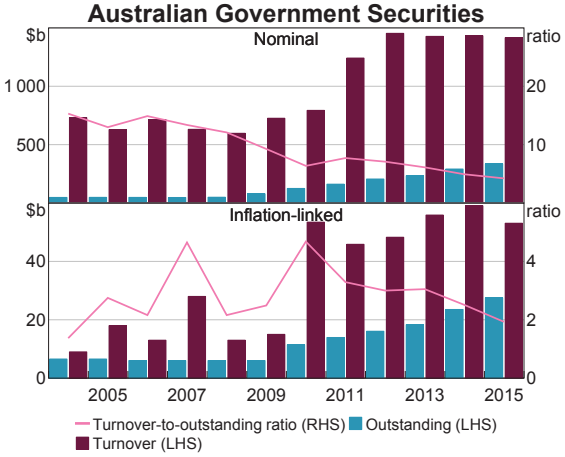
Inflation-linked bonds

Various metrics suggest that liquidity is substantially lower for inflation-linked AGS than for nominal AGS (Graph 6). It is for this reason that the yields on inflation-linked AGS are believed to embed a liquidity premium over nominal AGS. If the liquidity premium were constant over time, it would affect

6 This evidence is part of a long literature documenting the existence of time-varying risk premia in assets of all types (Shiller 1981; Fama and French 1988). There is some evidence in favour of the existence of time-varying risk in inflation swaps in Australia; however, because of the short time series available for swaps, this evidence is weak. Overseas research has found that time-varying risk premia are present in the yields on inflation-linked bonds and inflation swaps in other countries (Evans 1998).

7 I thank Jonathan Hambur for his work extending these estimates to 2016.

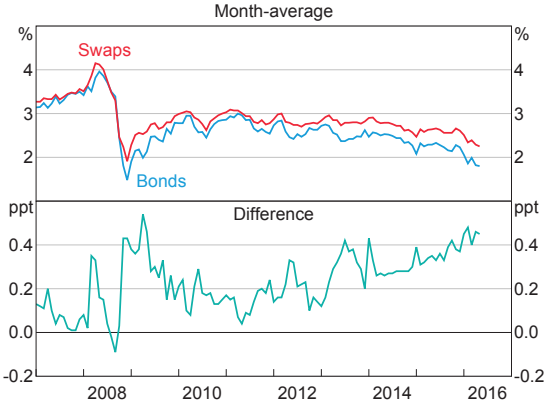
Graph 6
Australian Government Securities



Sources: Australian Financial Markets Association; Australian Office of Financial Management

only the level of the estimated bond break-even inflation rate. However, there is a steadily increasing wedge between the 10-year inflation swaps rate and 10-year bond break-even rates since about 2011 (Graph 7).

Graph 7
Ten-year Break-even Inflation Rates
Month-average



Sources: Bloomberg; Yieldbroker

The widening in the spread between the two rates might be the result of changes to either market. One possibility is that the liquidity premium in inflation-linked AGS has risen, exacerbating the downward bias in the bond-based measure of inflation expectations. This would be consistent with the widespread view that liquidity in global bond markets has declined noticeably since 2008 (e.g. Levine 2015; Debelle 2015; CGFS 2016). In Australia, the decline in fixed income market liquidity has been less pronounced than globally; nonetheless, there is some evidence that bond markets are less liquid than in the past, but that an increase in interest rate derivatives market liquidity has more than offset this (Cheshire 2016). This change reflects, at least in part, a correction in the pricing of liquidity, which had been 'underpriced in the years prior to the global financial crisis' (Debelle 2016). These developments may have raised the liquidity premium inherent in inflation-indexed AGS by more than in nominal AGS because of the lower initial liquidity in inflation-linked AGS. If this is the case, the bond-based measure of inflation expectations may have become more downwardly biased than in the past.

Inflation swaps

In theory, inflation swaps may be less affected by a liquidity premium than inflation-linked bonds; as long as a willing counterparty can be found, the swap can be created. Similarly, unlike purchasing government securities, inflation swaps involve no exchange of funds at the initiation of the contract. Despite being off-balance sheet, swaps nonetheless carry capital and leverage implications for prudential regulatory purposes. This means that balance sheet space still represents a constraint on liquidity in this market. Recent regulatory reforms, such as the Basel III leverage ratio, have made OTC derivatives (including inflation swaps) more expensive for banks (see Heath and Manning (2012) for more detail).[8] These developments are likely to have reduced liquidity in the inflation swaps market. However, it is unclear how this should affect inflation swaps rates – whether it should raise or

8 Other reforms, such as capital requirements for uncleared OTC derivatives and initial margin requirements for non-centrally cleared OTC derivatives, are also relevant. Australian dollar inflation swaps are not currently accepted for central clearing at SwapClear (the dominant central counterparty for OTC derivatives in Australia), so reforms requiring mandatory central clearing are unlikely to be relevant for inflation swaps at present.

lower the rate depends on which side of the swap the bank is on.

The main liquidity-related concern with inflation swaps is that the market is not particularly active and so prices are not broadly representative and are not always based on actual transactions. Because it is an OTC market, market liaison and the annual survey run by the Australian Financial Markets Association have previously provided the only data on market activity. Transaction-level data for OTC derivatives have recently become available as part of reforms to OTC derivatives markets, which require all transactions to be reported to a centralised repository.

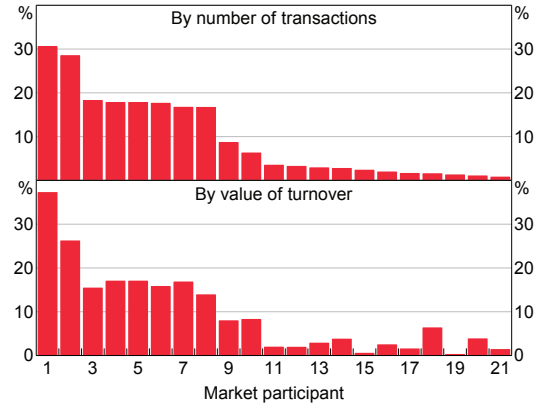
These data indicate that market activity is low, with an average of just 21 transactions per week over the first half of 2016 (Graph 8). Even at the most liquid tenor (10 years), there was an average of about six transactions per week. As a result, individual transactions may have greater price impact than would transactions in deeper, more liquid markets; similarly, many of the daily observations are not based on actual transactions and instead reflect quotes provided to Bloomberg by market makers. These factors suggest that daily changes in inflation swaps rates should be interpreted with caution; longer-term averages (such as monthly averages, which the RBA typically uses for inflation swaps) are likely to mitigate these factors.

These data also indicate that the inflation swaps market is dominated by a few large market makers (Graph 9).[9] Reflecting this concentration, activity is largely between institutions typically thought of as dealers.[10] Graph 10 classifies transactions according

Graph 8
Inflation Swaps – Transactions by Tenor
On average per week*

* For the period 1 January 2016 to 8 July 2016
Source: DTCC Data Repository (Singapore)

Graph 9
Inflation Swaps – Market Concentration
Participant's proportion of total market activity*



* As a proportion of all transactions outstanding as at 8 July 2016
Source: DTCC Data Repository (Singapore)

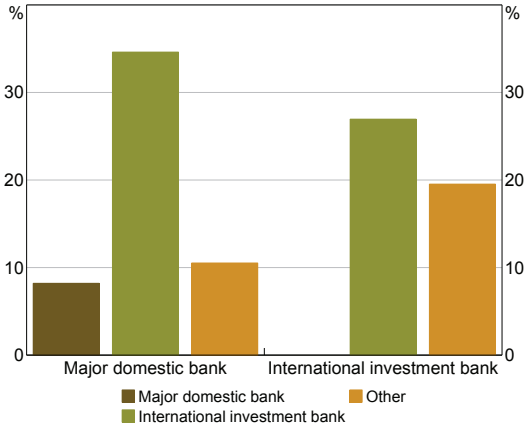
to the types of counterparties to the transaction.[11] Transactions between these dealers account for 70 per cent of all transactions, split as: 8 per cent between two domestic banks; 35 per cent between a domestic bank and an international investment

9 These numbers are not exclusive: a transaction between the two parties would be counted twice (since there are two sides to every transaction).

10 Dealers have been classified in two groups: the five major domestic banks; and the eight most active international investment banks (and two subsidiaries).

11 The bars sum to (almost) 100 per cent. The remaining transactions do not have a major domestic bank or international investment bank as at least one of the counterparties. This is a tiny fraction of transactions. The right-hand side of the graph does not include a 'Major domestic bank' series because doing so would double count those transactions.

Graph 10
Inflation Swaps – Transactions by Counterparties
Share of number of transactions outstanding, as at 8 July 2016



Sources: Author's calculations; DTCC Data Repository (Singapore)

bank; and 27 per cent between two international banks. These observations suggest that some caution is warranted when interpreting the inflation swaps measure because pricing is based on just a few participants and transactions, and may not be representative of broader inflation expectations. Whether this concentration of activity biases the inflation swaps measure of inflation expectations is unclear; further work could look into this issue.

Investment and super funds are the largest 'end users' of inflation swaps, together accounting for about 17 per cent of transactions.[12] These funds mostly transact with international investment banks, rather than major domestic banks. All of these findings are consistent with prior market liaison, which suggests that the main end users of inflation swaps are hedgers with long-dated inflation-linked obligations (such as super funds) or corporates who issue inflation-linked debt (Finlay and Olivan 2012).

12 Investment funds may be acting on behalf of other end users (such as super funds), but the database does not provide sufficient information to test this hypothesis.

Conclusion

There are a number of measures of inflation expectations, which include surveys of professional forecasters, households and firms, as well as financial market-based measures. All of these measures have various issues affecting their interpretation and so the RBA monitors all of them.

More recently, market-based measures of longer-term inflation expectations have moved lower than survey-based measures of longer-term expectations. Some of the variation in the market-based measures appears to be due to changes in the inflation risk premium. Also, the bond-based measure is likely to have been affected by a time-varying liquidity premium. Whether recent regulatory developments or the low level of activity in the inflation swaps market bias inflation swaps rates is not yet clear; further work could look into this issue.

Taking these observations together, long-term inflation expectations appear consistent with the RBA's medium-term inflation target. Nonetheless the low level of shorter-term measures requires ongoing monitoring, particularly if this were to become entrenched in longer-term measures. Previous generations of the RBA's inflation forecasting models have relied on the bond-based measure of inflation expectations (Gruen, Pagan and Thompson 1999; Norman and Richards 2010). One implication of this article is that alternative measures should be considered when incorporating inflation expectations into these types of models.

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The Cash Market

Al Hing, Gerard Kelly and David Olivan*

The cash market is the market for unsecured, overnight loans between banks. The weighted average of interest rates on these loans is the cash rate, the Reserve Bank's operational target for monetary policy and an important financial benchmark. Over the past decade or so there have been a number of regulatory and payment system developments that have affected the cash market, coinciding with a decline in aggregate market turnover. This article examines these developments using newly available data on payment system activity.

Introduction

Banks borrow and lend the balances they hold in their Reserve Bank Exchange Settlement Accounts (ESAs) in the cash market.[1] These transactions are undertaken between banks on an unsecured basis for a term of one business day. ESAs, which must be in credit at all times, are used to settle obligations arising from interbank payments within the Reserve Bank Information and Transfer System (RITS), Australia's high-value payments system. Each business day, banks that hold more exchange settlement (ES) balances than they need (i.e. to settle their net payment obligations) can lend the surplus in the cash market to banks with a shortfall.

The (annualised) weighted-average interest rate on these unsecured interbank loans is the overnight 'cash rate', which is the Reserve Bank's operational target for the implementation of monetary policy. The cash rate is an important benchmark in Australian financial markets, used as the reference rate for Australian dollar overnight indexed swaps and the Australian Securities Exchange's 30-day interbank cash rate futures contract. The cash rate also underpins other wholesale and retail market interest rates in the economy. It, therefore, influences the behaviour of borrowers and lenders, economic activity and ultimately the rate of inflation.

While the Reserve Bank does not directly participate in the cash market, it is able to control the aggregate amount of ES balances that are available for market participants to borrow and lend.[2] It does this by supplying enough ES balances through its open market operations, such that the demand for ES balances is satisfied at, or close to, the cash rate target. In recent years, deviations of the cash rate from the target determined by the Reserve Bank Board have been small and infrequent (Graph 1). The stability of this key policy rate relative to its target is one of the distinguishing features of the Australian financial system.[3]

Before May 2016, the Reserve Bank conducted a daily survey of banks to determine the amount and weighted-average interest rate at which they transacted in the cash market. From May 2016, however, the Reserve Bank has required banks to specify which of their transactions in RITS relate to cash market transactions. This has allowed the

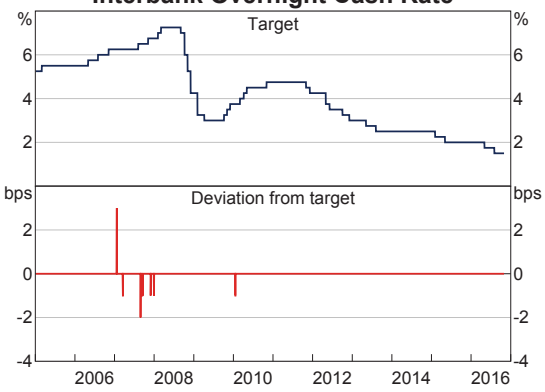
* The authors are from the Domestic Markets Department. We thank Anthony Brassil for his assistance in preparing the data for this article.

1 Balances in ESAs are liabilities of the Reserve Bank and assets of the banks that hold them. Although they exist only as an accounting entry, exchange settlement balances are referred to as 'cash' as they are equivalent to physical currency for the purposes of settling payment obligations between ESA holders. They represent the most liquid form of monetary asset and comprise the 'money base' along with banknotes and coins (for which they can be exchanged).

2 For details on the liquidity operations used by the Reserve Bank to manage the supply of ES balances, see Baker and Jacobs (2010).

3 A cross-country comparison of monetary policy regimes in interbank overnight markets is given in Bech and Monnet (2013).

Graph 1
Interbank Overnight Cash Rate



Source: RBA

Reserve Bank to use RITS transaction data to directly observe individual cash market transactions and calculate the cash rate. This article uses the new RITS cash market transaction data, along with longer-run transaction-level estimates dating back to 2005 from the research of Brassil, Hughson and McManus (2016), to explore the evolving characteristics of the cash market, including the effects of recent regulatory and payment system reforms. Box A details the Reserve Bank's new methodology for calculating the cash rate.

Cash Market Arrangements

More than 50 banks currently hold ESAs at the Reserve Bank, including Australian banks and domestic branches of foreign banks. Not all ESA holders are regular participants in the cash market. Between 25 and 30 of these banks transact in the cash market on a typical day.

The Reserve Bank operates standing facilities to assist banks in managing their ESAs. While these accounts are not permitted to be in overdraft at any time, banks are able to borrow intraday from the Reserve Bank using repurchase agreements (repos), which do not incur an interest charge.[4] In addition, some banks are also required to hold higher overnight balances in their ESAs to cover potential payment obligations that arise after the close of the cash market.[5] These banks borrow a pre-determined amount of ES balances under 'open' RBA repos, which are contracted at the cash rate target and have no fixed maturity date.[6]

Towards the end of each day, banks may borrow in the cash market to obtain the funds necessary to cover the day's outgoing payment obligations and unwind any intraday repos contracted with the Reserve Bank. Banks with open RBA repo positions are also required by the end of the day to hold an amount of ES balances (adjusted for some after-hours payments) at least equal to their contracted open repo position. In the event that these requirements are not met, banks are effectively deemed to have borrowed these funds overnight from the Reserve Bank at an interest rate that is 25 basis points above the cash rate target.[7] This occurs very infrequently. Conversely, banks with 'surplus' ES balances (in excess of their open repo positions) at the end of the day are paid an overnight interest rate on these surplus balances equal to 25 basis points below the target cash rate.[8] These remuneration arrangements on

4 A repo is economically, but not legally, equivalent to a secured loan. Counterparties provide eligible securities in exchange for cash on the agreement that these securities will later be 'repurchased' at an agreed price. The implied interest rate is the repo rate. Repos are the primary instrument used in Reserve Bank open market operations.

5 These arrangements have been in place since the introduction of same day settlement of direct entry payments in November 2013. Direct entry is a means of making electronic payments, such as 'pay anyone' transactions using internet banking. Since 25 November 2013, these payments settle as part of multilaterally netted batches at 10.45 am, 1.45 pm, 4.45 pm, 7.15 pm and 9.15 pm each day. Before this, settlement occurred in one batch at 9.00 am the morning following the payment date. For more information, see Fraser and Gatty (2014).

6 The size of these required balances takes into account each bank's historical after-hours payment patterns. The open RBA repos used to fund the ESAs involve no net cost for banks, as the interest rate charged on open repo is equal to the rate that the Reserve Bank remunerates banks on ES balances up to the amount of their open repo position; both rates are equal to the cash rate target. For more information, see Debelle (2013).

7 In the case of open RBA repo shortfalls, the Reserve Bank pays overnight interest on these shortfall balances at a rate 25 basis points below the cash rate target. This imposes a cost equivalent to borrowing at 25 basis points above the cash rate target.

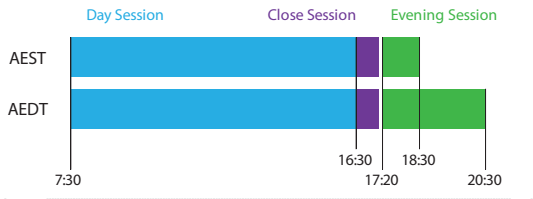
8 Before the introduction of same-day direct entry settlement and open RBA repo in 2013, all ES balances held overnight were effectively 'surplus' ES balances. The introduction of open repo did not affect the amount of funds available in the cash market, as banks are now required to hold ES balances equal to their open RBA repo position in order to avoid borrowing overnight from the Reserve Bank.

surplus ES balances are set by the Reserve Bank to provide an incentive for banks to transact in the cash market within a 50 basis point 'corridor' centred on the cash rate target.

While most bank customers can initiate transactions electronically on a 24/7 basis, the settlement of interbank obligations arising from these transactions is carefully managed. The cash market operates each day that RITS is open for interbank settlement, from 7.30 am (when RITS opens) until 6.30 pm Australian Eastern Standard Time (AEST) or 8.30 pm Australian Eastern Daylight Time (AEDT; Figure 1). The closing time of the cash market is determined by Continuous Linked Settlement (CLS) foreign exchange-related payment flows, which occur in the European morning. There are a few weeks of each year where the cash market closes at 7.30 pm.[9]

Within the trading day there is a 'Day Session' until 4.30 pm, during which most interbank loans from the previous day are repaid. In the 'Close Session' (4.30 pm to 5.15 pm) banks' existing customer transactions can be settled but new customer transactions cannot be initiated in RITS. As a result, banks can use this period to trade in the cash market with greater certainty over their end-of-day positions. A large share of daily cash market turnover occurs during the Close Session. There is also an 'Evening Session', which commences after 5.20 pm when around 20 'Evening Agreed' banks contract and settle any interbank transactions that may be required. Australian CLS members are required to participate in the Evening Session. All banks have the option of being an 'Evening Agreed' bank.

Figure 1: Cash Market Session Times



Source: RBA

9 This is due to mismatches in the timing of the changeover to or from daylight savings time in Australia and Europe (RBA 2015).

Trends in Cash Market Activity

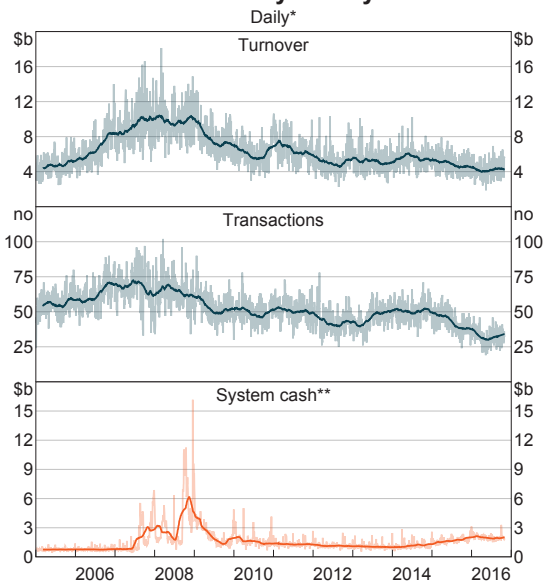
This section describes some trends in the cash market. Prior to May 2016, the data are based on cash market transactions in RITS that were identified based on an algorithm developed by Brassil *et al* (2016). The algorithm matches loans and repayments between the same counterparties, where the second transaction goes in the reverse direction to the first and is equal to the loan principal plus a plausible amount of interest. The algorithm is also able to identify loans in which a lender and borrower agree to extend a loan by one business day (a 'rolled' loan). From May 2016, the data are based on the cash market transactions observed by the Reserve Bank.

Aggregate trends

Cash market turnover currently averages around $4 billion each day, with an average of around 30 transactions (Graph 2, top and middle panels). During the global financial crisis, average daily turnover was around $10 billion; however, this has since more than halved and is now around levels observed prior to the crisis. The average number of daily transactions has also declined over this period, and is now lower than during the pre-crisis period. Although the median transaction size has increased since 2005 (from $50 to $70 million), the distribution in transaction sizes has been little changed over time. The majority of interbank cash loans have consistently been for amounts of less than $100 million, with loan sizes more frequently clustered in multiples of $50 million (Graph 3).

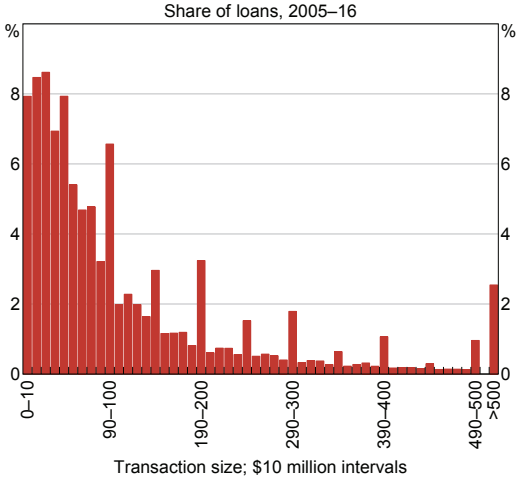
The positive correlation between cash market activity and the level of surplus ES balances (also known as 'system cash') has changed more recently. During the financial crisis, system cash increased significantly alongside rising cash market turnover (Graph 2, bottom panel). System cash returned to more normal levels in the years following the crisis, but began rising in 2014, initially associated with a small increase in cash market turnover. Since 2015, this correlation has reversed, with turnover

Graph 2
Cash Market Activity and System Cash



* Smoothed lines are 90-day centred moving averages
** Aggregate surplus ES balances as at the close of business
Source: RBA

Graph 3
Cash Market Transaction Sizes



Source: RBA

declining alongside a rise in system cash. This mainly relates to the introduction of the liquidity coverage ratio (LCR) in January 2015, which requires banks to hold enough high-quality liquid assets (HQLA) to cover projected net cash outflows in a stressful situation over a 30-day period. In order to meet the requirements of the LCR, a few banks have preferred to hold ES balances as HQLA, making them less willing to lend these funds in the cash market. In some cases, the LCR treatment of the repayment leg of cash market loans can also increase net cash outflows, reducing the LCR and making unsecured lending less attractive compared to secured lending.[10] To accommodate this shift in preferences, the Reserve Bank has used open market operations to increase system cash.

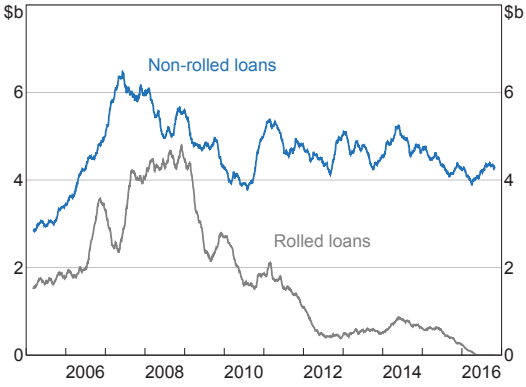
There has also been a significant reduction in loans that are rolled forward over the past few years (Graph 4; Brassil *et al* 2016). These increased during the crisis from 2007 to 2009, coinciding with the increase in the aggregate supply of system cash made available by the Reserve Bank to meet banks' demand for liquid, risk-free assets. Borrowers were likely to have found it to be convenient to roll existing loans to keep their ES balances at a certain target level until uncertainty diminished. The increase in ES balances during this period also meant that there was less chance that the rolled funds would be required to meet payment obligations. The decline in rolled lending since the financial crisis is likely to reflect less precautionary borrowing in the cash market, as well as a more cautious approach by lenders toward counterparty exposure.[11] Rolled loans have now fallen to zero, as counterparties are now required to repay all first-leg loans in full the following business day, to be consistent with the new cash rate methodology that was introduced in May 2016.

More conservative management of bank balance sheets since the financial crisis has also led to a reduction in 'wash' trades, which occur when one

10 A 75 per cent cap on cash inflows relative to cash outflows is applied as part of the calculation of the LCR. If this cap is binding, it means that a bank lending in the cash market could not count the repayment of the overnight loan as an offsetting cash inflow. Secured borrowing and lending does not affect a bank's LCR, as ES balances are exchanged for securities that are equivalent HQLA.

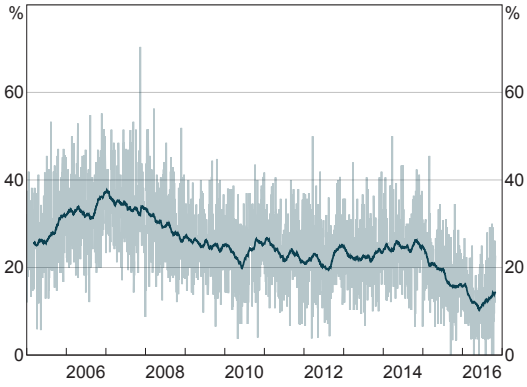
11 Non-rolled loans require borrowers to repay the loan before borrowing again. Rolling loans does not require the borrowing entity to demonstrate that it would have been able to repay the loan if it had not been rolled (Brassil *et al* 2016).

Graph 4
Cash Market Transactions
Daily; 90-day centred moving average



Source: RBA

Graph 5
Banks Lending and Borrowing Cash
Daily; share of institutions that both lent and borrowed*

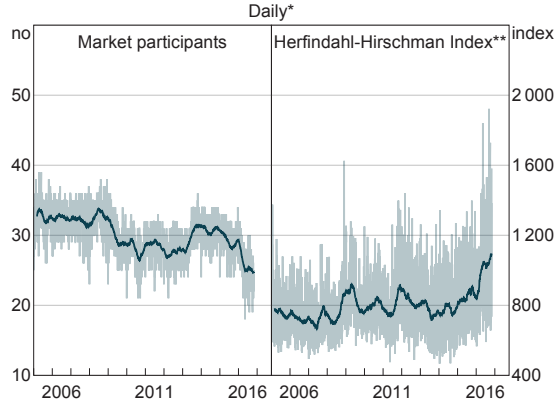


* Smoothed line is a 90-day centred moving average
Source: RBA

bank intermediates a transaction between two other banks that are unable to trade directly (for example, because the ultimate borrower had exhausted its unsecured credit limit with the initial lender).[12] While difficult to identify precisely, a proxy measure for wash trades is the number of institutions that are both borrowers and lenders on a given day, which has declined since 2015 (Graph 5).[13]

In line with the decline in turnover, the number of ESA holders that participate in the cash market has declined since the crisis. This trend is similar to what has occurred more broadly in the banking system, influenced by mergers and acquisitions as well as the withdrawal of some foreign banks from the Australian market. The downward trend in average turnover, transaction numbers and participation since 2005 suggest that the cash market has become increasingly concentrated (Graph 6). The Herfindahl-Hirschman Index (HHI) is a commonly used measure of market concentration; it is an index that measures the size of firms in relation to the market. The HHI for gross transaction volumes has been broadly steady over most of the period, although it has risen more recently. An HHI of around 1 000 or below indicates a low level of market concentration.[14]

Graph 6
Cash Market Concentration
Daily*



* Smoothed line is a 90-day centred moving average
** Calculated using participant shares of gross transaction volumes
Source: RBA

12 Lower overall credit limits have reduced banks' willingness to participate in wash trades. Participating in a wash trade also increases net cash outflows of the intermediating bank without an associated net increase in HQLA, which would decrease its LCR (other things being equal).

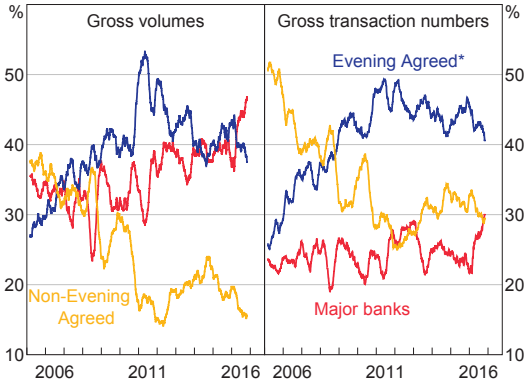
13 There are other reasons why a bank may be both a borrower and a lender on the same day (for example, it may borrow to fund payments that do not eventuate and then lend out its excess balances). However, most banks wait until they are reasonably certain of their liquidity position (and whether they will be a borrower or lender) before transacting in the cash market. This means that a reasonable proportion of instances where an institution is a borrower and a lender is likely to reflect wash trades.

14 The HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. A higher score indicates that a market is more concentrated. The US Department of Justice generally considers markets in which the HHI is between 1 500 and 2 500 points to be moderately concentrated, with a score over 2 500 reflecting high concentration. For more information, see US DoJ (2010).

Market composition and timing

The share of gross turnover accounted for by the four largest Australian (major) banks has increased in recent years, with these banks currently accounting for over 40 per cent of turnover in the market (Graph 7). Other Evening Agreed banks also account for around 40 per cent of turnover, while non-Evening Agreed banks now account for a small share of gross turnover in the market. Despite their large share of overall turnover, the major banks only account for around one-quarter of the number of transactions in the market, as these banks typically transact in volumes of a larger size.

Graph 7
Cash Market Shares
Daily; borrowing plus lending; 90-day centred moving average

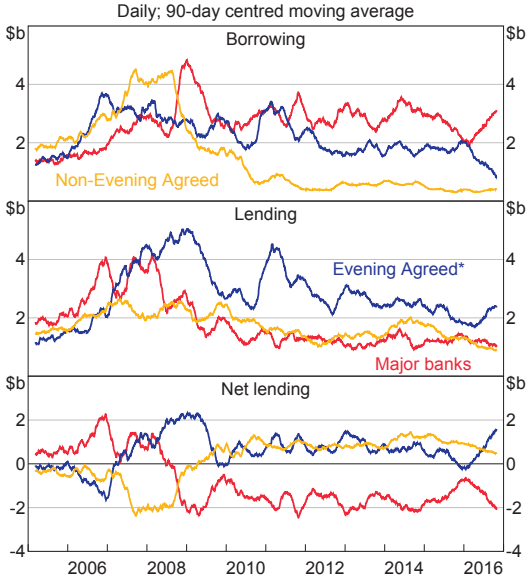


* Excluding the major banks
Source: RBA

While an individual bank can be either a lender or borrower on any given day, some banks are more likely to be lenders or borrowers on average. Prior to the financial crisis, the major banks lent more funds in the cash market than they borrowed, on average (Graph 8). However, since the financial crisis, these banks have reduced their lending in the cash market significantly and are now net borrowers of cash. The reverse trend has occurred for non-Evening Agreed banks, with the substantial increase in borrowing observed during the crisis by these banks having unwound.

In more recent times, there has been a slight reduction in lending by non-Evening Agreed

Graph 8
Cash Market Turnover
Daily; 90-day centred moving average



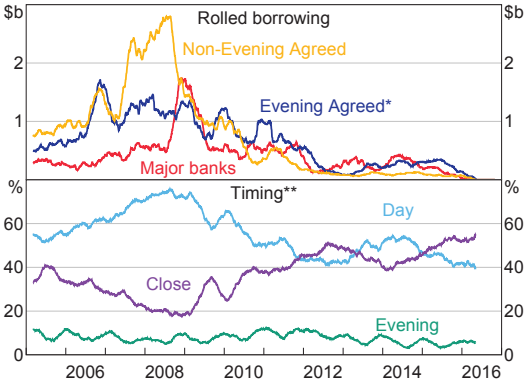
* Excluding the major banks
Source: RBA

institutions. This may be related to some of these banks holding ES balances as HQLA (discussed earlier), and therefore being less willing to lend these balances in the cash market.

The reduction in activity by non-Evening Agreed banks since the financial crisis appears to be related to the exit of some foreign banks from the Australian market. These banks had represented a sizeable share of market activity prior to and during the financial crisis, and were the main institutions that utilised rolled borrowing during this period (Graph 9, top panel). The decline in rolled borrowing also coincided with a fall in the share of cash market transactions contracted (or agreed) earlier in the trading day (Graph 9, bottom panel).[15] Rolled loans were typically contracted earlier in the day, around the same time as loan repayments, as the decision to roll a loan would need to be agreed in advance of repayment (Brassil *et al* 2016). In addition, non-Evening Agreed banks usually have greater certainty about their

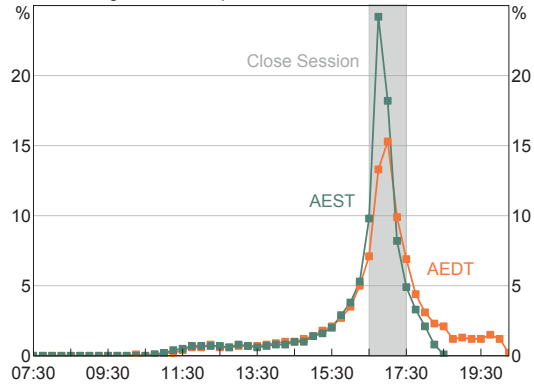
15 Data showing when all loans (rolled and non-rolled) were *contracted* were obtained from the (now superseded) Interbank Overnight Cash Rate Survey. In contrast, RITS transaction data only indicates when non-rolled loans *settled*.

Graph 9
Cash Market Activity
Daily; 90-day centred moving average



* Excluding the major banks
** Percentage of loans that were contracted in each session; data are from the now superseded Interbank Overnight Cash Market survey
Source: RBA

Graph 10
Cash Market Settlement Times*
Average loan share per 15-minute intervals, 2005–16



* First leg, non-rolled transactions
Source: RBA

end-of-day positions at an earlier stage, and are therefore more willing to undertake cash market transactions in the Day session.

While the cash market transaction data from RITS do not contain information on when loans were contracted, they show that non-rolled loans typically *settle* relatively late in the day (Graph 10). As noted earlier, this reflects the reluctance of most banks to lend cash until they are relatively certain of their daily liquidity requirements, and to avoid the need to borrow large amounts in the cash market late in the day to meet late unforeseen payments. Liquidity managers may also be concerned that very large net outflows are logistically more difficult to fund in the overnight unsecured market and that any failure to raise sufficient funds could require the use of the Reserve Bank's overnight repo facility (incurring a rate of 25 basis points above the cash rate target).[16]

The New Payments Platform (NPP) is scheduled to be implemented in late 2017. This will include a Fast Settlement Service (FSS), which will facilitate settlement of each individual payment in the NPP on a 24/7 basis. The impact of the FSS on activity in the cash market is uncertain, as it will depend on the volume of payments that migrate to the new system. Payments made in the Evening Session through the FSS will be treated in the same way as other payments settled when the cash market is closed, which means that they will be offset against open RBA repo positions and will not need to be funded in the cash market.

16 Although the financial cost associated with surplus or shortfall ES balances at the end of the day is symmetric (plus or minus 25 basis points to the cash rate target), banks have demonstrated a preference for accepting the costs associated with surplus balances rather than those associated with shortfalls.

Conclusion

The cash market facilitates the settlement of interbank obligations across the payments system, and transmits the monetary policy decisions of the Reserve Bank to the wider economy. Over the past decade or so there have been a number of developments affecting this market. These include a fall in turnover, the introduction of open repo arrangements, a reduction in rolled loans and wash trades, and changes in market participation. The cash rate has remained consistently at or near its target level throughout this period. From May 2016, new transaction reporting requirements for the cash market within RITS have allowed the Reserve Bank to observe cash market activity directly, and use the transaction data as inputs in order to calculate the cash rate. The Reserve Bank continues to monitor conditions in the cash market closely.

Box A
Calculation of the Interbank Overnight Cash Rate

In May 2016, the Reserve Bank implemented a new methodology to calculate the cash rate. The new process involves the Reserve Bank accessing a considerably more detailed dataset, which includes the individual amounts and interest rates at which ESA holders transact in the cash market. Calculating the cash rate from individual transaction data aligns the benchmark closely with international best practice standards for financial benchmarks. These standards are set out in the International Organization of Securities Commissions' *Principles for Financial Benchmarks*, which comprise four elements: governance; quality of the benchmark; quality of the methodology; and accountability (IOSCO 2013).

The cash rate is derived from transaction data sourced from RITS, which now captures all relevant transactions in the market. These data, which include the individual amounts and interest rates at which banks transact in the cash market, allow the Reserve Bank to calculate the cash rate as the volume-weighted average interest rate at which cash market transactions are settled in RITS. The Reserve Bank uses cash market transactions between banks that settle any payments across their own ESAs.

Before May 2016, the Reserve Bank conducted a daily survey of the amount and weighted-average interest rate at which banks transacted in the cash market. All banks that settled payments across their own ESA participated in the survey, with the published cash rate equal to the average interest rate reported by surveyed banks, weighted by value. A shortcoming of this methodology was that there were discrepancies between aggregate borrowing and lending, due to reporting errors by institutions. While this did not affect the published cash rate, since it happened to have been reported to have traded at the cash rate target each day, it meant that the published volume of cash market activity was the average of the total funds borrowed and lent in the market. The new methodology for calculating the cash rate has also reduced the reporting burden of banks, since they no longer need to make daily survey submissions.

The introduction of the new methodology required some minor adjustments to the way some banks participated in the cash market. One important change was that rolled cash market loans were no longer permitted under the Australian Financial Markets Association *Cash Conventions*. All cash market transactions now require the full exchange of principal. In addition, all cash market transactions must now be settled as cash transfers in RITS (AFMA 2016); previously, a small percentage of loans were settled as cash transfers in the Austraclear system.

The Reserve Bank has also started publishing a Cash Rate Total Return Index (TRI), which members of the public can use as a benchmark with a (near) risk-free rate of return. The TRI measures the performance of an investment earning the cash rate, where interest is reinvested:

$$TRI_t = TRI_{t-d} \times \left(1 + \frac{CashRate_{t-d} \times d}{365 \times 100}\right)$$

TRI = Cash Rate Total Return Index
t = a business day (a day that the cash market is open)
d = the number of days since the previous business day

The formula indicates that interest earnings are only paid and reinvested on business days. On non-business days, interest accrues at the cash rate of the preceding business day, but is not paid and reinvested until the next business day.

Further information on the calculation of the cash rate can be found in the Reserve Bank's *Cash Rate Procedures Manual* (RBA 2016).

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The Future of Cash

Cassie Davies, Mary-Alice Doyle, Chay Fisher and Samual Nightingale*

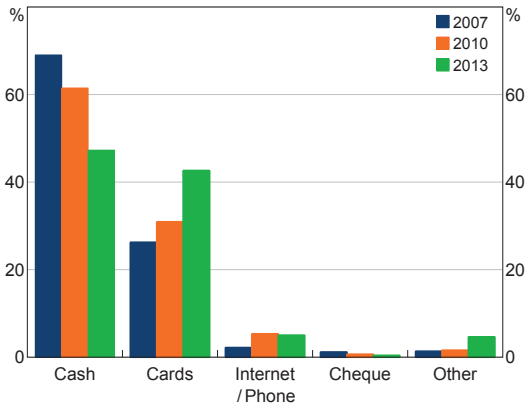
Australian consumers have increasingly been using electronic payment methods in preference to cash for their transactions. The overall demand for cash in Australia, however, remains strong. There is ongoing demand for cash for non-transaction purposes, particularly as a store of wealth. While the role of cash in society is evolving, it is likely to remain an important feature of the payments system and economy for the foreseeable future. Moreover, the current mix of banknote denominations continues to meet community demand for a secure means of payment and store of wealth. Given the ongoing importance of cash, the Reserve Bank will maintain the public's confidence in Australia's banknotes by continuing to ensure that banknotes are of high quality and secure from counterfeiting.

Introduction

Cash continues to play an important role in the Australian economy. Survey data indicate that cash accounted for 47 per cent of consumer payments (by number) in 2013 – still the most frequently used form of payment. This is nevertheless a decline from 2007 when cash accounted for 69 per cent of consumer payments (Graph 1).[1] A shift away from cash – and other paper-based payment methods – towards cards and other electronic means of payment has also occurred in many other advanced economies.[2] Even though the use of cash for transactions has been declining, the overall demand for cash more broadly remains strong, with the ratio of currency (which includes both banknotes and coins) to GDP rising over recent years in Australia and abroad.

The Reserve Bank produces and issues Australia's banknotes to meet public demand, while the distribution of banknotes to commercial banks, other deposit-taking institutions and retailers is undertaken by the private sector.[3] The Reserve Bank also ensures the quality of Australian banknotes by withdrawing old, worn banknotes from circulation and replacing them with new ones. The Reserve Bank conducts research and development to help Australian banknotes remain secure against counterfeiting and has recently issued a new $5 banknote as part of a multi-year upgrade

Graph 1
Use of Payment Methods
Share of number of payments



Sources: Colmar Brunton; RBA; Roy Morgan Research

* Samual Nightingale and Cassie Davies are from Note Issue Department; Chay Fisher and Mary-Alice Doyle are from Payments Policy Department. The authors thank Gordon Flannigan for assistance.

1 The Reserve Bank has conducted a survey of consumer payments every three years since 2007 and is in the process of undertaking the 2016 survey. See Emery, West and Massey (2008); Bagnall, Chong and Smith (2011); and Ossolinski, Lam and Emery (2014).

2 See also Richards (2016) for a detailed discussion of the cheque system.

3 For further information on banknote distribution arrangements, see Cowling and Howlett (2012).

program to introduce a range of new banknote security features.[4]

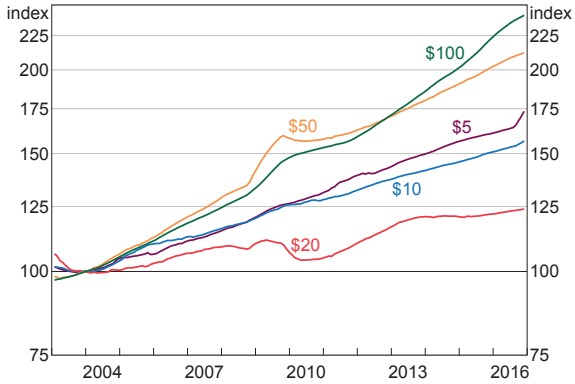
This article discusses the roles and use of cash in the Australian economy in the context of recent trends in the payments mix and the international debate about the future of banknotes. It discusses sources of demand for cash and some policy issues that might arise if the role of cash in the economy declines.

Trends in Cash Demand

There are currently around 1.5 billion Australian banknotes in circulation, worth $73 billion (Table 1). The higher-denomination banknotes – $50 and $100 banknotes – account for around two-thirds of the number of banknotes in circulation, with demand for these two denominations growing at a faster rate than that of the lower denominations in recent years (Graph 2).[5]

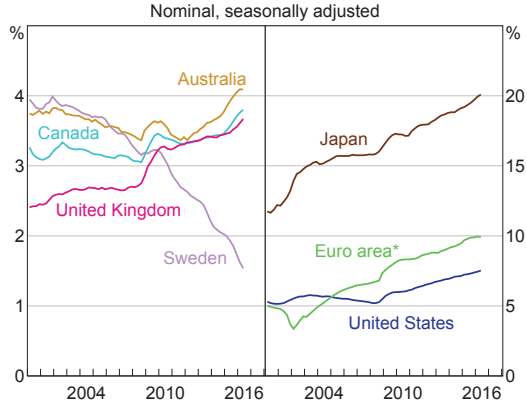
The overall demand for cash – as approximated by the total value of banknotes in circulation – increased by 6 per cent over the year to November 2016, which is around its trend pace of the past few years. The value of currency in circulation has increased at a faster rate than nominal GDP in recent years and the currency-to-GDP ratio has risen to its highest level in several decades. Similar trends in currency demand have been evident in many other advanced economies (Graph 3). In the United States, for example, the value of currency in circulation is at its highest level, relative to GDP, since the 1950s.

Graph 2
Number of Banknotes in Circulation
Rolling 12-month average, Dec 2003 = 100, log scale



Source: RBA

Graph 3
Currency to GDP
Nominal, seasonally adjusted



* Equivalent currencies prior to the 2002 introduction of euro banknotes and coins

Sources: Central banks; OECD; RBA; Statistics Sweden

Table 1: Banknotes in Circulation[(a)]
As at 30 November 2016

	$5	$10	$20	$50	$100	Total
Value ($b)	1.0	1.3	3.3	33.5	33.9	73.0
Share (per cent)	*1*	*2*	*5*	*46*	*46*	
Volume (M)	205	128	165	670	339	1 507
Share (per cent)	*14*	*9*	*11*	*44*	*22*	

(a) Includes banknotes held by banks, excludes RBA stocks
Source: RBA

4 See Fox, Liu and Martz (2016) for further detail on the development and issuance of the new banknote series.

5 Banknotes account for most of the value of currency in circulation, with coins making up around 5 per cent of the total.

A notable exception to this trend is Sweden, where the stock of currency has declined and the ratio of currency to GDP has fallen from around 4 per cent in the early 2000s to a little over 1½ per cent in 2016. This appears to reflect a decline in both transactional and store-of-value demand for cash in Sweden (Segendorf and Wretman 2015). Australia's currency-to-GDP ratio is currently broadly similar to that in the United Kingdom and Canada, but noticeably lower than the equivalent ratios in the economies of the major global reserve currencies, namely the United States, the euro area and Japan.

Demand for cash in the economy stems from its roles as a means of payment and a store of value. As a means of payment, cash has a number of attributes that may be valued by end users. It has near-universal acceptance, facilitates simultaneous exchange and instantaneous settlement, is convenient for person-to-person payments and can still be used at times when electronic payment methods are unavailable due to internet or electricity outages. Cash transactions are also anonymous and, with low rates of counterfeiting in Australia, fraud may be less of a concern than when using alternative payments. There are, however, a number of less desirable attributes of cash. It can be inconvenient for large transactions, both because it is somewhat bulky to carry and because of the security risk associated with large amounts of cash, and cannot be used for online transactions.

Cash can also be used as a store of value and, for this purpose, its attributes come to the fore in times of economic/financial uncertainty. In particular, in circumstances in which the viability of banks is under question – as was the case in many countries during the 2008–09 financial crisis – cash may be considered a superior store of value to money held in the form of bank deposits. That is, claims on the central bank are preferred to claims on a commercial bank. However, the strengthening of depositor protection arrangements in Australia, as well as storage and security challenges associated with large cash holdings, may offset any such considerations. The value of cash holdings will also be eroded over time by inflation, although this effect is considerably lower in the current low inflation/low interest rate environment.

Transactional Demand for Cash

The most recent detailed data on the use of cash for consumer payments in Australia are from the Reserve Bank's 2013 Survey of Consumers' Use of Payment Methods (Consumer Use Survey).[6] In the 2013 survey, cash was still the most frequently used payment method for consumer transactions, although its use had been declining relative to other payment methods, particularly electronic ones, for a number of years (Graph 1).[7] Cash is used more often for smaller transactions, with participants in the 2013 survey using cash to make 69 per cent of payments (by number) worth $20 or less. But even for low-value transactions, consumers are shifting to electronic alternatives, most notably contactless cards (Ossolinski, Lam and Emery 2014). By value, cash accounted for 18 per cent of transactions in 2013, compared with 38 per cent in 2007. Since 2013, there has been a sustained decline in ATM and point-of-sale debit card cash withdrawals, which is consistent with a reduction in cash use in transactions (Graph 4).

Australian consumers are not alone in shifting away from cash for transaction purposes, although there are some notable differences in cash use across countries. Several advanced countries conduct studies of payment patterns similar to the Reserve Bank's Consumer Use Survey. Although the survey results are not fully comparable, some broad observations can be made:

- Consumers are shifting away from cash transactions globally, with relative cash use for transaction purposes having fallen in all countries for which data are readily available (Table 2).

6 Note that while the majority of cash transactions are made by consumers, cash is also used in some business-to-business payments. The available data do not provide information on these types of payments.

7 For previous analyses of the use of cash based on the Reserve Bank's consumer use surveys, see Bagnall and Flood (2011) and Meredith, Kenney and Hatzvi (2014).

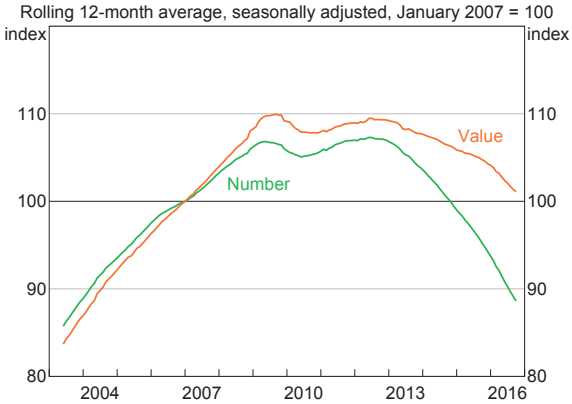
Table 2: Cash Use across Countries[(a)]

Country	Most recent estimate			Previous estimate		
	Share of transactions (per cent)		Year	Share of transactions (per cent)		Year
	By number	By value		By number	By value	
Australia	47	18	2013	62	29	2010
Austria	83	68	2011	86	70	2005
Canada	44	23	2013	54	23	2009
France	58		2011	64		2005
Germany	79	53	2014	82	53	2011
Netherlands	50	30	2015	65	38	2010
Sweden	15		2016	39		2010
UK	45		2015	64		2005
US	32	9	2015	40	14	2012

(a) Estimates are not fully comparable across countries due to different collection methods and inclusions – the US and UK estimates, for example, include recurring bill payments, which are not included in all countries' estimates; most countries' estimates are based on survey respondents' payment diaries kept over 1–8 days; estimates for Sweden and the UK use other methods

Sources: National sources; RBA

Graph 4
Cash Withdrawals*



* ATM withdrawals and debit card cash-out at point of sale

Source: RBA

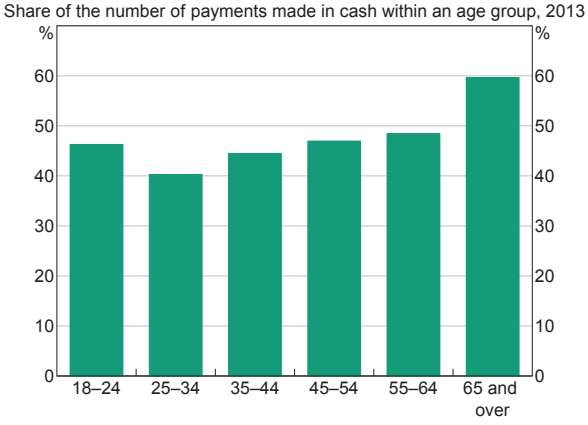
- Cash remains the dominant means of payment in some European economies; for example, around 80 per cent of consumer transactions in Germany and Austria are conducted in cash.
- Australian consumers use cash in a roughly similar share of transactions (around half) as Canadian, Dutch and UK consumers, according to each country's most recent survey.
- Swedish consumers use cash relatively infrequently as a means of payment (in less than one-fifth of transactions).
- Because it is most often used for low-value transactions, cash makes up a much smaller share of the payment mix in most countries when measured by value.

Research indicates that cash use in Australia, and elsewhere, is associated with particular types of transactions and consumer characteristics. For example, cash is used more frequently for lower-value transactions, cash use tends to decrease with higher levels of education and income and cash tends to be used more frequently by older generations (Graph 5).[8] However, consumer preferences also seem to play an important role. In Germany, for example, there is a clear preference for cash that cannot be explained by other factors (Schmidt 2016).

Despite greater use of electronic payment methods, survey evidence suggests that consumers continue to use cash at the point of sale for a number of reasons. These include non-acceptance of cards for small transactions, a desire to avoid card

8 Bagnall, Bounie, Huynh, Kosse, Schmidt, Schuh and Stix (2014) suggest that cross-country differences in cash use may also be associated with variation in factors such as merchant acceptance, market structure and pricing policies for retail payments. See also Meredith *et al* (2014), who found that education was not an important factor in determining cash use in Australia after controlling for other factors.

Graph 5
Cash Payments by Age in Australia
Share of the number of payments made in cash within an age group, 2013



Sources: Colmar Brunton; RBA

surcharges at some merchants, the speed or ease of completing a transaction (although this may be changing with the growth of contactless cards) and a preference for using one's own funds to help with budget management (Meredith *et al* 2014).

It is likely that the share of total consumer payments conducted with cash will continue to decline – though not necessarily for all consumers – as the range of alternatives to cash expands and electronic payment methods are increasingly adopted, including for low-value transactions. The rapid uptake of contactless card payments, for example, indicates that many consumers have been willing to substitute away from cash for low-value payments when an electronic alternative could match cash for speed at the checkout. Mobile phone payments offer another potentially convenient alternative to cash at the point of sale and it would not be surprising to see strong growth in this method of payment, although the substitution here may partly be away from physical cards rather than cash. The New Payments Platform (NPP), which is due to be launched in late 2017, will provide an electronic alternative to cash in some circumstances where there are currently few convenient non-cash options.[9] Whereas substitutes for cash already exist for most types of consumer transactions, the NPP will offer a genuine alternative to cash in other situations, such as person-to-person transfers and payments to small businesses.[10] Broader social and demographic trends may also influence the future payments mix, as generations with a higher propensity to use electronic payment methods account for a larger share of the population.

A related issue that has been widely debated in recent years is the potential for digital currencies to displace cash. As noted by Richards (2016), however, it seems improbable that privately established virtual currencies will displace the use of national currencies within individual economies. While a number of central banks have announced that they are exploring issues pertaining to state-issued digital currency, most commentary indicates that this issue will be approached cautiously and that there are no plans to phase out cash.[11]

Overall, cash is expected to remain an important part of the payment system for the foreseeable future. Some people may still have few alternatives to cash that are readily available or accepted by merchants. And some members of the community are likely to continue to prefer to use cash for reasons that may not necessarily be influenced by the availability of alternatives.

Other Sources of Cash Demand

Trends in cash demand across a range of countries cannot be easily reconciled with changes in consumer payment preferences. The implication is that there is ongoing demand for cash for purposes other than domestic consumer transactions, including as a store of value in the domestic economy. Foreign demand and the use of cash for unlawful purposes – both of which may derive from transactional or store of value motives – are other potential sources of cash

9 The NPP will allow individuals and businesses to make account-to-account funds transfers in real time, at any time of the day or night, seven days a week.

10 In Sweden, for instance, use of the real-time mobile payments app Swish has grown rapidly since the launch of real-time payments in 2012. By 2016, just over half of the respondents to a Riksbank survey had used Swish in the past month, compared with 10 per cent in 2014. Overall it was used for around 2 per cent of transactions.

11 See, for example, Broadbent (2016) and Skingsley (2016).

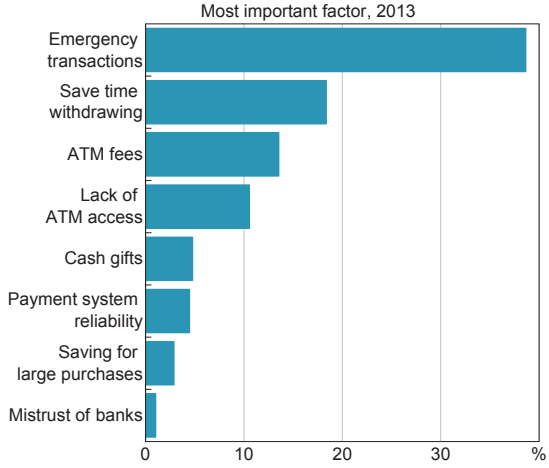
demand. As holdings and use of cash are anonymous, however, it is not possible to accurately measure these various sources of demand.

Domestic store of value

Even though the share of cash transactions is declining, cash is still held as a store of wealth, including for precautionary purposes. In Australia, around three-quarters of respondents to the 2013 Consumer Use Survey reported that they held cash in places other than in their 'wallets', with the most important reason – other than for day-to-day transactions – being to fund emergency transactions. Other reasons related to the costs of accessing cash, including the time and cost of making withdrawals and access to ATMs (Graph 6). It is difficult to predict how demand for cash as a store of value may evolve in the future, partly because 'hoarding' behaviour is probably influenced by personal preference, particularly for those holding large sums of cash. It is, however, possible that future technological advances could play a role. For example, at some point in the future, digital currencies might provide a viable alternative to cash holdings for some people, including those who value privacy and anonymity.

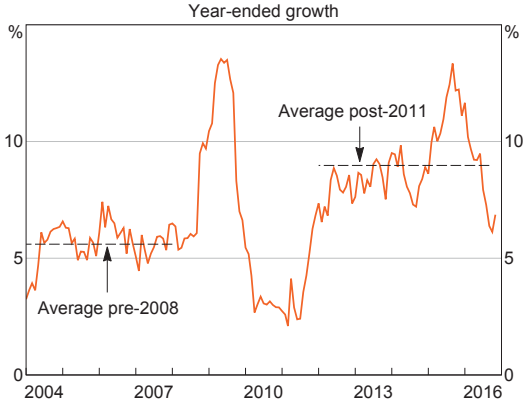
Macroeconomic factors are likely to have also contributed to recent strong demand for cash as a store of value, with low global and domestic interest rates reducing the opportunity cost of holding cash over other assets.[12] Although interest rates around the world are expected to remain low for some time, any significant rise in rates will increase the opportunity cost of holding cash and demand for cash may gradually diminish over time. There is also evidence that the global financial crisis contributed to demand for cash for precautionary purposes, with year-ended growth in the number of $100 Australian banknotes in circulation – the denomination most often used as a store of value – rising sharply in 2008 (Graph 7). Similar spikes in demand for high-denomination banknotes were observed in other countries during the crisis.

Graph 6
Why Hold Cash?
Most important factor, 2013



Sources: Colmar Brunton; RBA

Graph 7
$100 Banknotes in Circulation
Year-ended growth



Source: RBA

Foreign demand

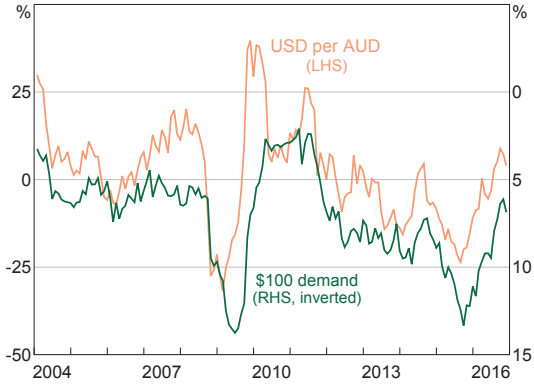
Foreign citizens may wish to hold cash issued in another economy, either for transactional purposes or as a store of value. For some countries, offshore demand is likely to be an important contributor to the overall demand for their currency. The Federal Reserve estimates that one-half to two-thirds of US currency in circulation is held abroad (Federal

12 Cusbert and Rohling (2013) find evidence that non-bank demand for currency holdings in Australia is negatively correlated with changes in deposit rates. In Japan, an increase in non-transactional demand for cash may be partly attributable to persistent low interest rates (Otani and Suzuki 2008).

Reserve 2016). Similarly, the Bank of England estimates that 'no more than half' of the stock of sterling banknotes in circulation is legitimately held within the United Kingdom (Fish and Whymark 2015) and the European Central Bank (ECB) has suggested that at least 18 per cent of euros on issue were held outside of the euro area in 2014 (ECB 2015).

While there are no reliable data available on foreign holdings of Australian banknotes, there is evidence to suggest that offshore demand has increased in recent years, with movements in the exchange rate influencing short-term foreign demand for Australian banknotes. The sharp depreciation of the Australian dollar during the global financial crisis, for example, coincided with a spike in demand for Australian $100 banknotes (Graph 8). Further, liaison with major cash industry participants indicates that increases in overseas demand are a fairly usual occurrence when the Australian dollar depreciates. Part of this demand is likely to stem from the increased attractiveness of Australia as a destination for tourism and education, with both of these groups of visitors tending to be large users of cash.

Graph 8
$100 Demand and Exchange Rate
Year-ended percentage change



Sources: RBA; Thomson Reuters

Shadow economy and high-denomination banknotes

A potential source of currency demand that has attracted international attention recently is the use of cash, particularly high-denomination banknotes, to avoid reporting income to the authorities, or to finance illicit activities. Cash may be valued by those engaged in such activities because it is anonymous and untraceable. By definition, however, this also means that it is not possible to assess the demand for cash for these purposes accurately.[13] Some commentators have nonetheless argued that strong demand for cash globally reflects, to a significant extent, the use of cash for unlawful purposes.[14]

Internationally, there have been some moves to change the mix of banknote denominations, aimed at making it more difficult to use cash for nefarious purposes. Most prominently, the ECB announced in May 2016 that it would end production and issuance of its EUR 500 (AUD 711) banknote around the end of 2018. The ECB will, however, continue to issue EUR 200 banknotes (AUD 285).[15] Another example is the recent announcement by the Indian Government that the existing 500 rupee (AUD 10) and 1 000 rupee (AUD 20) banknotes would cease to be legal tender, to address problems with counterfeiting and 'black money' (income earnt illegally or not declared for tax purposes). The Indian Government is, however, issuing a new series of 500 rupee banknotes, and is introducing a 2 000 rupee (AUD 39) banknote.

In an international context, Australia's banknotes are not available in unusually large denominations. The value of the AUD 100 banknote, our highest denomination, is similar to national equivalents in a range of advanced economies (Table 3).[16]

Contrary to some claims, high-denomination Australian banknotes are used in a non-negligible proportion of legitimate transactions. For example,

13 The Australian Bureau of Statistics (ABS) estimated that in Australia the underground economy (that is, activity that may be legal, but is concealed from public authorities) accounted for around 1½ per cent of total GDP in 2010/11, which is significantly smaller than the estimates from cross-country studies that are sometimes referred to in this context (ABS 2013).

14 See Sands (2016), Summers (2016), and Rogoff (2016) among others.

15 Exchange rates as at end November 2016.

16 In addition, the real value of the AUD 100 banknote has declined significantly over time. Since the AUD 100 banknote was first issued in 1984 consumer prices have increased by around 200 per cent.

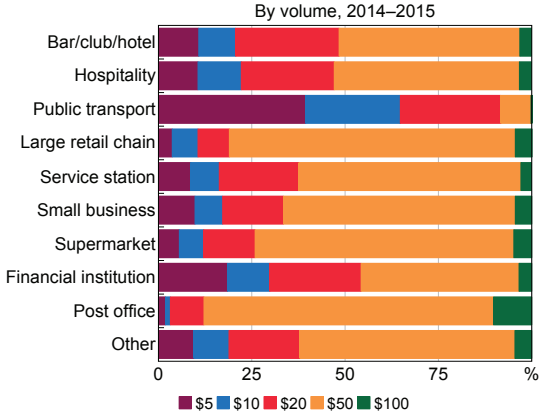
Table 3: Highest Denomination Banknote

	US	New Zealand	Canada	Euro area[a]	Switzerland	Japan	UK
Local currency	100	100	100	500	1 000	10 000	50
AUD equivalent[b]	134	96	100	711	1 321	119	84

(a) The ECB has announced its intention to stop producing EUR 500 banknotes in 2018, the EUR 200 banknote (AUD 285) will become the highest remaining denomination
(b) Exchange rates as at end November 2016
Sources: Central banks, RBA, Thomson Reuters

sampling by the Reserve Bank suggests that $100 banknotes account for up to 5 per cent of the cash banked by retailers and supermarkets, and 10 per cent for post offices, likely reflecting the payment of some household bills (Graph 9). While these figures do not represent the chance of a particular denomination being used in any given transaction, they indicate continued transactional use of the $100 banknote at a range of retailers.

Graph 9
Denominations Banked by Retailers
By volume, 2014–2015



Source: RBA

As noted, it is not possible to estimate the extent to which cash, or any particular banknote denomination, is used in illegal activities. However, liaison with AUSTRAC (Australian Transaction Reports and Analysis Centre) and the Australian Crime Commission suggests that it is the $50 denomination – rather than the $100 – that tends to be preferred by criminal elements because of its ubiquitous use in legitimate transactions. This suggests that to the extent that the $100 banknote is being used for nefarious purposes, any phase-out may not be particularly disruptive to those engaged in such activities.

Any deliberation on the future denominational mix of Australian banknotes should also consider the potential costs of phasing out a particular denomination. In the case of $100 banknotes, this would include the welfare reduction associated with the loss of these banknotes for legitimate transactions and as a store of wealth. Another potentially significant cost would be higher printing and distribution costs if consumers and businesses shifted to using lower-denomination banknotes. An assessment of the case for phasing out $100 banknotes would also need to consider the issue in the context of a broader range of policy measures that could potentially be taken to deter activities such as tax avoidance and crime.[17]

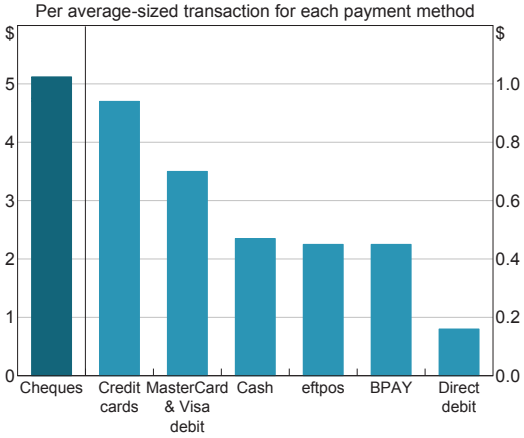
Costs of Cash Use

One argument that is sometimes made in support of phasing out cash is that it is a costly payment instrument relative to the electronic alternatives. Data from the Reserve Bank's latest Payment Costs Study, however, indicated that the direct resource costs incurred by financial institutions and merchants in accepting an average-sized payment in cash from households were relatively low compared with some other payment methods (Graph 10).[18] The study estimated that, in 2013, cash would have been the lowest-cost payment method for just under half of consumer payments (based on

17 For example, in some countries cash registers must be certified so that information on transactions can be audited.

18 The resource cost is a measure of how much it costs the economy to 'produce' a payment. For more information on the costs of payment methods, see Schwartz *et al* (2008) and Stewart *et al* (2014).

Graph 10
Direct Resource Costs*
Per average-sized transaction for each payment method



* Payment function only
Source: RBA

transaction size), although this share had fallen from around three-quarters when estimated at the time of the previous costs study in 2006.[19]

It was, however, estimated that the average resource costs of cash had increased between the two payment costs studies: from 37 cents per transaction in 2006 to 48 cents per transaction in 2013. This increase was largely attributed to higher average per-transaction costs incurred by financial institutions and merchants in the course of distributing cash; for example, bank branch staffing and location rental costs were spread over fewer branch withdrawals.

If the decline in cash use continues, all else being equal, the average per-transaction cost of cash payments is likely to continue to increase, both in absolute terms and relative to other payment methods. That is, the fixed costs associated with storing, transporting and distributing cash in a country the size of Australia would be spread over fewer transactions. Over time, this dynamic may raise issues around the supply of cash services across the country if private sector participants were to become disinclined to offer such services, or to do so at a much higher cost to consumers. This appears to have been the case in Sweden, where the speed at which private financial institutions have cut back on the provision of cash services has become a policy concern, and the official sector has considered measures to ensure that these services remain readily available (Sveriges Riksbank 2016).

A particular consideration in this context would be to ensure that cash is accessible to all those who need and wish to use it, including segments of society that are particularly reliant on cash. The 2013 Consumer Use Survey showed that there is a small but significant share of the Australian population that relies heavily on cash, with around 10 per cent of respondents making all their in-person payments with cash. While the Reserve Bank's current cash distribution arrangements – which as noted above are undertaken by the private sector – are working well, the Reserve Bank will continue to monitor cash distribution throughout the economy to ensure that it continues to meet the needs of the community.

Conclusion

The share of cash-based transactions in the economy has declined. This trend is likely to continue with the growing adoption of mobile payments and the commencement of the NPP, which will offer further alternatives to cash. Nevertheless, it is likely that cash will continue to be used extensively by certain groups of consumers and in particular types of transactions, and cash will remain an important part of the Australian economy and the payments system for the foreseeable future. It will also continue to be valued as a store of wealth.

As the role of cash evolves, the Reserve Bank will continue to consider how best to meet the demand for banknotes, in order to ensure that cash is readily available to those who wish to use it. In this regard, ensuring appropriate access to cash for citizens who have few alternatives is likely to be a priority. Over a

19 These estimates combine information from the consumer use surveys and payment costs studies. In 2007, the median consumer transaction value was $20, while cash was the method with the lowest average cost for transactions under $60. In 2013, the median transaction amount was $23, with cash having the lowest average cost for transactions under $20.

longer horizon, there will be attention globally on the potential for new technologies to influence the way in which central banks meet society's demand for currency.

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The Effect of Chinese Macroeconomic News on Australian Financial Markets

Thomas Mathews*

Over the past two decades, economic and financial developments in China have become more important for the Australian economy in many ways. This article focuses on the effect of economic data releases in China on financial markets in Australia, and argues that Australian financial markets, particularly the Australian dollar, react more strongly to news about the Chinese economy than in the past.

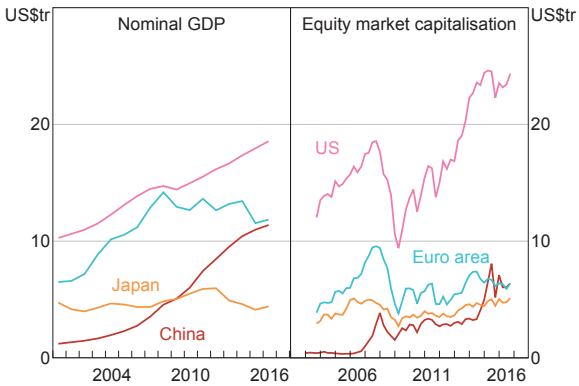
Introduction

China has become an increasingly important part of the global economy over the past two decades. Its rapid economic growth has seen its share of world GDP more than double since 2000, along with a commensurate increase in its share of world trade (Graph 1). The size of China's financial markets has also increased substantially since the turn of the century, as has turnover in the Chinese renminbi (RMB) (Garner, Nitschke and Xu 2016).

Alongside the increase in China's economic and financial size, there appears to have been an increase in the extent to which developments in China are affecting financial markets elsewhere. For example, in August 2015 the People's Bank of China (PBC) changed the way it determines the Chinese RMB's daily fixing rate against the US dollar.[1] This resulted in only a relatively small move in the exchange rate, but led to substantial volatility in global exchange rates and asset markets. More generally, over the past two decades co-movements (as measured by correlation coefficients) between Chinese financial markets and those elsewhere (including in Australia) have increased (Graph 2; Graph 3). Recent literature suggests that developments in China are increasingly affecting global financial markets. Several studies find that, after controlling for global factors, changes in Chinese asset prices explain a larger share of changes in Asian asset prices (including those of Australian assets) than they did in the past, and that this probably reflects growing trade (Arslanalp, Liao and Seneviratne 2016; Shu *et al* 2016).[2] And Roberts *et al* (2016) find that Chinese economic growth has had large effects on global commodity prices.

This article considers the effect of Chinese macroeconomic news on Australian financial

Graph 1
Indicators of China's Economic and Financial Growth*



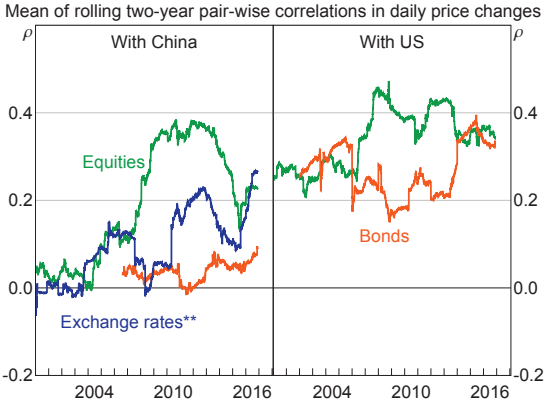
* Converted to US dollars at market exchange rates
Sources: Bloomberg; IMF; RBA

* The author is from International Department.

1 The fixing rate is the central rate around which the PBC allows the RMB to trade against the US dollar.

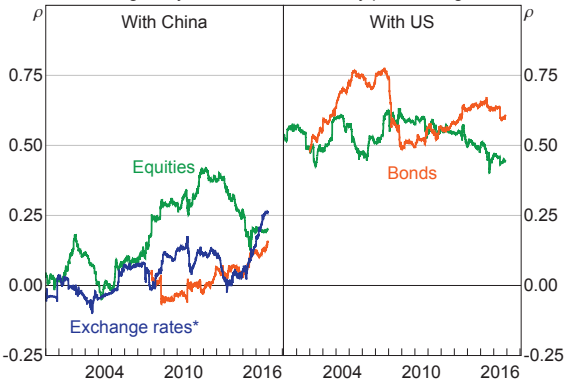
2 An alternative explanation for an increase in correlations might be, for example, that China itself is increasingly affected by global shocks.

Graph 2
Asian Financial Market Correlations*
Mean of rolling two-year pair-wise correlations in daily price changes



* Includes Australia, India, Indonesia, Malaysia, New Zealand, South Korea, Taiwan and Thailand
** Against US dollar
Sources: Bloomberg; RBA; Thomson Reuters

Graph 3
Australian Financial Market Correlations
Rolling two-year correlations in daily price changes



* Against US dollar
Sources: Bloomberg; RBA; Thomson Reuters

markets. First, it discusses the channels through which economic news about China can affect financial markets in other countries, including Australia. It then attempts to quantify these 'spillovers' from China to Australia by focusing on one particular type of news: economic data releases. Releases of data measuring economic activity in China help financial market participants assess the state of the Chinese economy and, relatedly, the effect that might have on economies exposed to China, such as Australia. If data releases are different to expectations, they could be expected to result in immediate changes to financial market variables, such as equity prices, exchange rates and bond yields of exposed countries. We might therefore expect increasingly large movements in Australian financial markets around the time that Chinese economic data are released if developments in China are having a larger impact on Australia over time. We therefore focus on whether this effect has increased in size over time, in contrast to some other work on this topic.

Spillovers of Country-specific Shocks to International Financial Markets

Spillovers from one economy to the financial markets of another are often instantaneous, unlike spillovers to economic activity, which may take effect over several years. This is because financial market prices reflect market participants' expectations about future developments, and these expectations can be revised immediately upon receiving new information. These spillover effects can occur through different transmission channels, which can be categorised in two ways: whether they are *direct* or *indirect,* and whether they are due to *economic* or *financial* links (Table 1).

Direct economic links refer to trade exposures, where one economy exports or imports goods and services to or from another. For example, developments in a trading partner's economy are likely to have an effect on the earnings of firms that export goods or services there, and therefore the price of these firms' equity. As trade often involves transactions in different currencies, news about the trading partner's economy can also affect demand for the currency of the exporting economy and thereby affect exchange rates.

Direct financial links refer to cross-border investment, or capital flows. If residents in one economy own assets in another, they may buy or sell those assets due to developments in their own economy. For example, if a foreign residents' domestic income unexpectedly declines, they may sell foreign assets in response.

Table 1: Spillover Channels

	Economic links	Financial links
Direct channel	Trade	Capital flows
Indirect channel	Global commodity prices	Risk sentiment

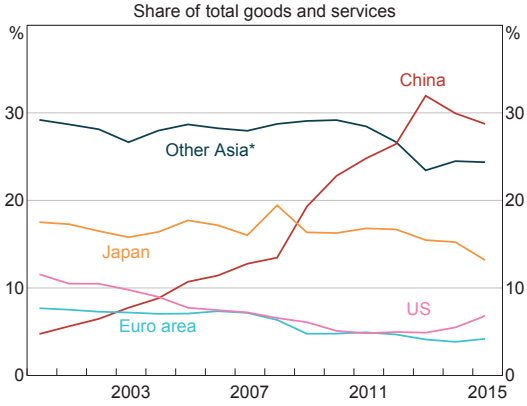
Source: Arslanalp, Liao and Seneviratne (2016)

However, economies do not need to have direct links to have an effect on each other's financial markets. For example, a potential *indirect economic* channel for spillovers is via global commodity prices, which are affected by developments in larger economies and can therefore affect the financial markets of smaller economies that produce or consume these commodities, whether they have direct trade links to the larger economy or not.

Similarly, developments in large economies can have *indirect financial* effects on other economies' financial markets, as such developments might be expected to have material effects on global investors' confidence and appetite for risk, affecting the relative prices of different types of assets around the world.

Economic links are likely to be the most important avenue for spillovers from China to Australia's financial markets, particularly via the direct channel. Australian trade with China has grown rapidly over the past decade, and exports to China now account for nearly 30 per cent of all Australian exports (Graph 4). Indirectly, demand from China also has a large effect on the prices of commodities that Australia exports, including to countries other than China. This means that developments in China often have implications for the profitability of Australian firms, the demand for the Australian dollar and the outlook for the Australian economy and monetary policy, all of which affect prices in Australian financial markets. Direct financial links between the two economies, while growing, remain limited due in part to China's still relatively closed capital account. However, indirect financial links are becoming stronger as developments in China increasingly affect global risk sentiment.

Graph 4
Australian Exports by Destination
Share of total goods and services



* Includes Hong Kong, India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan and Thailand

Sources: ABS; RBA

The Effect of Chinese Data on Australian Financial Markets

The different channels for spillovers suggest that Chinese economic data should have had an increasingly important effect on Australian financial markets as China's links with the Australian economy have grown. As noted above, economic data releases are useful for analysing these financial market spillovers, in part because they represent clearly defined shocks that can be thought of as originating in China. And their spillover effects can be estimated over a narrow window of time in which it can be assumed that little else is happening that would affect financial markets.

We estimate the effect of Chinese data releases on Australian financial markets using a simple model in which the volatility of the prices of Australian financial market instruments around the time when Chinese data are released is compared to the volatility at the same time on days when the data are not released, using data from January

2000 to November 2016.[3] Initially, we focus on the Australian dollar exchange rate against the US dollar (AUD/USD exchange rate), using a 20-minute window around the time of the data release, starting 10 minutes before and ending 10 minutes after the release.[4] We use an approach similar to that used in Edwards and Plumb (2009), which looks at the effects of US data releases on Australian financial markets. Specifically, an equation is estimated for the absolute change in the AUD/USD exchange rate around the release time ($|\Delta p|$), depending on a set of i dummy variables (denoted x_i), which take the value 1 in periods when the data are released and 0 otherwise. The coefficient β_i represents the estimated extra volatility around data release i, in addition to normal volatility in the market.

$$|\Delta p| = \alpha + \sum \beta_i x_i + \varepsilon \quad (1)$$

This approach does not control for the *surprise* content of a data release, which is what typically matters for financial markets, as some expectation for the outcome is embedded in pre-existing prices. Other similar analyses, such as D'Arcy and Poole (2010) and Baum, Kurov and Wolfe (2015), have used surveys of market economists to determine a consensus expectation, and then compared that to the data as released. But these surveys do not have particularly long histories for many Chinese data releases, and scaling the size of a surprise is difficult when the level and volatility of many Chinese economic statistics have changed over time. Instead, the approach used in this article implicitly assumes that the surprise content of Chinese economic data has stayed approximately constant over long periods of time.

The results suggest that Chinese data releases coincide with additional volatility in the AUD/USD exchange rate, and that this effect has grown substantially over time. Table 2 shows results for releases of quarterly Chinese GDP data and monthly 'activity' data, which includes data on fixed asset investment, industrial production and retail sales, all released at the same time. The estimated effects of economic data releases in the United States, which historically has been a key source of international economic and financial spillovers to Australia, are shown for comparison (full results for all data releases are in Table A1).[5] The values show the estimated additional volatility, in per cent terms, around the releases of these data series. The results are shown for the first and second halves of the sample, to provide an indication of whether the estimated effects have changed over time. On average, since 2008, the volatility of the AUD/USD exchange rate is higher by around 0.5 percentage points at the time of Chinese GDP data releases, and volatility is higher by just under 0.2 percentage points around the time of 'other activity' data releases.[6] These results are comparable with other similar studies, such as Baum *et al* (2015), for corresponding sample periods.

While the release of Chinese GDP data has a statistically significant effect on volatility in the Australian dollar over the whole sample, the change in estimated coefficients between the first and second half of the sample suggests that this is a relatively recent development: the coefficient estimated over the second half of the sample (2008–16) is large and statistically significant, while the coefficient estimated over the first half (2000–07) is much smaller and not statistically

3 The series of release times for some Chinese data releases starts slightly after the beginning of this period with the latest, GDP, beginning in 2003.

4 Starting the window before the data are released allows for potentially thin trading conditions immediately before the data release, which might result in more volatile prices, as well as situations in which the data may have been known to market participants a short time before they were officially published. For example, Orlik (2011) argues that in China newspapers have occasionally published stories on new economic data before the official release time. All intraday price data are sourced from Thomson Reuters.

5 The purchasing managers indices (PMIs) for China are another data release typically considered important by financial market participants and analysts; however, the relatively short time series means analysing its effect over time is impractical. However, consistent with other work (such as Baum *et al* (2015)), we find that China's PMIs have a statistically significant effect on the AUD/USD exchange rate over the time frame data are available.

6 GDP data are typically released at the same time as activity data; the model used assumes that in these months the volatility is the sum of that caused by each release.

Table 2: Estimated Effect on Australian Dollar Volatility[a]
Per cent

	2000–07	2008–16	Full sample
China GDP	0.01	0.06***	0.05***
China activity[b]	–0.01	0.04***	0.02**
US GDP[c]	0.09***	0.05***	0.07***
US labour force	0.16***	0.20***	0.18***

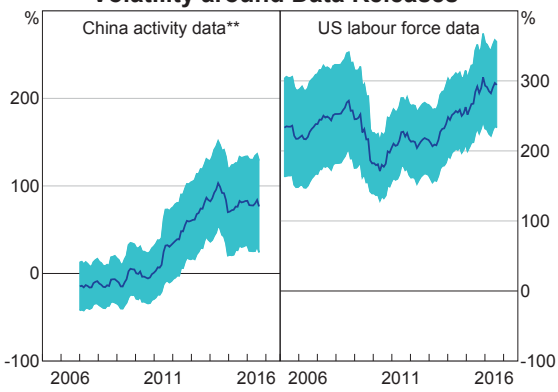
(a) AUD/USD exchange rate, ** and *** denote statistical significance at 95 and 99 per cent confidence levels, respectively, using bootstrapped standard errors
(b) Includes fixed asset investment, industrial production and retail sales
(c) Advance release
Sources: Bloomberg; RBA; Thomson Reuters

significant. Similarly, the coefficient for Chinese activity data is estimated to be insignificant from zero in the first half of the sample and somewhat larger and statistically significant over the second half of the sample. In contrast, the effect of US data, while particularly large in the case of the US labour force release, is not estimated to have changed much over this period.

Another way to estimate how the influence of Chinese data releases on Australian financial markets has changed over time is to use rolling regressions, whereby the equation shown above is re-estimated on a five-year subset of data at the start of the sample, and then the estimation window is repeatedly shifted forward and the equation re-estimated. This helps to avoid issues around selection of the sample start and end points, which can affect the estimation results. However, reducing the sample size also means the coefficients are less precisely estimated.[7]

Similar to the results using a split sample, the rolling regressions show that the volatility in the Australian dollar exchange rate around Chinese data releases has increased over time, while the volatility around US data releases is little changed. Graph 5 shows the estimated additional effect of Chinese activity data on the volatility of the Australian dollar, expressed relative to normal volatility outside of release times. For example, a value of 50 per cent indicates that the volatility around the release of the data is 50 per cent higher than that observed at the same time on other days. The results suggest that the volatility around the release of Chinese activity data has increased substantially: in the early 2000s the movements in the Australian dollar around the releases were indistinguishable from its movements at other times, while more recently volatility has roughly doubled around times the Chinese activity data are released. In comparison, the estimated effect of US labour force data releases on volatility in the Australian dollar exchange rate is broadly similar to its value at the start of the sample period, though

Graph 5
Additional Australian Dollar Volatility around Data Releases*



* Additional volatility in the AUD/USD exchange rate as per cent of average volatility at same time of day as data release, estimated using five-year rolling regressions; shaded areas show 95 per cent confidence intervals
** Includes fixed asset investment, industrial production and retail sales
Sources: Bloomberg; RBA; Thomson Reuters

7 For simplicity, the rolling regressions are calculated using heteroskedasticity-consistent standard errors rather than the bootstrapped errors used in Table 1; however, this was found to make little difference to the statistical significance of the results.

it appears to have declined somewhat and then picked up a bit more recently.

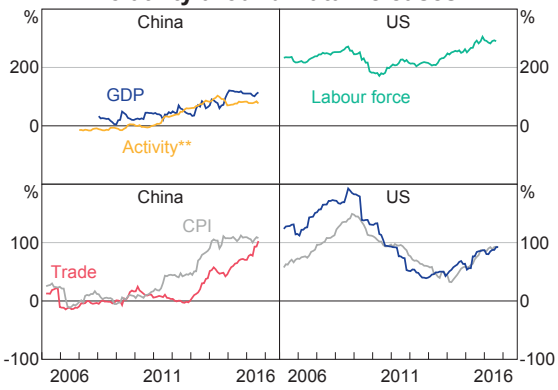
The same results hold for a range of other Chinese data releases, such as GDP, the Consumer Price Index (CPI) and trade (Graph 6). Towards the end of the sample, the increase in the volatility in the AUD/USD exchange rate around the time of these releases is estimated to be similar to that around the Chinese activity data releases, although this appears to be a slightly more recent development for the trade data. In contrast, additional volatility coinciding with the US GDP and CPI data releases appears to be broadly unchanged over the sample period; there is some variation in the middle of the sample but this is largely not statistically significant.

So far, the analysis presented here has focused on exchange rate volatility, but similar developments may have taken place in Australian domestic asset markets. To analyse this, a similar equation to the one above is estimated, using absolute changes in Australian government bond yields and equity prices as the dependent variables. Because Australian domestic markets are often not open when US data are released, futures market prices are used.

Overall, the results when using volatility in bond yields as the dependent variable are similar to the results using volatility in the exchange rate. The estimated effects of Chinese data releases are statistically significant towards the end of the sample and have trended up over time, particularly over the past decade (Graph 7). However, the effects are somewhat smaller, particularly for activity and GDP data: relative to typical volatility these releases appear to have about half the effect on volatility in bond markets that they do on volatility in the exchange rate. These broad results also hold when controls are added for interactions between the different markets; that is, controlling for the fact that changes in the price of one market might affect the price in another. This suggests that Chinese data are affecting the Australian bond market directly, rather than just affecting the exchange rate and, through this channel, spilling over to the bond market.

In contrast, results for equity markets are somewhat less clear: while the effects are typically larger in the latter half of the sample, they are less precisely estimated and generally smaller than those seen for bond yields and the exchange rate (Graph 8; Table A3). This may be, for example, because good news about exports to China for Australian firms is in part offset by an associated appreciation of the exchange rate, reducing

Graph 6
Additional Australian Dollar Volatility around Data Releases*

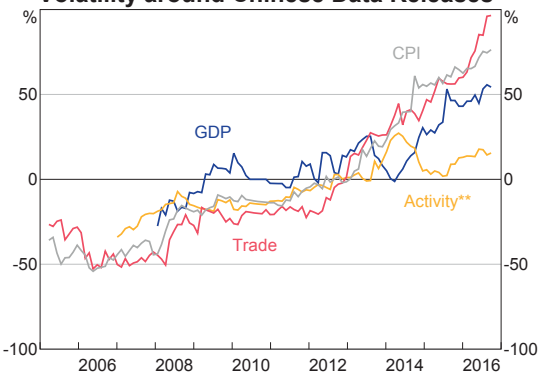


* Additional volatility in the AUD/USD exchange rate as per cent of average volatility at same time of day as data release, estimated using five-year rolling regressions

** Includes fixed asset investment, industrial production and retail sales

Sources: Bloomberg; RBA; Thomson Reuters

Graph 7
Additional Australian Bond Market Volatility around Chinese Data Releases*



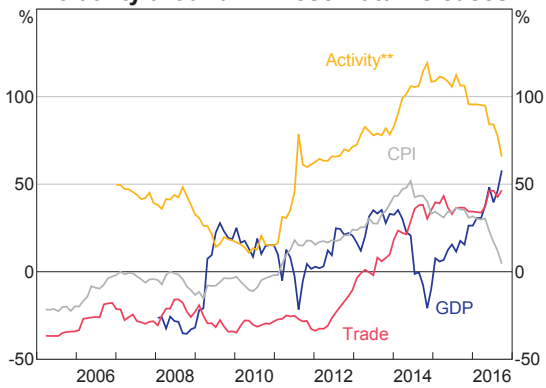
* Additional volatility in 10-year Australian government bond futures as per cent of average volatility at same time of day as data release, estimated using five-year rolling regressions

** Includes fixed asset investment, industrial production and retail sales

Sources: Bloomberg; RBA; Thomson Reuters

the Australian dollar value of those exports, and therefore muting the equity market reaction to the news. Nonetheless, it is still the case that the effects of Chinese economic news on the equity market appear in some cases to be somewhat larger than they were in the past.[8]

Graph 8
Additional Australian Equity Market Volatility around Chinese Data Releases



* Additional volatility in ASX SPI 200 futures as per cent of average volatility at same time of day as data release; estimated using five-year rolling regressions

** Includes fixed asset investment, industrial production and retail sales

Sources: Bloomberg; RBA; Thomson Reuters

Interpretation and Implications

The results presented here are consistent with the hypothesis that China's increased economic importance over the past two decades has led to greater spillovers to Australian financial markets via direct and indirect economic channels. In particular, the trade links between the two countries mean that news about the Chinese economy is important for assessing the prospects for Australian exports and the wider Australian economy. Similarly, China is a large source of global demand for commodities, such that news about the Chinese economy affects the prices of commodities that Australia exports globally, as well as to China. Indeed, the estimated effects in the rolling regressions appear to become larger around the same time that Australian exports to China picked up sharply and commodity prices rose in 2009–13.

However, there are a number of other reasons why the effect of Chinese data on Australian markets may have increased over time. One reason is that market participants have used Australian financial markets, particularly the Australian dollar, as a proxy to gain exposure to China. This is due to the fact that Chinese portfolio assets are still relatively difficult for foreign residents to acquire, and the renminbi is relatively tightly controlled (Ho, Ma and McCauley 2005). Given Australia's links to China, Australian assets might therefore be an easier way of gaining exposure to China, for either speculative or long-term purposes. This may have led to higher trading volume in Australian assets than would otherwise be expected and therefore potentially higher volatility around the time of Chinese data releases, and reflects an additional channel through which Chinese economic policies are affecting Australian financial markets. It is possible that the role of Australian assets as a proxy for Chinese assets will decline as China continues to gradually liberalise its capital account and exchange rate.

Another reason that Chinese data may be increasingly affecting Australian markets is that the information content of Chinese data releases may have risen. In particular, methodological improvements over time, both in the collection and reporting of data, could have made Chinese data a better guide to the state of the economy. In addition, Orlik (2011) argues that in the past Chinese data have sometimes been leaked or announced ahead of their official release time. This might mean that by the time the data are released, the information content has already been incorporated into financial market prices. If the prevalence of this has decreased over time, then it could be expected that volatility around the official release time would increase, even if the importance of the news itself is unchanged.

8 Volatility in Australian bond and equity markets around US data releases appears to have increased slightly over time, particularly in the case of bond markets, although the increase is in most cases less than the increase seen around Chinese data releases (Table A2; Table A3).

Moreover, the surprise content of Chinese economic data may have increased; that is, market participants are finding these data harder to anticipate than in the past. However, available surveys on economists' forecasts relative to the actual outcome show no clear trend, and Chinese economic variables have been relatively smooth in recent years, suggesting that it is unlikely to have become more difficult to forecast Chinese data.[9]

Conclusion

Australian financial markets are increasingly affected by news about China's economy. This is consistent with the large share of Australian exports going to China, the influence of Chinese demand and supply on global commodity prices and the importance of China to the global economy more broadly. As these factors continue to become more important, and China liberalises its capital account, the effect of Chinese macroeconomic news on Australian financial markets may increase further. These results therefore reiterate the importance of understanding developments in China for policymakers and financial market participants in Australia.

Appendix A

Table A1: Regression Results for AUD/USD Exchange Rate[(a)]
Additional volatility, per cent

	2000–07	2008–16	Full sample
China GDP	0.01	0.06***	0.05***
China activity[(b)]	–0.01	0.04***	0.02**
China trade	0.01*	0.03***	0.02***
China CPI	0.03***	0.04***	0.01
US GDP[(c)]	0.09***	0.05***	0.07***
US labour force	0.16***	0.20***	0.18***
US CPI	0.06***	0.05***	0.06***

(a) *,** and *** denote statistical significance at 90, 95 and 99 per cent confidence levels, respectively, using bootstrapped standard errors
(b) Includes fixed asset investment, industrial production and retail sales
(c) Advance release
Sources: Bloomberg; RBA; Thomson Reuters

9 Another possible interpretation of the results is that the estimates are capturing some change in the underlying volatility of Australian financial markets around data or news events in general that is not specific to Chinese data, perhaps due to structural changes in markets such as regulatory reforms or the increase in algorithmic trading. However, the fact that the effect of US data on volatility in Australian financial markets has not similarly increased over the sample period suggests that the estimates are not a result of this effect.

Table A2: Regression Results for Australian Government Bond Yields[a]
Additional volatility, basis points

	2000–07	2008–16	Full sample
China GDP	–0.12	0.23	0.16
China activity[b]	–0.07	0.01	0.00
China trade	–0.04	0.18*	0.07
China CPI	–0.13	0.22***	0.09
US GDP[c]	0.32***	1.09***	0.66***
US labour force	0.39***	2.68***	1.29***
US CPI	0.36***	0.44***	0.39***

(a) Australian 10-year government bond futures; *,** and *** denote statistical significance at 90, 95 and 99 per cent confidence levels, respectively, using bootstrapped standard errors
(b) Includes fixed asset investment, industrial production and retail sales
(c) Advance release
Sources: Bloomberg; RBA; Thomson Reuters

Table A3: Regression Results for Australian Equity Prices[a]
Additional volatility, per cent

	2000–07	2008–16	Full sample
China GDP	–0.04	0.07**	0.04*
China activity[b]	0.04*	0.02	0.04**
China trade	–0.03	0.00	0.01
China CPI	–0.03	0.00	0.00
US GDP[c]	0.04	0.09***	0.07***
US labour force	0.12***	0.24***	0.20***
US CPI	0.04***	0.03*	0.04***

(a) ASX SPI200 futures; *,** and *** denote statistical significance at 90, 95 and 99 per cent confidence levels, respectively, using bootstrapped standard errors
(b) Includes fixed asset investment, industrial production and retail sales
(c) Advance release
Sources: Bloomberg; RBA; Thomson Reuters

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Developments in Foreign Exchange and OTC Derivatives Markets

Megan Garner, Anna Nitschke and David Xu*

The Bank for International Settlements (BIS) conducts the Triennial Central Bank Survey of Foreign Exchange and Over-the-counter (OTC) Derivatives Markets Activity (Triennial Survey) to collect information about the size and structure of these markets. The 2016 survey results suggest that global activity in these markets declined since the previous survey, partly reflecting higher-than-usual activity in April 2013 and exchange rate movements. Over the same period, activity in the Australian foreign exchange market declined markedly in US dollar terms, but only modestly in Australian dollar terms. For Australian banks, the value of OTC derivatives outstanding continued to increase, though gross credit exposure declined.

Background

The Triennial Survey provides a comprehensive and unique source of information about the activity and structure of the foreign exchange and OTC derivatives markets. The 2016 survey was undertaken in two parts: the turnover portion measured activity in foreign exchange and OTC single-currency interest rate derivatives markets in the month of April, while the 'outstandings' portion measured the amount of OTC derivatives outstanding with reporting dealers as at end June.[1] This article discusses the key results from the Triennial Survey and examines some of the trends in 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, gross market value and gross credit exposure.

Foreign Exchange Turnover

After rising strongly for many years, global foreign exchange turnover declined slightly over the three years to April 2016, to an average of US$5.1 trillion per day (Graph 1).[2] To some extent, this decline in turnover appears to have reflected higher-than-usual activity in April 2013, when the Triennial Survey was previously conducted. The increased activity in April 2013 was primarily in response to the Bank of Japan's (BoJ) decision at that time to expand its asset purchase program substantially (Brooks, Deans, Wallis, Watson and Wyrzykowski 2013). Evidence from semiannual surveys conducted in six of the largest foreign exchange markets suggests that, abstracting from the spike in April 2013, turnover in these markets remained around

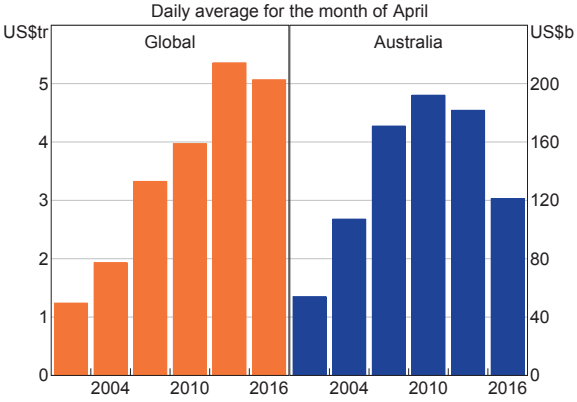
* The authors are from Financial Markets Group.

1 The turnover portion of the Triennial Survey was conducted by central banks and other authorities across 52 jurisdictions, and included 24 Australian reporting dealers. Data collected are based on the location in which the trade is booked. The outstandings portion covered 46 jurisdictions and included responses for the consolidated operations of 6 large Australian banks.

2 Unless otherwise stated, global turnover figures are at current exchange rates and 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.

its average since 2011.[3] In addition, the US dollar appreciated against a range of currencies between April 2013 and April 2016, which reduced the US dollar value of turnover in currencies other than the US dollar; at constant 2016 exchange rates, global foreign exchange turnover increased slightly over this three-year period.

Graph 1
Foreign Exchange Turnover
Daily average for the month of April

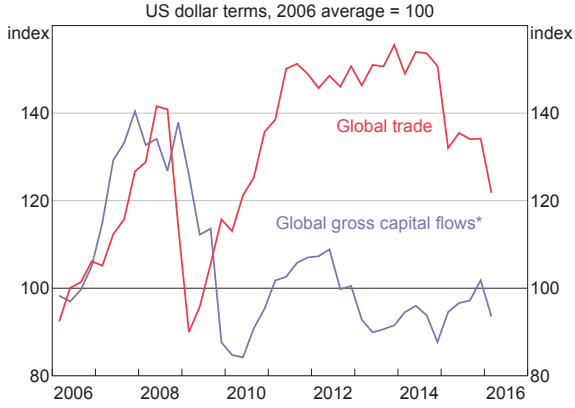


Sources: BIS; RBA

The decline in global turnover over the three years to April 2016 coincided with a 16 per cent decrease in the (US dollar) value of international trade over the same period (Graph 2). While cross-border trade continues to be one of the underlying drivers of foreign exchange turnover, its influence is often limited, especially for advanced highly financialised economies where foreign exchange turnover is significantly larger than gross trade. Global cross-border lending and investment, which are also key sources of demand for foreign exchange transactions, were little changed over the three-year period.

3 Semiannual surveys are conducted by central banks and other authorities in Australia, Canada, Japan, Singapore, the United Kingdom and the United States. These jurisdictions now account for around 80 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/fx-turnover-reports/>. Quarterly data for the Australian market are also available at <http://www.rba.gov.au/statistics/tables/> (Statistical Tables F9 and F10).

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



* Excluding official reserve flows; rolling four-quarter sum for 48 countries
Sources: ABS; IMF; RBA; Thomson Reuters; World Trade Organization

In contrast to the small reduction in global turnover, turnover in the Australian foreign exchange market declined markedly in US dollar terms over the three years to April 2016, to reach a daily average of US$121 billion.[4] The decline in turnover in the Australian foreign exchange market partly reflected a depreciation of the Australian dollar over this period, with a 26 per cent depreciation against the US dollar. Quarterly data collected by the Reserve Bank of Australia and denominated in Australian dollars indicate that activity in the Australian foreign exchange market declined modestly over the three years to April 2016.

Turnover by jurisdiction

The global foreign exchange market continued to become more geographically concentrated in the largest financial centres over the three years to April 2016. The five largest jurisdictions accounted for 77 per cent of global turnover, up from 75 per cent in 2013 (Table 1; Graph 3). Turnover in the United Kingdom declined by around 10 per cent, although the United Kingdom remained the largest foreign exchange centre, accounting for around 37 per cent of global turnover.

4 The Australian turnover data contain a series break in April 2016; all growth rates discussed with reference to the Australian market are break adjusted.

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

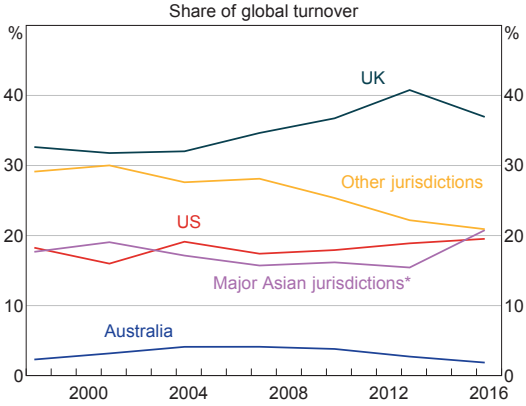
	Daily average	Market share	
	April 2016	April 2013	April 2016
	US$ billion	Per cent	Per cent
Total	**5 067**	**na**	**na**
United Kingdom	2 406	40.8	36.9
United States	1 272	18.9	19.5
Singapore	517	5.7	7.9
Hong Kong	437	4.1	6.7
Japan	399	5.6	6.1
France	181	2.8	2.8
Switzerland	156	3.2	2.4
Australia	121	2.7	1.9
Other jurisdictions	1 025	16.1	15.7

(a) The sum of jurisdiction subtotals exceeds the global total as jurisdiction subtotals are not adjusted for cross-border double counting; subtotals may not sum to total due to double counting

Source: BIS

Graph 3
Geographical Distribution of Foreign Exchange Turnover

Share of global turnover



* Hong Kong, Japan and Singapore

Sources: BIS; RBA

The United States remained the second largest centre, followed by Singapore, Hong Kong and Japan. These four jurisdictions accounted for just over 40 per cent of global turnover, up from around 35 per cent in April 2013. In contrast, turnover declined in the smaller foreign exchange markets of France, Switzerland and Australia. These jurisdictions continued to lose market share, with Switzerland and Australia recording some of the larger declines in the value of turnover among the advanced economies (although, as mentioned above, part of the decline in Australia over the past three years can be accounted for by exchange rate movements). Nonetheless, the Australian foreign exchange market remained the eighth largest in the world.

There was a notable increase in the share of foreign exchange turnover in Asian financial centres over the past three years, alongside an increase in turnover of the Chinese renminbi (RMB) as that currency has become increasingly internationalised. Turnover in Hong Kong increased by nearly 60 per cent and turnover in Singapore and Japan also increased. Collectively, these three jurisdictions accounted for around 20 per cent of global turnover, up from 15 per cent at the time of the previous survey. The strong growth in turnover in Hong Kong and Singapore – a substantial proportion of which is with cross-border reporting dealers – partly contributed to a significant increase in the share of cross-border transactions, which accounted for 65 per cent of global turnover in April 2016.

Turnover by currency

The decline in global foreign exchange turnover was broad based across most of the major currencies (Table 2). An 11 per cent reduction in global turnover of the Japanese yen was driven by significant declines in turnover of the three most

Table 2: Foreign Exchange Turnover by Currency[a]
April 2016

	Global		Australia	
	Daily average US$ billion	Share of total Per cent	Daily average US$ billion	Share of total Per cent
Total	**5 067**	**na**	**121**	**na**
Currency[b]				
USD	4 438	87.6	112	46.3
EUR	1 591	31.4	21	8.6
JPY	1 096	21.6	18	7.2
GBP	649	12.8	7	2.9
AUD	348	6.9	56	23.1
RMB[c]	202	4.0	2	0.9
Other currencies	1 811	35.7	26	10.9
Currency pair				
EUR/USD	1 172	23.1	18	14.6
USD/JPY	901	17.8	15	12.2
GBP/USD	470	9.3	6	4.7
AUD/USD	262	5.2	49	40.7
USD/CAD	218	4.3	4	3.1
Other currency pairs	2 044	40.3	30	24.7

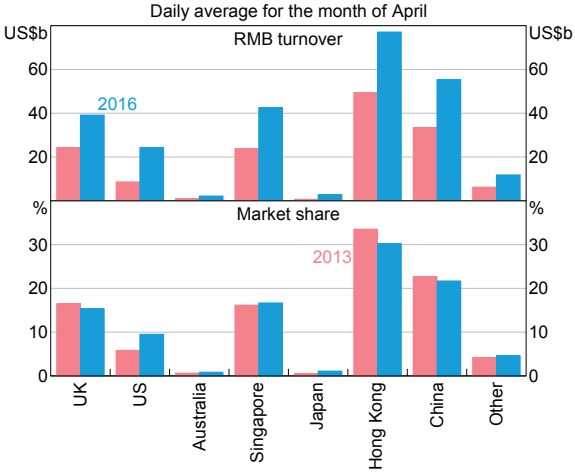
(a) Sub totals may not sum to total due to rounding
(b) The sum of currency subtotals is divided by two as each transaction involves two currencies
(c) Includes onshore (CNY) and offshore (CNH) renminbi turnover
Sources: BIS; RBA

actively traded yen currency pairs (USD/JPY, EUR/JPY, and JPY/AUD). These declines may reflect the elevated level of activity denominated in Japanese yen at the time of the 2013 Triennial Survey, in response to the BoJ's decision to expand its asset purchase program. Reflecting the US dollar's role as a global reserve currency, it remains the most traded and liquid currency in the world; it was on one side of 88 per cent of all foreign exchange transactions in April 2016.

Global turnover in the RMB increased by 69 per cent since April 2013, making the RMB the most traded emerging market currency. The RMB was the eighth most traded currency in April 2016, almost doubling its share of global turnover to 4 per cent. The increase was reasonably widespread across markets, and 48 per cent of RMB turnover was recorded outside of Hong Kong and China, up from 44 per cent in 2013, consistent with the ongoing process of internationalising the RMB (Graph 4). RMB-denominated turnover in the Australian market increased notably over the three years to April 2016, but accounts for only a small proportion of total Australian foreign exchange turnover.

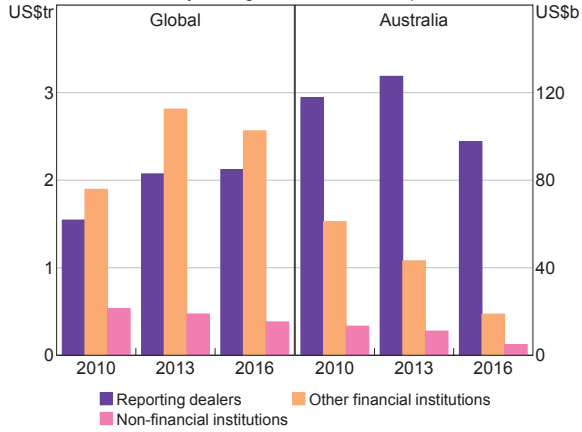
Global turnover of the Australian dollar declined by around 25 per cent over the three years to April 2016 measured in US dollar terms. However, at constant (2016) exchange rates, Australian dollar-denominated activity was estimated to be little changed. The decline reflected substantial reductions in turnover in US dollar terms in the three most actively traded Australian dollar currency pairs (AUD/USD, AUD/EUR and AUD/JPY). In geographical terms, turnover of the Australian dollar increased in Singapore and Hong Kong, but declined in the UK. Around three quarters of all Australian dollar activity

Graph 4
Geographical Distribution of RMB Turnover
Daily average for the month of April



Sources: BIS; RBA

Graph 5
Foreign Exchange Turnover
Daily average for the month of April



Sources: BIS; RBA

is conducted offshore. Although it lost market share, the Australian dollar remains the fifth most traded currency and AUD/USD remains the fourth most traded currency pair.

Turnover by counterparty

Reporting dealers in each jurisdiction provide information on their turnover with other reporting dealers (the interdealer market), with other financial institutions, and with non-financial institutions. Over the three years to April 2016, activity between reporting dealers and other financial institutions declined. The decline was partly driven by turnover between reporting dealers and hedge funds and proprietary trading firms, and occurred alongside a decline in the assets under management of hedge funds that pursue currency driven return strategies (Graph 5). The decline was also driven by a reduction in turnover between reporting dealers and non-reporting banks. Activity between reporting dealers and institutional investors (e.g. pension funds) rose over the three-year period.

The share of trading between reporting dealers (i.e. in the interdealer market) grew marginally over the three-year period. This partly reflected the strong growth in turnover in Hong Kong and Singapore, where around 65 per cent of turnover is with cross-border reporting dealers compared with around a third in the United Kingdom and United States. While turnover in the Australian interdealer market declined, this activity accounted for a much larger share of the local market (at around 80 per cent) compared with the global market (at around 40 per cent), and has risen over recent years at the expense of turnover between reporting dealers and other financial institutions.

Notwithstanding the growth in interdealer turnover over the three years to April 2016, the observed decline in the share of global foreign exchange turnover conducted in the interdealer market between 1995 and 2013 has been linked to the rise in trade internalisation. This is a process by which reporting dealers offset trade orders from one customer with those from another, thereby allowing dealers to manage their inventory imbalances without having to access the traditional interdealer market. To be considered as internalisation, positions are expected to be held only for a short period – typically a few minutes – until they are offset against a trade order in the opposite direction. Data on internalisation were collected for the first time in the 2016 Triennial Survey, in order to assess the

importance of this trend for the evolving structure of global foreign exchange markets.

The results of the survey indicate that spot transactions had the highest internalisation of all foreign exchange instruments. This is expected, given the more standardised nature of these transactions compared with other foreign exchange instruments. In line with this, the Australian internalisation ratio was also highest for spot transactions. Across jurisdictions, internalisation ratios tended to be higher for larger foreign exchange trading centres and where electronic trading is prevalent. Australia's estimated internalisation ratio was around 40 per cent in April 2016, which was broadly in line with the global average.

Global turnover between reporting dealers and non-financial institutions continued to decline over the three years to April 2016. This is consistent with the decline in global trade recorded over this period, which is likely to be a key source of foreign exchange demand from non-financial institutions. The decline in turnover with non-financial institutions was also evident in Australia, with this segment accounting for around 4 per cent of turnover in the domestic market.

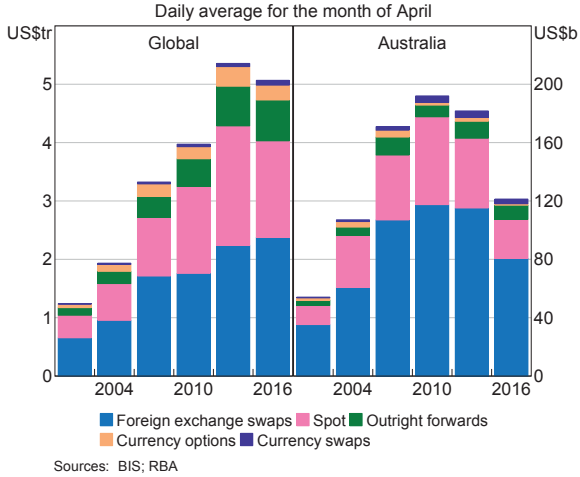
Electronic trading methods remained the most popular method for executing foreign exchange trades over the three years to April 2016, both globally and in the Australian market. The share of global activity executed via single bank trading platforms and other electronic communication networks (such as multi-bank electronic trading platforms) increased over the three-year period, while the share of traditional multilateral trading platforms, such as Reuters Matching and EBS, declined. In contrast to the global results, Australian turnover conducted electronically via single bank platforms declined notably over the three years to April 2016, and may have reflected the exit of some large foreign banks from the domestic foreign exchange market.

Estimates of the amount of activity that occurs via dark pools – private platforms for trading securities where access is restricted and prices are not revealed – were collected for the first time in the 2016 Triennial Survey. These data indicate that dark pools accounted for only a small share of global and Australian foreign exchange market activity.

Turnover by instrument

Turnover of foreign exchange swaps continued to increase over the three-year period, and accounted for 47 per cent of global foreign exchange turnover in April 2016. The increase was broad based across most currencies, with turnover of foreign exchange swaps denominated in Japanese yen increasing notably, and occurred alongside an increase in cross-border turnover of foreign exchange swaps between reporting dealers and between reporting dealers and other financial institutions (in particular, institutional investors). These results are consistent with increased use of these instruments by Japanese investors to hedge their foreign currency exposures, resulting in part from ongoing purchases of foreign equities and bonds. Global turnover in spot transactions declined by 19 per cent over the three-year period, alongside a decline in global trade, and accounted for 33 per cent of all global foreign exchange activity in April 2016 (Graph 6).

Graph 6
Foreign Exchange Turnover
Daily average for the month of April



Sources: BIS; RBA

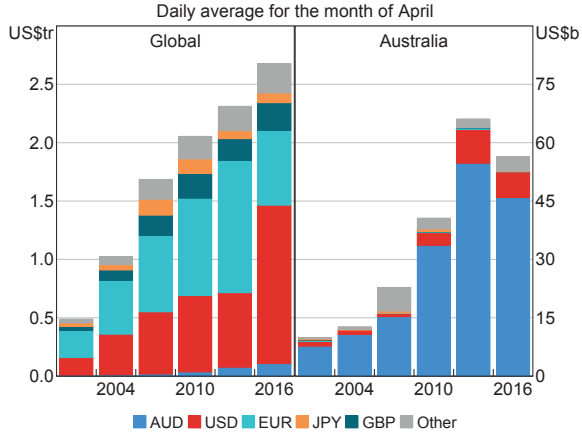
In contrast to the global results, turnover of foreign exchange swaps in the Australian market declined in US dollar terms. This largely reflected the 26 per cent depreciation of the Australian dollar against the US dollar over the three-year period. Almost half of all foreign exchange swaps in the domestic market involved the Australian dollar and a majority of these were against the US dollar.

Turnover in cross-currency swaps in the Australian market also declined over the three years to April 2016, and Australia's share of the global cross-currency swap market declined accordingly. This result largely reflects the depreciation of the Australian dollar against the US dollar over the period; in Australian dollar terms, activity in this market declined only a little. Australian financial institutions issue around two-thirds of their bonds offshore and typically use cross-currency swaps to hedge the foreign exchange exposures associated with this borrowing. The decline in Australian activity in these instruments over the three-year period is in contrast to Australian banks' foreign currency-denominated bond issuance, which increased over the three years to April 2016. This is also in contrast to the small increase in the notional amount of these instruments outstanding with Australian banks (see below), and could be due to an increase in the average maturity of new bond issuance and also methodological differences between the turnover and the outstanding portions of the Triennial Survey.

Single-currency interest rate OTC derivatives turnover

Over the three years to April 2016, average daily global turnover in single currency OTC interest rate derivatives increased by around 15 per cent to US$2.7 trillion (Graph 7).[5] The increase in US dollar-denominated activity was particularly strong, with these instruments accounting for around half of total turnover in single-currency

Graph 7
Single-currency Interest Rate Derivatives Turnover
Daily average for the month of April



Sources: BIS; RBA

OTC interest rate derivatives. In contrast, turnover in euro-denominated instruments declined considerably, and could partly reflect a 13 per cent depreciation of the euro against the US dollar over the period.

Global turnover of Australian dollar-denominated interest rate derivatives continued to increase, with the share of global turnover accounted for by Australian dollar-denominated interest rate derivatives rising to around 5 per cent. However, turnover of Australian dollar-denominated instruments *in the Australian market* declined – the first such decline since 2001.

In the Australian market, turnover of interest rate derivatives declined over the three years to April 2016, primarily driven by a decline in turnover of forward rate agreements. This could reflect market participants moving away from OTC forward rate agreements and towards centrally cleared alternatives (such as certain types of OTC interest rate swaps) to maximise the netting benefits, including the associated lower capital required when centrally clearing such activity.

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

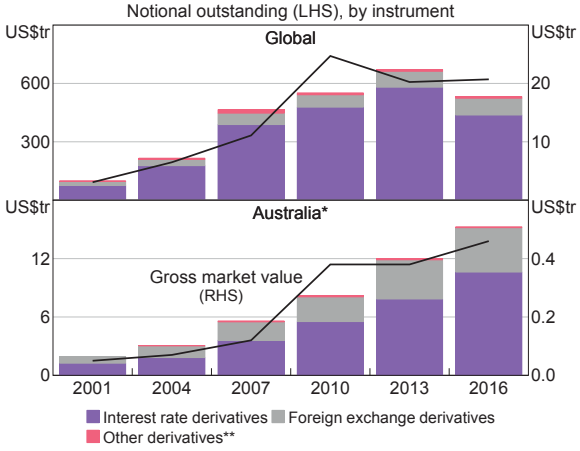
The Size of OTC Derivatives Markets

Over the three years to June 2016, most measures indicate that global OTC derivatives markets have contracted. However, due to sharp movements in the UK pound and Japanese yen around the time of the survey, the market value of open contracts increased slightly. While some measures suggest that OTC derivatives held by Australian banks increased, the underlying credit risk associated with outstanding exposures has fallen. There are three different measures of market size included in the survey: the notional amount outstanding, the gross market value and the gross credit exposure.

The gross notional amount outstanding reflects the principal amounts used to calculate payments made on derivatives contracts. The notional amount of global OTC derivatives outstanding has contracted since 2013 (Graph 8). Much of the decline in the size of global OTC derivatives was due to trade compression, particularly for interest rate derivatives, which involves the consolidation of similar derivatives contracts into smaller trades and acts to reduce the number of offsetting positions.[6] In contrast, the notional amount outstanding with Australian dealers continues to grow strongly, increasing by 26 per cent from 2013, led by growth in OTC interest rate derivatives.[7,8] Relative to other jurisdictions, the use of trade compression by the Australian banks has been less extensive, particularly for Australian dollar-denominated instruments (Reserve Bank of Australia (RBA) 2016).

The gross market value outstanding measures the cost that a counterparty would face if all open contracts were to be replaced on the survey date. This measure reflects both the quantity of derivatives outstanding and changes in the market value of the underlying reference variables (e.g. interest rates, exchange rates) between the start of the contract and the survey reporting date. The gross market value therefore shows changes in the value of a contract and is only a small proportion of the contract's notional value. In contrast to the notional amount outstanding, the gross market value of derivatives outstanding increased slightly in global markets over the three years to June 2016, largely due to an increase in the gross market value of foreign exchange derivatives (see below). The gross market value of derivatives held with

Graph 8
OTC Derivatives Markets
Notional outstanding (LHS), by instrument



* Not adjusted for interdealer double counting
** Includes equity-linked, commodity and other derivatives
Sources: BIS; RBA

6 The increase in trade compression has been supported by increased clearing of certain instruments (in particular interest rate swaps) through central counterparties. Banks have an incentive to undertake trade compression to reduce the capital they require to meet the Basel III leverage ratio.

7 This increase was partly offset by the 20 per cent depreciation in the Australian dollar relative to the US dollar between the June 2013 and 2016 Triennial surveys, which lowered the US dollar value of Australian dollar contracts (OTC derivative positions are reported in US dollars). A constant exchange rate would have translated into an estimated 57 per cent increase in outstanding positions.

8 For the OTC derivatives outstanding component of the survey, BIS reporting banks disclose the value of their transactions with all other reporting banks globally, but do not separately identify the value of transactions conducted with reporting banks within the home jurisdiction. As a result, the notional amounts outstanding between Australian reporting dealers are counted twice, whereas this double counting is removed by the BIS at a global level, by halving the aggregate outstandings between reporting banks. The Australian data will therefore be somewhat overstated relative to the global data; however, this double counting is likely to be small as transaction level data indicate that most of the Australian banks' derivative trades are conducted with non-Australian banks.

Australian reporting dealers also increased over the three years to June 2016.

Both the notional amount outstanding and gross market value measures include the value of economically offsetting positions between counterparties. As such, while these measures capture overall market activity, they may not accurately gauge market or counterparty credit risk. These risks are better captured by the gross credit exposure measure, which excludes the value of offsetting positions (such as those covered by bilateral netting arrangements, which legally enforce the consolidation of offsetting positions across all derivative instruments) and provides an aggregate measure of net exposures.[9] Gross credit exposures declined across global markets in the three years to June 2016. For Australian reporting dealers, the gross credit exposure fell to US$135 billion, which is around 30 per cent of the gross market value.

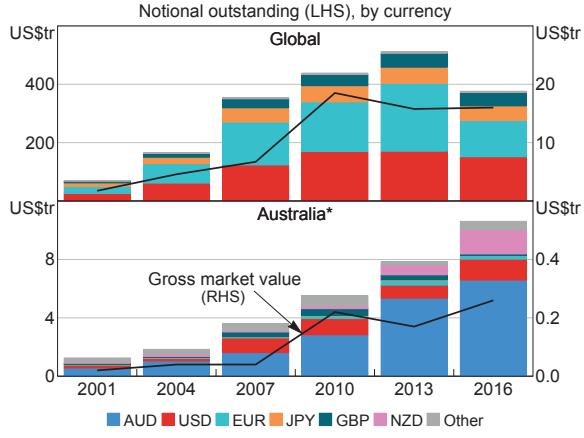
While the majority of outstanding OTC derivatives contracts, both globally and with Australian banks, are single-currency interest rate derivatives, their relative share of the OTC derivatives market has fallen due to increased trade compression alongside the central clearing of these instruments. As a result, foreign exchange derivatives now comprise 16 per cent of global OTC derivatives markets, compared with 12 per cent in 2013. Foreign currency derivatives form a sizeable share of the Australian banks' OTC derivatives, in part due to their use of foreign currency instruments to hedge the exposures on their foreign currency borrowings.[10] In contrast, commodity, equity linked and other derivatives contracts form a very small share of both Australian and global OTC derivatives markets.

Single-currency interest rate OTC derivatives

Globally, the notional amount outstanding of single-currency interest rate OTC derivatives declined substantially over the three years to June 2016, driven by a 47 per cent fall in the notional amounts of euro-denominated contracts (Graph 9). In contrast, the notional amount of single-currency interest rate derivatives held by Australian dealers increased by 35 per cent. The increase was driven by Australian, US and New Zealand dollar-denominated interest rate derivative contracts. The value of contracts outstanding with Australian banks that are denominated in New Zealand dollars was larger than US dollar-denominated contracts in the most recent Triennial Survey. The growth in New Zealand dollar instruments partly reflects an increase in New Zealand dollar funding by the major Australian banks, which all have sizeable New Zealand subsidiaries.[11]

Globally, the vast majority of interest rate derivatives were traded between reporting dealers and other financial institutions (including central counterparties (CCPs)). Data on OTC derivatives

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



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

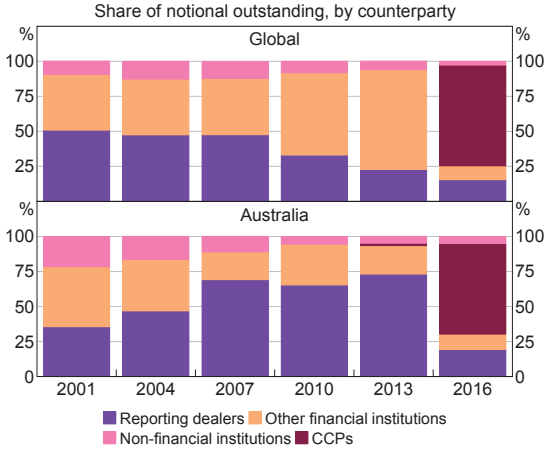
9 The difference between gross credit exposures and the notional amount outstanding (or the gross market value) may be smaller than it would have otherwise been due to the increasing use of trade compression, which acts to reduce the number of offsetting positions captured in the notional amounts outstanding and gross market value.

10 Australian banks hedge virtually all of their foreign currency liabilities using derivatives. For further information, see Rush, Sadeghian and Wright (2013).

11 The Australian banks' increased use of New Zealand dollar funding in recent years appears to have led to higher demand for New Zealand dollar-denominated interest rate derivatives to hedge the associated interest rate risk.

traded between reporting dealers and CCPs were separately identified for the first time in the 2016 survey and indicated the majority of interest rate derivatives are now traded between reporting dealers and CCPs, both globally and for Australian banks (Graph 10).[12] For more than a decade, Australian entities had mostly traded OTC interest rate derivatives with other reporting dealers, but this business has shifted towards CCPs as a result of regulatory changes that mandate the use of CCPs for OTC interest rate derivatives denominated in major currencies.[13]

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

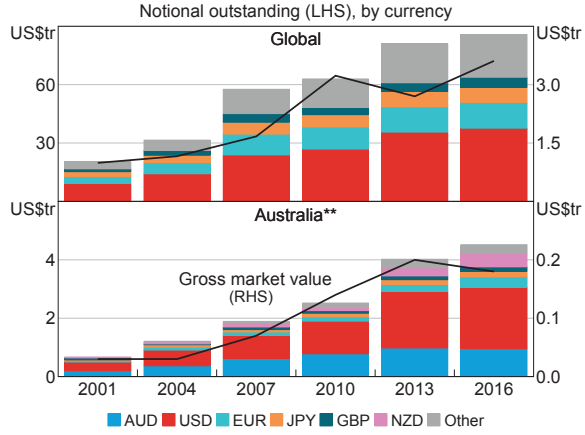


Sources: BIS; RBA

Foreign exchange OTC derivatives

The notional amounts of global foreign exchange derivatives increased by 6 per cent over the three years to June 2016 (Graph 11). The gross market value of foreign exchange derivatives also increased, partly due to the sharp moves noted earlier in the UK pound and Japanese yen around the time of the survey, which increased the market value of contracts denominated in these instruments. The notional amount outstanding reported by Australian dealers continued to grow, increasing by 13 per cent over the three years to June 2016. Nonetheless, the gross market value of foreign exchange derivatives held by Australian dealers declined. In contrast to the global data, Australian dealers have a smaller share of outstanding contracts denominated in the UK pound and Japanese yen, with most trades involving the Australian and US dollars.

Graph 11
Foreign Exchange Derivatives*
Notional outstanding (LHS), by currency



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

Globally, the increase in foreign exchange derivatives was reflected in a rise in UK pound and US dollar-denominated contracts and instruments issued in 'other' currencies.[14] Growth in the notional amounts outstanding with Australian banks was reflected in foreign exchange derivatives denominated in a range of other currencies, in particular the New Zealand, Singapore and Hong Kong dollars. The increase in foreign exchange

12 The number of trades with other financial institutions in the global data (including CCPs) in 2013 was exaggerated because when contracts are cleared through CCPs, one trade between reporting dealers becomes two outstanding contracts.

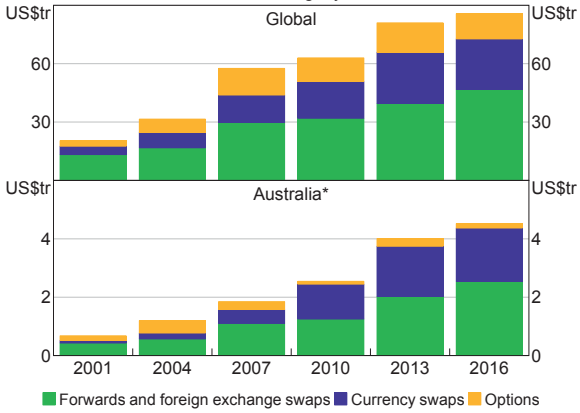
13 A considerable proportion of trades from Australian dealers moved to CCPs over recent years ahead of the domestic implementation of mandatory central clearing of OTC interest rate derivatives denominated in major currencies and the Australian dollar in April 2016. This excludes Australian dollar overnight indexed swaps, for which mandatory clearing requirements were introduced in October 2016, and forward rate agreements, which will be subject to mandatory clearing requirements from April 2018. Prior to this, some trades were subject to overseas mandatory clearing requirements. In addition, banks face higher capital requirements for OTC derivatives that are not centrally cleared. For more information see Edey (2015).

14 The BIS does not provide a breakdown of the 'other' currencies category.

derivatives may have been in part driven by the hedging activity of the major banks, which have substantially increased issuance in these currencies since June 2013.

The notional amount outstanding of forwards and foreign exchange swaps rose by 18 per cent globally, with those reported by Australian banks increasing by 26 per cent over the three years to June 2016. Forwards and foreign exchange swaps continued to form the largest share of foreign exchange derivatives held by reporting dealers both globally and in Australia (Graph 12). Australian dealers' notional amount outstanding of cross-currency swaps, which differ from foreign exchange swaps as they involve a stream of interest payments in addition to the exchange of principal, increased by 6 per cent since June 2013. Since 2007, currency swaps have comprised an increasingly large share of Australian dealers' foreign exchange derivatives, accounting for 40 per cent of the notional value outstanding in June 2016. This reflects the extensive use of these instruments as a hedging tool for foreign currency-denominated debt issued by the major banks (Arsov *et al* 2013). Options only represented a small share of foreign exchange derivatives held by Australian banks, but comprised around 15 per cent of the global market.

Graph 12
Foreign Exchange Derivatives
Notional outstanding, by instrument

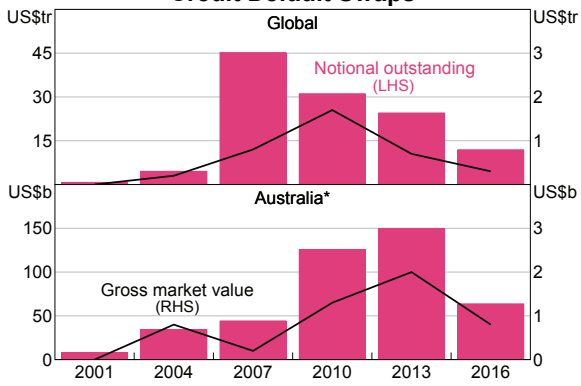


* Not adjusted for interdealer double counting
Sources: BIS; RBA

Credit default swaps

The notional amount of credit default swaps (CDS) outstanding held by reporting dealers fell by more than 50 per cent both globally and in Australia over the three years to June 2016 (Graph 13). While globally most CDS reference a single entity, the majority of CDS in Australia reference multiple entities by indexing a tradable basket of CDS contracts. The Australian market is also considerably more concentrated than global markets, with more than 80 per cent of the notional amount outstanding held between reporting dealers, compared with just under 45 per cent for global markets. The ongoing decline in the global and Australian CDS markets may reflect continued use of trade compression to reduce offsetting positions.

Graph 13
Credit Default Swaps



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

Conclusion

Turnover in global foreign exchange markets declined slightly in US dollar terms over the three years to April 2016, although turnover increased a little once account is taken for the effect of exchange rate movements. The share of foreign exchange turnover in Asian financial centres increased noticeably over the three-year period, alongside a rise in RMB-denominated turnover. While activity in the Australian foreign exchange market declined modestly in Australian dollar terms,

the Australian foreign exchange market remained the eighth largest in the world and the Australian dollar the fifth most traded currency.

According to most measures of market size, global OTC derivatives markets contracted over the three years to June 2016, with single-currency OTC interest derivatives accounting for most of this decline. However, due to sharp movements in the UK pound and Japense yen around the time of the survey, the gross market value of global OTC contracts outstanding increased slightly. For Australian reporting dealers, both the notional amount and gross market value of OTC derivatives outstanding continued to increase, while gross credit exposure declined.

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Macroprudential Policy Frameworks and Tools

David Orsmond and Fiona Price*

Over the past decade, policymakers have increasingly used macroprudential tools to address a range of financial stability concerns. International institutions have identified and offered guidance on the components of an effective macroprudential framework, while noting the need for such a framework to be sufficiently broad to reflect differences in national circumstances. This article outlines key issues faced by policymakers in identifying and mitigating systemic risk and notes the flexible approach taken by Australia's regulatory agencies. In this context, macroprudential policy is seen as just one component of an effective financial stability framework.

Background

The global financial crisis has increased the focus of policymakers on financial stability risks. This focus has taken three broad forms: to collect the necessary data and develop early warning approaches in order to identify and monitor systemic risk in banking and other parts of the financial system; to put in place appropriate prudential and other financial sector regulations to enhance institutions' resilience to shocks; and to adopt macroprudential and other policies to contain system-wide risks. While macroprudential policies were used in some economies well before the crisis, they are a relatively new policy approach for many, especially advanced economies.

What is Macroprudential Policy?

While there is no universally accepted definition, most refer to macroprudential policy as the use of prudential actions to contain risks that, if realised, could have widespread implications for the financial system as a whole as well as the real economy; these risks are often referred to as systemic risks.[1]

The actions generally involve employing a range of tools, such as caps on loan-to-value ratios (LVRs), to target particular sources of systemic risk. Systemic risk can build over time (the time dimension) or be related to the distribution of risk in the financial system (the cross-sectional dimension). In addition to addressing the sources of risk, macroprudential policy also aims to ensure that financial system resilience is proportionate to the level of risk.

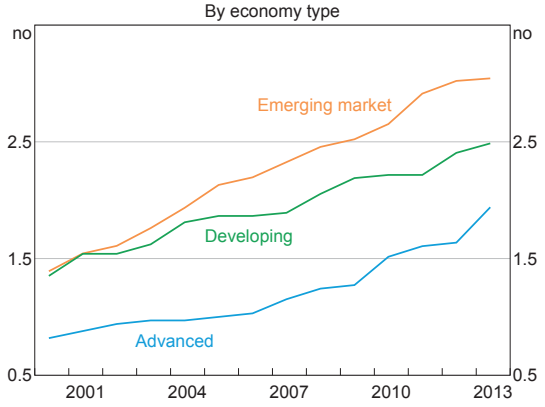
Macroprudential policy is often discussed separately from *microprudential* policy, with macroprudential policy seen as taking a system-wide and often time-varying approach to risk while microprudential policy is said to take an institution-specific approach, focusing on ensuring that individual financial institutions are resilient to shocks and apply appropriate risk management frameworks. However, these two policies generally complement and reinforce each other, since sound individual financial institutions support a stable financial system while a stable financial system supports the soundness of individual institutions (IMF 2013). Furthermore, there is a significant overlap between the tools used to achieve the objectives of microprudential policy and macroprudential policy; since they work through similar transmission mechanisms, it can be difficult to separate these two policies.

* This work was completed within Financial Stability Department.

1 This definition reflects that used by many international bodies, including the International Monetary Fund. Note that non-prudential tools can also have implications for systemic risk, such as tax policies, capital controls and monetary policy.

The use of macroprudential tools has increased significantly since the early 2000s; the increased use in advanced economies in recent years is particularly noteworthy (Graph 1). In part this trend reflects the increased realisation that adverse developments in the financial system can in turn affect the real economy. Most recently, the increase in debt levels and in residential and other asset prices in many economies, largely associated with the low global interest rate environment since the onset of the financial crisis, has prompted an increased use of macroprudential policy to contain the potential risks to financial stability (Graph 2).

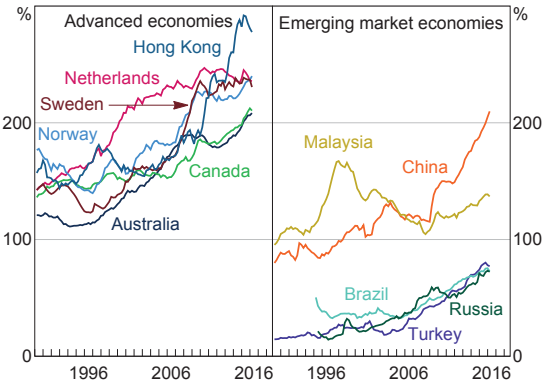
Graph 1
Use of Macroprudential Tools*
By economy type



* Use is measured by the average number of tools used per economy type; economy types are defined using the October 2016 IMF *World Economic Outlook* and World Bank publications

Sources: Cerutti, Claessens and Laeven (2015); RBA

Graph 2
Private Non-financial Sector Debt*
Relative to annual GDP



* Economy types are defined using the October 2016 IMF *World Economic Outlook* and World Bank publications

Source: BIS

Macroprudential Policy Frameworks

Macroprudential policy frameworks vary significantly across jurisdictions. Building on earlier work and the growing evidence from national experiences with these policies, in August 2016 the International Monetary Fund, Financial Stability Board and Bank for International Settlements released a report for the G20 that aimed to identify the elements of an effective macroprudential framework (see IMF, FSB and BIS (2016); hereafter referred to as the *Report*).[2] This work covers three components of jurisdictions' macroprudential frameworks: institutional arrangements; the approach to identifying and monitoring systemic risk; and the macroprudential toolkit.

Institutional arrangements

International work emphasises the importance of adequate institutional arrangements so that macroprudential policies can effectively mitigate systemic risk. Three key aspects are covered in the *Report*:

- *Mandate*. A clear mandate for macroprudential policy is essential for reducing the risks of policy inertia. Across jurisdictions, there are three common models for assigning a macroprudential mandate: (1) to the board or governor of the central bank if the central bank is also the prudential supervisor; (2) to a committee within the central bank that also allows the participation of external authorities if the central bank holds both the monetary and macroprudential policy functions; and (3) to an inter-agency committee, usually chaired by the central bank or the ministry of finance, if the powers and financial stability mandates are spread across multiple authorities. Hence, in all three cases the central bank typically plays an important role in the macroprudential decision-making process, which the *Report* suggests is likely to reflect the expertise, incentive to take action and independence of central banks.

2 The earlier international work includes IMF, FSB and BIS (2011a, 2011b), CGFS (2012) and IMF (2013, 2014).

- *Powers*. Macroprudential authorities need sufficient powers to achieve their financial stability mandate. This means that these authorities need the powers to request information, develop and adjust regulatory instruments, designate certain institutions as systemically important and if necessary seek to expand their powers to cover financial institutions that lie outside the regulatory perimeter. The types of powers used vary from hard powers (e.g. implementing a macroprudential tool) to soft powers (e.g. providing a risk warning). Both types of powers are useful, though the *Report* notes that soft powers alone are unlikely to be sufficient.
- *Domestic cooperation*. Coordination problems can arise if the macroprudential policy mandate and/or powers are split across many authorities. Problems can also arise when the objectives of macroprudential policies are in conflict with the objectives of other policies that can affect financial stability (e.g. monetary policy). The international work suggests that inter-agency cooperation can be useful since it allows the relevant authorities to discuss different perspectives on systemic risks, possible tools and the potential for arbitrage opportunities across the various regulations being imposed on financial institutions. The *Report* notes that explicit mechanisms for cooperation and information-sharing can improve the effectiveness of macroprudential frameworks, including legal requirements, memoranda of understanding and inter-agency committee arrangements.

Identifying and monitoring systemic risk

The international work emphasises that timely and appropriate policy decisions require macroprudential authorities to identify and assess systemic risks at an early stage. There is no single framework used across jurisdictions to do so. Rather, the *Report* presents the main types of indicators and approaches typically used by macroprudential authorities for this purpose, including:

- aggregate credit and asset prices, such as the private sector credit-to-GDP gap, which some research has found to be a useful early warning indicator of financial crises and has been incorporated into the Basel III countercyclical capital buffer (CCyB) framework (BCBS 2010; Drehmann, Borio and Tsatsaronis 2011)[3]
- sectoral credit, such as housing credit growth
- maturity and foreign currency mismatches, such as the Liquidity Coverage Ratio (LCR) and the proportion of business debt denominated in foreign currency[4]
- concentration of risk measures, such as the size and interconnectedness of financial institutions
- resilience measures, such as leverage ratios, debt-service burdens and stress tests.

The international work provides two broad suggestions for monitoring systemic risk. The first is that authorities have a comprehensive and flexible framework to regularly monitor risks in the financial system as a whole. This should include monitoring risks that emanate from the non-bank financial sector as well as those arising from innovation in the financial system. The second is that authorities take into account the broader economic context when assessing the signal provided by their systemic risk indicators.

The macroprudential toolkit

As with the identification and monitoring of systemic risk, there is no single framework for choosing and calibrating specific macroprudential policy tools (MPTs). Past experiences suggest that a wide range of tools have been used to address systemic risk. In terms of choosing the appropriate tool, international work suggests that flexibility is needed since the effectiveness of different MPTs

3 The CCyB is a Basel III reform that aims to ensure that banking sector capital requirements take into account the macrofinancial environment in which banks operate.

4 The LCR is a Basel III reform that requires a bank to have an adequate stock of high-quality liquid assets that can be converted into cash easily and immediately to meet its liquidity needs for a 30-day liquidity stress scenario.

is not well understood at present, and probably depends on domestic circumstances. Nonetheless, the *Report* notes that establishing a comprehensive macroprudential toolkit *ex ante* can be useful since it can take some time to finalise the legal and operational features necessary to make use of some MPTs when they are most needed.

There are many options available and choices to make when it comes to calibrating policy responses to systemic risks, including which tools to use, how many tools to use, how targeted the tools should be and whether a gradual or more activist approach should be taken. Another important option is whether the policy response should be based on pre-defined rules or left more to the discretion of policymakers. While a rules-based calibration can in principle address policy inertia and potential political influences, it may not be sufficiently flexible to the shifting sources of risk and improvements in the understanding of the system over time, and could be prone to regulatory arbitrage. Instead, it is common across jurisdictions to use judgement when calibrating macroprudential policy responses; this is often referred to as 'guided discretion'. Nonetheless, some jurisdictions are attempting to provide a more formal quantifiable approach to these decisions (e.g. Hong Kong's indicative CCyB).[5]

Policymakers have many MPTs to choose from. The *Report* separates the MPTs commonly used across jurisdictions into four types:

- Broad-based capital tools: These are tools aimed at addressing vulnerabilities associated with a broad-based credit boom, such as dynamic provisioning requirements, the CCyB and time-varying leverage ratio caps.
- Sectoral capital and borrower-based tools: These are tools aimed at addressing vulnerabilities associated with specific sectors and asset markets. These tools include restrictions on borrowers such as caps on LVRs, debt-to-income ratios and debt-service-to-income ratios, as well as restrictions on lenders such as risk-weight floors and sectoral capital requirements.
- Liquidity-related tools: These are tools primarily aimed at addressing the build-up of liquidity and foreign-exchange risks associated with lending booms. They include reserve requirements, the LCR requirement, the Net Stable Funding Ratio (NSFR) requirement and caps on loan-to-deposit ratios.[6]
- Structural tools: These are tools aimed at addressing vulnerabilities from interconnectedness and limiting contagion. They include interbank exposure limits and additional loss-absorbing capacity for systemically important financial institutions.

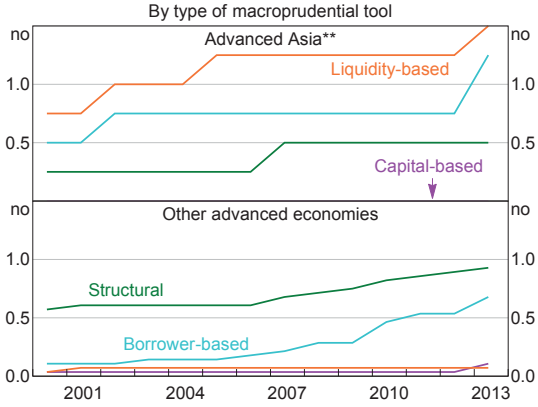
In general, the use of all four types of MPTs has increased across all types of economies over the past decade (Graph 3; Graph 4), though there are some notable differences in the use of MPTs across economies. Advanced Asian economies have made considerably more use of liquidity-based and borrower-based MPTs compared with other advanced economies, which have instead tended to rely more on structural tools (particularly limits on interbank exposures and on the concentration of lending). The use of borrower-based tools such as LVR limits has also increased sharply of late in the advanced economies. Emerging market and developing economies make extensive use of structural tools, though unlike many advanced economies outside Asia, they rely on liquidity tools and capital-based tools as well.

The greater use of liquidity-based and capital-based MPTs in emerging market and developing

5 Hong Kong's CCyB decisions are guided by its Initial Reference Calculator (IRC). The 'composite CCyB guide' is calculated as 1.1 times the simple geometric mean of the credit-to-GDP gap and the residential property price-to-rent gap. The 'indicative CCyB ceiling' sets thresholds of stress based on the interbank market spread and average loan quality that are mapped to a maximum CCyB rate. The IRC rate is then taken as the lower of the composite CCyB guide and the indicative CCyB ceiling, though the authorities can choose to diverge from the IRC buffer guide.

6 The NSFR is a Basel III reform that aims to match the duration of banks' liabilities and assets more closely by comparing liabilities considered stable (such as deposits and long-term debt) with longer-term assets (such as loans).

Graph 3
Use of Macroprudential Tools in Advanced Economies*
By type of macroprudential tool

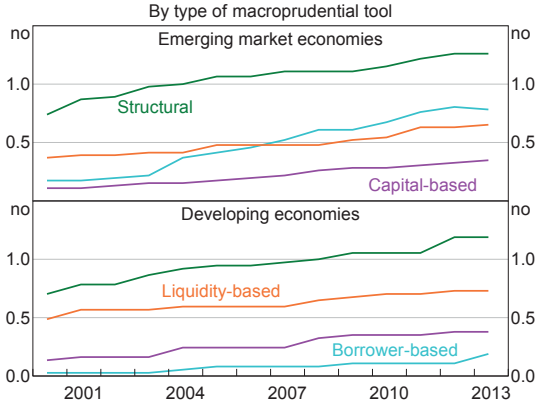


* Use is measured by the average number of tools used per economy type; advanced economies are defined using the October 2016 IMF *World Economic Outlook*

** Advanced Asia includes Hong Kong, Japan, Singapore and South Korea

Sources: Cerutti, Claessens and Laeven (2015); RBA

Graph 4
Use of Macroprudential Tools in Emerging and Developing Economies*
By type of macroprudential tool



* Use is measured by the average number of tools used per economy type; economy types are defined using the October 2016 IMF *World Economic Outlook* and World Bank publications

Sources: Cerutti, Claessens and Laeven (2015); RBA

economies compared with many advanced economies could be attributed to their greater exposures to external shocks, such as volatile capital flows, and their less liberalised financial systems (Claessens 2014). That said, the use of some of these tools can sometimes be motivated by reasons other than financial stability concerns. The main example of this is reserve requirements, which can be used to supplement or substitute monetary policy to reduce capital inflows and manage the exchange rate (Montaro and Moreno 2011; Blundell-Wignall and Roulet 2014). The greater use of borrower-based tools in advanced economies could reflect their more developed mortgage markets, which have been an increasing source of concern for financial stability in the ongoing low global interest rate environment (Cerutti, Claessens and Laeven 2015).

Potential Challenges of Macroprudential Policy

The international work, including the *Report*, alongside that of academic and other commentators, has discussed a number of challenges that macroprudential authorities face when designing policy frameworks and employing MPTs. These challenges include: measuring the effectiveness of MPTs; the potential for leakage and spillovers; the interaction between MPTs and other policies; and the limited experience with relaxing or deactivating time-varying MPTs.

Measuring effectiveness of macroprudential tools

To date, the evidence on the effectiveness of MPTs is mixed.[7] The *Report* highlights several themes that appear in the literature. Aggregate and sectoral capital-based tools appear to support financial system resilience and promote credit growth in economic downturns, though there is only limited evidence that these tools dampen the pace of credit growth once a credit boom has started. On the other hand, borrower-based tools appear to dampen credit growth and increase borrower resilience, though there is limited evidence that these tools affect the pace of housing price growth. The effects of most liquidity-related tools (e.g. LCR, NSFR) are as yet unknown since they are relatively

7 For recent work on the effectiveness of macroprudential tools, see Claessens (2014), Akinci and Ohmstead-Rumsey (2015) and Cerutti *et al* (2015).

new. Notwithstanding these themes, the *Report* acknowledges that there is no consensus in the literature on which tools are the most effective and under what circumstances. This makes it challenging for the relevant macroprudential authority to know which, if any, of the tools it should implement.

The mixed evidence on the effectiveness of MPTs to date could arise from a number of factors:

- There is only a *relatively short sample period* in which MPTs have been widely used, particularly in advanced economies and for certain types of tools. This makes it challenging to find statistically significant evidence for or against their effectiveness. Moreover, if some tools are only effective under certain circumstances, it will be difficult to show their effectiveness since a wide range of country experiences with MPTs would first be needed to establish statistical significance.
- *The overall aim of macroprudential policy – financial system stability – cannot be mapped into a clear single target*. A multiplicity of intermediate targets has been proposed, including: sufficient levels of bank capital; sound liquidity and risk management; prudent lending standards; and robust crisis resolution frameworks. However, it is not clear how these intermediate targets translate to the ultimate goal of financial stability. As a result, financial stability cannot be quantified in a precise manner, making the effectiveness of MPTs in terms of their contribution to the degree of financial stability difficult to measure.
- *MPTs are many and varied and their transmission mechanisms to achieve the various intermediate targets are largely unknown*. Not only is the mapping from intermediate target to the ultimate goal unclear, but so is the relationship between particular MPTs and achievement of these intermediate targets. Combining this with the use of multiple MPTs and the potential for the transmission channels of these tools to interact causing unintended consequences highlights the complexity involved in measuring the effectiveness of individual tools.
- *It is difficult to isolate the effects of MPTs*. Many of the intermediate objectives that the tools aim to achieve will also be influenced by other policies, domestic circumstances, and economic and financial developments, making it challenging to disentangle the effects of different MPTs from these other influences.

Overall, this section highlights that there is still considerably more work to be done in this space. As more experiences with macroprudential policy are collected across different jurisdictions, transmission mechanisms of the tools are better understood and the effects of these tools assessed over a longer period, the body of research on their effectiveness will expand. As a result, policymakers should find it easier over time to know which tools are likely to be most appropriate for their circumstances.

Leakage and spillovers

There is evidence that MPTs can result in leakage, both within and across jurisdictions, which further complicates the measurement of their effectiveness. In terms of cross-border leakage, Aiyar, Calomiris and Wieladek (2014) find that one-third of the fall in lending resulting from higher bank capital requirements in the United Kingdom was offset by lending by foreign branches that were exempt from the requirements. An example of both cross-border and domestic leakage is the implementation of a cap on bank credit growth in Croatia in 2003, which slowed bank credit growth but was accompanied by a strong rise in the growth of foreign borrowing as well as loans and financial leases provided by domestic leasing companies (Galac 2010). On the other hand, there has been little evidence of leakage from New Zealand's 2013 LVR limits on mortgage lending (OECD 2015). While all types of MPTs can experience leakage, the *Report* notes that leakage from borrower-based tools is more easily contained than for capital-based tools. In addition to leakage, MPTs could also have undesirable

spillovers if financial institutions respond by shifting their risky activities into other jurisdictions or other domestic industries.

Given the potential for leakage and spillovers, international work has emphasised the importance of jurisdictions monitoring all areas of the financial system, taking actions to contain domestic risks and considering the potential for negative cross-border and domestic effects when designing and calibrating their tools. In addition, the international work has noted the potential for collaboration on macroprudential policy to help address leakage and undesirable spillovers, including reciprocity arrangements such as those agreed for the Basel III CCyB. Some integrated regions, such as the Nordic countries and the euro area in general, have sought to address the impact of cross-border leakage and spillovers by establishing reciprocity arrangements for MPTs as well as mechanisms to monitor regional risks.

Interaction with other policies

It is uncertain how macroprudential policies should best be used in the context of other policies. As discussed in IMF (2013), fiscal and monetary policies, among others, can also affect financial stability and either complement or conflict with macroprudential policy. For example, expansionary monetary policy promotes additional risk-taking, which could increase systemic risks even when they are already high. As a result, the macroprudential authority needs to consider how its policy objectives are affected by the stance of other policy tools (and vice versa for other policymakers). The *Report* suggests that some form of coordination between policymakers may be needed to resolve any significant tensions between macroprudential policies and other policies (e.g. inter-agency committee arrangements). More research on the interactions of macroprudential policy and other policies as well as more experiences of coordination should help alleviate this challenge to some extent.

Relaxing tools

There are relatively few experiences to date of relaxing time-varying MPTs once the risk is assessed to have diminished (Cerutti *et al* 2016). This skew towards tightening could reflect the ongoing low interest rate environment and may change once the data collected span a full financial cycle. However, it could also reflect the challenges that macroprudential authorities and other policymakers face when determining the appropriate conditions and strategies for the relaxation of MPTs, especially given the challenges in quantifying a decline in the degree of systemic risk and related biases towards maintaining measures intended to enhance resilience in the absence of clear evidence that the risks have receded. Notably, there could be significant costs to relaxing tools too early or too late (CGFS 2012; IMF 2014); relaxing a tool too early could lead to a further build-up in financial imbalances, while relaxing a tool too late could exacerbate a slowdown in credit and economic activity.

An Australian Perspective

The relevant agencies consider the Australian regulatory framework to be consistent in broad terms with the guidance provided by the international work, though in some respects Australia has a less formal framework than many other economies. The Australian framework includes: a shared responsibility for financial stability across regulatory agencies with effective coordination arrangements; clear mechanisms for identifying and monitoring systemic risk; and a number of policy tools available to contain systemic risk, including supervisory tools. In particular, the Australian authorities have taken a holistic approach, seeing macroprudential policy as being subsumed within a broad and comprehensive financial stability policy framework that is backed by inter-agency cooperation and coordination. Furthermore, the Australian Prudential Regulation Authority (APRA) modifies the intensity of its prudential and supervisory tools in line with variations in the level

of institution-specific risks as well as overall systemic risks. This framework is viewed as having been effective to date in helping to mitigate systemic risk; the policy actions taken in late 2014 to shore up prudent residential housing lending standards is a recent example as outlined below.

Macroprudential policy within the Australian financial stability framework

Four main agencies play a role in managing financial stability. APRA is the primary regulator of financial institutions and has an explicit statutory financial stability mandate. It supervises a range of institutions including banks and other deposit-taking institutions, sets prudential standards and holds a wide range of directive and resolution powers. It is also the only agency with the power to directly change the behaviour of financial entities, and hence the majority of the tools for macroprudential policy in Australia can only be exercised by APRA. The Reserve Bank of Australia provides liquidity to the financial system, has regulatory powers over clearing and settlement facilities and the payments system, and incorporates financial stability assessments in its monetary policy decision process and publications. The Australian Securities and Investments Commission (ASIC) is the corporate regulator, promotes market integrity and helps to ensure sound consumer protection laws, including within the financial sector. The Australian Treasury provides advice to the government on public legislation and enacting the Treasurer's powers. The actions of these four agencies in promoting the stability of the Australian financial system are coordinated by the Council of Financial Regulators (CFR), which is chaired by the Reserve Bank Governor. The CFR serves as a discussion and information-sharing forum for its four members and as a means of coordinating macroprudential and other regulatory actions, though it has no regulatory functions or powers apart from those of its individual members.

APRA and the Reserve Bank undertake a variety of analyses to assess systemic risk. Both agencies use a broad range of information to detect emerging vulnerabilities and risks to the financial system, including individual institution credit, balance sheet and other data, macroeconomic and asset price indicators and behavioural indicators (e.g. measures of risk appetite). Lending standards and the capacity of borrowers to service their debts receive particular attention. In carrying out its duties, APRA takes an industry-wide or systemic perspective, consistent with its financial stability mandate. For example, APRA's risk-based approach subjects institutions that pose greater systemic risks to more intensive supervision and APRA can apply higher capital or other prudential requirements on a financial institution of concern.[8] APRA also undertakes 'bottom-up' system-wide stress testing and the Reserve Bank is currently developing a 'top-down' system-wide stress testing framework. This approach to detecting financial stability risks helps to ensure that a broad range of indicators and developments is taken into account in order to determine where the most significant risks lie.

In terms of policy actions to mitigate the identified risks, both agencies see macroprudential policy as inseparable from microprudential policy. In essence, effective policy measures to mitigate financial stability risks are seen as ensuring ongoing good *microprudential* supervision as much as *macroprudential* policy. The framework is therefore not just about regulation, but also ongoing supervision at an institutional level that takes into account a macro perspective (including the supervision of lending standards and practices).[9] Against this background, APRA can use a variety of tools to address systemic risk, including its supervision and its prudential tools. APRA's toolkit includes the CCyB, which has an explicit macroprudential focus in line with the Basel

8 For further details, see RBA and APRA (2012).

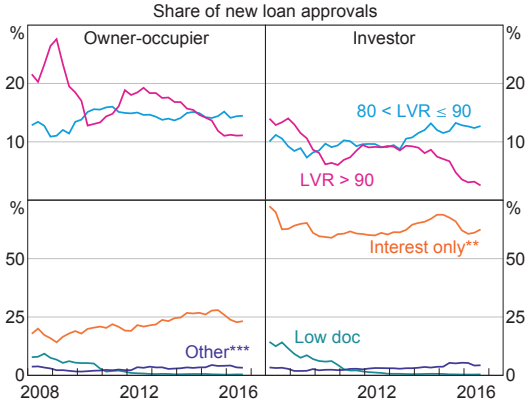
9 For further rationale and details of this approach, see Edey (2012), Ellis (2012, 2014) and RBA and APRA (2012).

framework, and other measures such as the LCR and the capital buffers for domestic systemically important banks. APRA also has the ability to alter the behaviour of regulated entities through its advisory capacity, communication with individual entities and industry, public commentary and its directive powers. The complementary instruments available to the Reserve Bank in pursuing its financial stability objective include the use of its role as liquidity provider to the financial system. The Bank also recognises that the setting of macroeconomic policies needs to be informed by financial stability developments, and financial stability assessments are therefore regularly incorporated into its decision-making processes. Public discussion of these assessments in the semiannual *Financial Stability Review* also aims to help shape the risk assessments and decisions of households and firms.

An example in the context of Australia

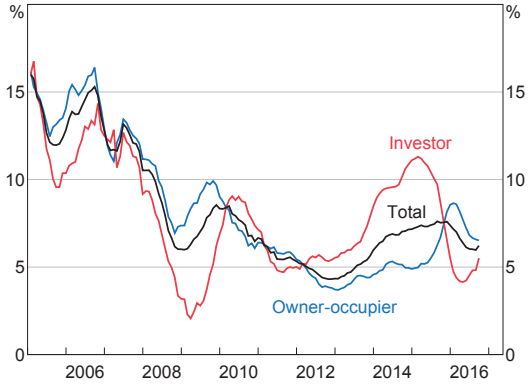
A recent example of the interaction between supervisory and macroprudential policy is the approach taken by the Australian regulators in late 2014 to reinforce residential housing lending practices. At that time, a number of trends were raising concerns about the level of risk-taking by banks and other financial institutions as well as households in the housing market. In particular, aided by lower funding costs, price competition in the mortgage market had intensified, with lenders extending larger discounts on their advertised variable rates and broadening the range of borrowers that received these discounts. In this climate, the characteristics of new loan approvals suggested that some non-price lending terms had started to be relaxed. For instance, the share of new loans extended by authorised deposit-taking institutions (ADIs) on interest-only terms to owner-occupiers and investors had been drifting up (Graph 5). These loans tend to amortise more slowly than principal and interest loans, which increases the risk of borrowers moving into a negative equity position (and being more likely to default) in the event of a decline in nominal housing prices. In addition, investor lending had increased sharply, with investor loan approvals in New South Wales more than doubling since 2012. Nationally, investor housing credit growth had picked up to over 10 per cent in six-month annualised terms (Graph 6) and housing price growth in Sydney and Melbourne had been strong. This was cause for some concern since investors are likely to induce a more pronounced cycle in housing prices than would otherwise occur, in part because they face fewer barriers to exit when the housing market

Graph 5
ADIs' Housing Loan Characteristics*
Share of new loan approvals



* Series are break-adjusted for reporting changes
** Investor series is seasonally adjusted
*** 'Other' includes loans approved outside normal debt-serviceability policies and other non-standard loans
Sources: APRA; RBA

Graph 6
Housing Credit Growth
Six-month-ended annualised



Sources: APRA; RBA

turns down (Haughwout *et al* 2011; RBA 2015). Any subsequent downswing could have posed risks to the housing market and household balance sheets overall, not just those of the recent investors. While these risks were largely macroeconomic in nature, risks to the financial sector were also increasing.

Against this background, APRA and ASIC announced a number of prudential and supporting supervisory measures to address the growing risks being undertaken by the banking sector and households. These actions were taken following discussions within the CFR, and built on increased supervision and communication on housing market risks that had already been undertaken by the CFR member agencies at the time. In particular:

- In December 2014, APRA advised that: (i) supervisors would be alert to annual growth in a bank's investor housing lending above a benchmark of 10 per cent; (ii) serviceability assessments for new mortgage lending should include interest rate buffers of at least 2 percentage points above the effective variable rate applied for the term of the loan, and a minimum floor assessment rate of at least 7 per cent to allow borrowers to accommodate future increases in interest rates; and (iii) supervisors would be alert to high levels of higher-risk mortgage lending, such as lending with a high LVR and/or loan-to-income ratio and lending to owner-occupiers with lengthy interest-only periods. In contrast to the approach used in other countries, these benchmarks were not intended to be 'hard' limits. However, where a bank was not maintaining a prudent approach to housing lending practices and/or where a bank's growth in investor lending materially exceeded APRA's stated 10 per cent benchmark, these could serve as a trigger for more intense supervisory action, potentially including additional capital requirements.
- At the same time, ASIC announced that it would undertake a loan review to determine whether lenders' interest-only housing lending practices complied with responsible lending obligations. This included the condition that new borrowers do not overstretch themselves to purchase property or rely on expectations of future increases in housing prices to enable them to do so. The results of this review indicated several instances where this and other conditions had not been met. ASIC followed up with a review of large mortgage broker lending practices in September 2016.
- In early 2015, APRA undertook the first of several 'hypothetical borrower' exercises, which required lenders to provide serviceability assessments for two hypothetical owner-occupier borrowers and two investor borrowers. The results revealed large variability in lending limits and serviceability practices across the industry. Partly in response to these concerns, APRA stepped up the intensity of its supervisory activities by: (i) increasing its analysis of lenders' underwriting standards, including strengthening household income definitions in pre-loan serviceability calculations (e.g. applying a discount to some income such as bonuses and overtime) and presenting its concerns to the chief risk officers and senior management of banks; (ii) tightening requirements around interest-only lending; and (iii) conducting onsite reviews of past and new loan documents to spotlight additional areas where stronger actions are needed to enhance resilience.
- In late 2016, APRA put out for public consultation a revised *Prudential Practice Guide* that formalised the recent tightening of standards on serviceability buffers and interest-only lending for residential mortgages (APRA 2016).

Lenders have since announced many changes to a range of price and non-price lending terms and conditions to strengthen their lending practices in response to supervisory expectations. In particular, interest rates for both new and existing investor loans were increased,[10] high-LVR lending

10 There is now a differential between the indicator rate for owner-occupier and investor housing loans for the first time since 1996.

(above 90 per cent) was further reduced (for new loans) and serviceability criteria for housing loans were tightened across a range of metrics.[11] By April 2016, the pace of investor housing credit had declined from its recent peak of about 11 per cent to just below 5 per cent on a six-month annualised basis (Graph 6).[12] Nonetheless, loan approvals for investor housing have increased over recent months, accompanied by an increase in housing price growth, driven by Sydney and Melbourne in particular. Even so, the earlier tightening in lending standards has helped to increase the resilience of household sector balance sheets, and hence also those of lenders, as new borrowers should be better placed to withstand any adverse shocks to income or decline in housing prices than would otherwise have been the case.

Conclusion

With the use of macroprudential policy increasing, international institutions have been monitoring and examining international experiences with macroprudential frameworks and tools as well as the potential lessons from these experiences. To date, this work has indicated that a range of frameworks and practices have been used to manage the systemic risks faced by each jurisdiction. In addition, policymakers face a number of challenges when designing macroprudential frameworks and employing macroprudential tools; as more experience with these frameworks and tools is gained, some of these challenges may diminish. In Australia, the relevant agencies have found that the use of a macroprudential focus within their broad regulatory and supervisory approach has helped to underpin an effective framework and thereby enhance the overall level of financial stability.

11 For details, see RBA (2015).

12 The risk of leakage through non-ADI originators is expected to be limited, given that these lenders are a small part of the market and they have limited scale and capacity to write large volumes of loans. They also rely on warehouse funding from banks, which regulators are monitoring. Reports from liaison also suggest that there is unlikely to be sufficient appetite from institutional investors to absorb any material increase in the issuance of residential mortgage-backed securities, which are the originators' main source of funding, though this is an area that will receive ongoing attention.

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Reserve Bank Publications

Most of the publications listed below are available free of charge on the Bank's website (www.rba.gov.au). Printed copies of these publications, as well as a wide range of earlier publications, are also available on request; for details refer to the enquiries information at the front of the *Bulletin*.

Statement on Monetary Policy

These statements, issued in February, May, August and November, assess current economic conditions and the prospects for inflation and output.

Financial Stability Review

These reviews, published semiannually, 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*

Research Discussion Papers (RDPs)

This series of papers is intended to make the results of current economic research within the Bank available for discussion and comment. The views expressed in these papers are those of the authors and not necessarily those of the Bank.

Abstracts or introductions of all RDPs, and the full text of RDPs published since 1988, are available on the Bank's website.

Conference Volumes

Conference volumes have been published on the Bank's website since 1993. The most recent titles are:

- *Structural Change in China: Implications for Australia and the World,* March 2016
- *Small Business Conditions and Finance,* March 2015
- *Financial Flows and Infrastructure Financing*, July 2014
- *Liquidity and Funding Markets*, December 2013
- *Property Markets and Financial Stability,* December 2012
- *The Australian Economy in the 2000s,* December 2011
- *Reserve Bank of Australia 50th Anniversary Symposium,* July 2010
- *Inflation in an Era of Relative Price Shocks,* May 2010

Other Publications

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

- *Dual-Network Cards and Mobile Wallet Technology: Consultation Paper,* December 2016
- *Survey of Foreign Exchange and Derivatives Markets*, September 2016
- *Reserve Bank of Australia Corporate Plan*, 2016/17
- *Review of Card Payments Regulation: Conclusions,* May 2016
- *Consultation on Changes to the Bank's Standards for Card Payment Systems*, December 2015
- *Reserve Bank of Australia Corporate Plan*, 2015/16
- *Submission to the Senate Inquiry into Matters Relating to Credit Card Interest Rates*, August 2015
- *Central Clearing of Repos in Australia: A Consultation Paper,* March 2015
- *Review of Card Payments Regulation – Issues Paper,* March 2015
- *Submission to the Inquiry into Digital Currency,* November 2014

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Remarks to FINSIA's Regulators Panel, Guy Debelle, Deputy Governor, November 2016

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The Global Code of Conduct for the Foreign Exchange Market, Guy Debelle, Assistant Governor (Financial Markets), September 2016

The New Regulatory Framework for Surcharging of Card Payments, Tony Richards, Head of Payments Policy Department, at the 26th Annual Credit Law Conference, September 2016

After the Boom, Christopher Kent, Assistant Governor (Economic), September 2016

Remarks to the Asian Development Bank – Institute of Global Finance International Conference, Philip Lowe, Deputy Governor, September 2016

Remarks at a Reserve Bank Board dinner with members of the Sydney community, Philip Lowe, Deputy Governor, September 2016

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Disclaimer

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