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The Mortgage Interest Rates and Cash Rate Cycle Relationship and International Funding Cost: Evidence in the Context of Australia[1]

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Abstract

Australia is a nation of home-loan borrowers. Hence, the movement of mortgage rates is closely watched in the country. Borrowers expect mortgage rates to synchronise with the cash rate, particularly when the cash rate decreases. More recently, however, the media has reported a weakening of this link. This has been accompanied by complaints from the public and politicians that banks no longer automatically pass on full reductions in the cash rate to mortgage holders. Banks claim that this is due to the effect of international funding costs. We test this claim in this paper. We investigate the relationship between mortgage rates and the cash rate, taking into account international funding costs in the context of Australia. Using a battery of econometric tests, we analyse data pertaining to all 20 Australian banks during the period 1996 to 2012. We find that international funding costs significantly affect mortgage rates, but the cash rate still continues to drive mortgage rates in Australia. However, the linkage between the cash rate and mortgage rates has indeed weakened since 2006. Our findings, therefore, confirm the divergence of mortgage rates from the cash rate cycle and provide support for the claim by banks that this is due to the effect of international funding costs. The innovation of this paper is that it is the first to test the effect of international funding costs in the context of the cash rate cycle and mortgage interest rate relationship in Australia.

Keywords: Bank mortgage rates, cash rate, international funding cost.

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1. Introduction

The globalisation and integration of financial markets has led to the snowballing reliance of the Australian lending sector on those markets. The global financial crisis (GFC) initiated by the US sub-prime mortgage crisis triggered banking liquidity problems and economic recessions worldwide: this led to an increase in bank funding costs in global and Australian markets. This in turn unfavorably affected the Australian banking industry because these lenders now significantly rely on international financial markets to source their funds (Davis, 2011; Ralston and David, 2011). As of 2012, Australian banks' international liabilities accounted for 52% of GDP (Bailey, Van Uffelen and Wood, 2012). The crisis, therefore, highlighted the importance and urgency of understanding the extent of the impact of international financial markets on the mortgage costs of Australian bankers.

This paper closely examines a mortgage rate issue that is highly important to Australian policymakers, bankers, and ordinary households, among others. According to CoreLogic and RP Data, in July 2014, the residential housing market was valued at AU$5.6 trillion, 3.5 times larger than the listed equity value of AU$1.6 trillion and the annual output of the economy (AU$1.53 trillion GDP in 2013). More importantly, mortgages accounted for 60.2% of the total outstanding loans of banks while borrowings for business and other purposes only accounted for 33.4% and 6.4%, respectively (Property Capital Market Report, 2014 – Issue 01). Mortgages outstanding as at June 2014 reached AU$1.37 trillion (RBA, table D2[3]). Based on this figure, if interest rates were increased by 25 basis points, mortgage interest costs alone would rise by $3.446 billion per annum. From a historically high level of 17% in 1989, mortgage rates in Australia are now at a historically low level of 5.10%. If current interest rates were to increase by 3% (i.e. 300 basis points) to 8.10%, one may ask a practical question: What would happen to mortgage costs in Australia? This implies that mortgage holders would pay an extra $41.4 billion per annum which would put many borrowers in financial distress and create further housing affordability problems[4]. The huge extent of media coverage and political interest in relation to mortgage interest rate movement provides a clear indication of the importance of this issue. Since the GFC, publicity about lenders' pricing behaviour has greatly increased, as exemplified by statements in the media such as: 'Australian homeowners … fearing the big four banks will react to the shift in the global funding marketplace … the nation's big four will need to resort to "out-of-cycle" interest rate rises – lifting their lending rates beyond changes in the official cash rate' (*International*

[3] http://www.rba.gov.au/statistics/tables/index.html

[4] Australia is listed among the worst housing affordability nations in the World, in Demographia (2014), 10th Annual Demographia International Housing Affordability Survey, pp, 1-58, at http://demographia.com/dhi.pdf

funding fight gets tougher for local banks in Herald Sun, 2014). The debate is about why banks do not necessarily pass on decreases in cash rates to mortgage holders and banks have countered that their funding cycle is different now from the cash rate cycle primarily because of their international funding costs.

In spite of the strong coverage of the issue by both the media and politicians, no systematic empirical studies have yet investigated this claim by Australian banks. Prior Australian studies focus on determinants of mortgage fees (Liu and Roca, 2014) and on the effect of cash rate on mortgage rates and credit card interest rates (Karamujic, 2011; Lim, Tsiaplias, and Chua, 2013; Lowe and Rohling, 1992; Valadkhani, 2013, 2014; Valadkhani and Anwar, 2012). However, none of these has dealt specifically and extensively with the effect of changes in international funding costs on mortgage interest rates. Also, the high presence of overseas funding sources may lower the effect of the cash rate on mortgage rates: This has not hitherto been researched in the literature. This study sheds a new light on these knowledge gaps, contributing to the literature on banking and mortgage pricing in particular and on financial market integration in general.

Australia has recently experienced upward trends in the market interest rate spreads, while the synchronous decline in absolute terms of funding costs, lending rates and the cash rate has gradually occurred since 2008. Australian lenders have increased the spreads over the cash rate of all their operating interest rates, indicating changes in their pricing behaviour. Dean and Stewards (2012) claim that since the GFC, both deposit and lending interest rates have been synchronised with the cash rate reduction in absolute terms; however, their average spreads over the cash rate have been increasing. The work of Stewart, Robertson and Heath (2013) and of Berkelmans and Duong (2014) draw conclusions alike to Dean and Stewards (2012). Their assertion is empirically confirmed by Valadkhani (2014) who provides solid evidence of a significant upward shift of the mortgage rate spreads over the cash rate for the 39 sampled lenders since the 2007 GFC. However, Valadkhani (2014) uses only the GFC as the dummy variable, representing the cost of wholesale funding, to identify the changes in the funding costs. None of these authors has empirically detected other factors driving mortgage rates apart from the cash rate. In this paper, we address the second question: Do the differences in pricing behaviour between mortgage lenders and policymakers (the RBA) stem from the large proportion of offshore mortgage funding?

In this study, we provide a scientific investigation of this issue. We empirically examine the relationship between the cash rate cycle and the mortgage rates and how this has been affected by international funding costs. In particular, we conduct a dynamic examination of the relationship between mortgage rates and the cash rate. We also investigate the

extent by which international funding costs have affected mortgage rates. We analyse the movement across time of the relationship between mortgage rates and the cash rate and foreign funding costs. We use a battery of advanced econometric techniques such as Dynamic Conditional Correlations (DCC), Autoregressive Distributed Lag (ARDL), Granger Causality, Cointegration, the Vector Error Correction Model (VECM) and Impulse Response Functions to analyse time series data covering the period 1996:11 to 2012:8.

This paper makes at least three key contributions to the literature. Firstly, this study is the first paper that provides systematic evidence on the link between offshore funding costs and mortgage interest rates in relation to the Australian residential housing market. This relationship is tested using the London Interbank Offer Rate (converted to an Australian rate), unlike other studies such as Valadkhani (2014) who uses the GFC as a proxy for changes in the costs of funding. Secondly, this study contributes by capturing the full costs of mortgages through the use of effective interest rates, in contrast to prior researchers (e.g., Lim, 2013; Valadkhani, 2012; Valadkhani and Worthington, 2014) who employed only the nominal interest rates as proxy for mortgage rates to examine the relationship between the cash rate and home loan rates. Since Australian mortgage holders are charged significant fees by lenders (Liu and Roca, 2014), the use of effective interest rates as the proxy for mortgage rates would therefore be more appropriate. Finally, our findings are of practical usefulness to the Reserve Bank of Australia (RBA), the Australian Prudential Regulation Authority (APRA), policymakers, lenders, and the real estate industry, as well as to mortgage holders. Our empirical findings confirm that the Australian mortgage market has become increasingly integrated with the global financial market, while decreasingly relying on the cash rate. Therefore, this confirms that the RBA and related parties need to pay close attention to the volatility of the changes in offshore funding costs when setting their policy rates, pricing policies, and borrowing decisions.

The rest of the paper is organised as follows: Section 2 discusses previous relevant studies relating to issues in Australian residential housing markets and developments of hypotheses; Section 3 describes the data and outlines the methodology used to examine our research hypotheses; Section 4 analyses the empirical results. Section 5 presents a summary of the results and outcomes.

2. Literature review and research hypotheses

2.1. Cash Rate Pass-through on Mortgage Rates

A number of studies scrutinise the monetary policy transmission mechanism with regard to the policy interest rate pass-through to mortgage lending rates, specifically in developed financial markets. Techniques used in prior studies can be divided into two main categories: Conventional linear methods and non-linear switching models. The former were used by Heffernan (1997) to examine the degree of funding-cost pass-through on mortgage rates in the UK; the latter have been widely employed by Scholnick (1996) and many other researchers. For example, Hofmann and Mizen (2004) who used the non-linear switching model to explore the relationship of the base rate (the average interest rate of the four major clearing banks in England) with deposit rates, and with mortgage rates, find a complete long-term pass-through for deposit rates but not for mortgage rates. The pass-through literature on the effect of policy rates on market rates has been enriched by studies such as those of Chong (2010), Chong, Liu, and Shrestha (2006) in the Hong Kong and Singaporean markets as well as (Liu, Margaritis, and Tourani-Rad, 2008; 2011) in the New Zealand market. These authors confirm the findings of Hofmann and Mizen (2004). Interestingly, recent studies conducted in the US mortgage market (Payne, 2006a; 2006b, 2007) that show miscellaneous results, particularly the incomplete long-term pass-through of the Federal Fund rate (FFR) to the mortgage rates, are similar to the work of De Graeve, De Jonghe, and Vennet (2007). However, mixed outcomes have been found in the literature regarding the short-term responses of mortgage rates, affirming that the fixed mortgage rate does not have any short-run response to FFR (Payne, 2006a), but there is a short-term reaction of the rates of conventional mortgages and adjustable newly built mortgages (Payne, 2006b, 2007).

In the Australian mortgage market, increasing attention to lending pricing behaviour in relation to the response of mortgage interest rates to cash rate changes has recently attracted researchers although their prior work has provided ambiguous findings. Both the incomplete short- and long-run pass-through of the cash rate to mortgage rates have been documented by Lowe (1995) to be 0.56 and 0.65 respectively. Lim (2001) finds a complete cash-rate pass-through that favours borrowers with a pass-through of rate cuts faster than that of rate rises. By contrast, recent research shows that changes in cash rate have incompletely passed on mortgage lending rates, both in the long and short terms (Valadkhani, 2013, 2014; Valadkhani and Anwar, 2012; Valadkhani and Bollen, 2013). However, the models of Valadkhani and Anwar (2012) could suffer from misspecification because they are bivariate models. These researchers emphasise that their results are based on '*ceteris paribus*'. In particular, these authors assume that all the other factors affecting the dependent variables are constant, and hence, they have not controlled for these other variables. In reality, however, these variables are inconstant. In addition, they only use normal interest rates to be as proxies for mortgage rates rather than effective interest rates. Overall, their work is consistent with the conclusion that

changes in policy interest rate (the cash rate) strongly affect Australian financial market rates (Smales, 2012; Valadkhani, 2013; Valadkhani and Anwar, 2012; Valadkhani and Bollen, 2013; Valadkhani and Worthington, 2014). Based on the literature, we therefore provide the following hypothesis:

Hypothesis 1: Changes in the cash rate positively affect effective interest rates of standard adjusted mortgages in both the short term and the long term, as effective rates cover all types of fees and normal interest rates, reflecting the total costs of a mortgage.

2.2. International Funding Costs and Australian Banks

We have so far not found any empirical studies assessing the important issue of offshore funding costs and their effect on the mortgage interest rates of banks in Australia. Indeed, in recent years, we observe instead numerous debates between politicians, the public and Australian lenders over this topic in the media. Bailey et al., (2012), Deans and Stewart (2012), Stewart et al., (2013), and Berkelman and Duong (2014) present facts and figures that show the increasing trend of offshore funding costs, analysing some key elements that influence lender pricing. By 2014, appropriate 35% of Australian mortgage funding has been raised from global financial markets (The Australian Mortgage Report 2014, Deloitte, p.28). The lack of empirical evidence on this issue encourages us to conduct this study.

The heavy reliance of Australian banks on offshore funding sources during the last decade might arise from several reasons. Since 2000, Australian lenders have tapped overseas wholesale markets, as stated in Davis (2011), Bailey et al. (2012), Deans and Stewart (2012), Stewart et al., (2013), and Berkelman and Duong (2014). These authors show that the amount of domestic funding had decreased from 2000 to 2007, while that of offshore funding had increased. Davis (2011) concludes that international wholesale funding has played a significant role in banks financing, accounting for 20% to 30% of the total liabilities of banks during the last decade. Since post GFC, there has been a significant increase in domestic deposits and less dependence on overseas funds because of funding liquidity constraints in offshore markets. However, the offshore funding composition was still large, accounting for around 38% of mortgage funding in 2011, indicating a still very high position in the use overseas debt, just behind the UK, Italy and Mexico (Stewart et al., 2013). Moreover, the proportion of Australian mortgage funding accounted by overseas sources, which stood at 35%, was much higher than that of Canada (i.e. 12.8%) (The Australian Mortgage Report 2014, Deloitte, p. 28). In brief, the Australian lenders' funding costs may be significantly affected by the costs of

international funding due to a large volume of Australian debt funding coming from overseas. Hence, we develop the following hypothesis:

Hypothesis 2: We anticipate a positive response of mortgage interest rates of banks to changes in international funding costs.

2.3. The Cash Rate Cycle, International Funding Costs and Mortgage Rates.

From the late 1990s to 2006, the decreasing dominance of the traditional lenders (i.e. commercial banks) in providing home-loans is seen as one of the key explanations why these banks followed the cash rate cycle even if they were affected by overseas funding costs (Yates, 2014). In particular, four factors have impeded the dominance of the four major banks: An increasing growth of the residential mortgage backed securities (RMSB) through securitization; a proliferation of non-bank lenders (Commonwealth of Australia 2007:5); technological advances that allowed customers to compare interest rates among lenders; and policy measures that facilitated switches among lenders (RBA 2008: 14–17). Therefore, increasing competition resulted in a reduction in the spread between the standard bank variable mortgage rate and the cash rate during the period 1995–2006 (Yates, 2014). More importantly, the close association between the cash rate and bank interest rates from 1995 to 2006 caused by the loosening of credit policy resulted in this synchronised rate-setting behaviour (Yates, 2014). In brief, increasing competition in the mortgage market and a firm relationship between the policy rate and mortgage rates are the two main justifications for the synchronisation of bank funding costs and the cash rate.

The decreasing effect of the cash rate on mortgage rates since 2007 arises from three main reasons. Firstly, the restructure of the Australian mortgage market since 2007 arising from the withdrawal of mortgage brokers and the collapse of the RMBS[5] market has triggered higher costs of funding because Australian lenders have replaced their short-term wholesale funding with domestic deposits (Battelino, 2009: 71, Davis, 2011). Prior to the GFC, mortgage corporations (such as Wizard Home Loans) mainly funded their lending books by issuing RMBS to international financial markets and therefore could compete against banks in the home loan market. However, since the 2007 GFC, the global securitisation market has been frozen; as a consequence, non-bank lenders have nearly withdrawn from the market, resulting in a recovery of banks' pricing power. Secondly, a perception of bank safety has been established by the four domestic majors

[5] The share of home-loans funded through securitisation had peaked at 25% by mid-2007, plummeted to 2% in 2011 and slightly recovered at 5% in 2014 (Yate, 2014, RBA 2011b: 36, RBA 2014)

which have similar funding patterns and AA or above credit ratings[6] (Davis, 2011); therefore, their dominance might have encouraged them lenders to widen their margins over the official cash rate. Thirdly, the effect of the GFC on offshore funding costs has induced lenders to revalue risk (Debelle, 2012). Australian lenders have tightened their credit conditions resulting in a breakdown of the firm relationship between the cash rate and mortgage rates (Yates, 2014). These notions explain why Australian banks have been reluctant to follow the cash rate movement since the 2007 GFC. Therefore, we form the third hypothesis:

Hypothesis 3: The effect of the cash-rate cycle on mortgage rates has been weakened by the increasing reliance of lenders on offshore funding.

3. Methodology and Data

3.1. Methodology

We examine the long-term and short-term relationships between mortgage rates, on one hand, and the cash rate and international funding costs, on the other hand. We therefore examine the relationship between mortgage rates and the costs of funds by banks: That is, the cash rate and international funding costs.

The cash rate is the benchmark for mortgage pricing (Lim et al., 2013) as it affects the domestic costs of funds such as domestic deposits and domestic borrowings by banks. From the perspective of funding costs, as analysed by Deans and Stewart (2012), deposits are the major sources of funding so that changes in deposit rates do affect mortgage rates. As well as financing in the local deposit market, Australian lenders raise a large proportion of their funds from offshore sources (Bailey et al., 2012). Hence, the analogous justification of Deans and Stewart (2012) for international costs of funding is as a determinant of mortgage rates (See Sections 2.2 and 2.3).

The examination of the relationships between mortgage rates, cash rate and international funding costs is undertaken within a Vector Autoregression (VAR) and Vector Error Correction Model (VECM) context. The dynamic causal relationship among these variables in the long run is investigated using cointegration based on the Autoregressive

[6] In the late of 2000s, the four majors were among only nine large banks in the world to have an AA or better credit ratings (Davis, 2011)

Distributed Lag (ARDL) model[7] (also called the bounds test approach), proposed by Pesaran, Shin, and Smith (2001) represented by the following equation:

$$\Delta y_{1t} = \beta_0 + \Sigma\, \beta_i \Delta y_{t-i} + \Sigma\gamma_j \Delta x_{1t-j} + \Sigma\delta_k \Delta x_{2t-k} + \theta_0 y_{t-1} + \theta_1 x_{1t-1} + \theta_2 x_{2t-1} + e_{1t} \qquad (1)$$

where e_{it} is a random 'disturbance' term, which is assumed to mean 'well-behaved' in the usual sense. In particular, it will be serially independent. Δ denotes the difference operator; y_{1t} is the mortgage rate; X_{1t} and X_{2t} stand for the funding costs: The cash rate (CR) and offshore funding costs (AUDLIBOR), respectively; β_0 is a constant.

For Equation 1, the *F-test* is employed. The null hypothesis of no cointegration is H_0: $\theta_0 = \theta_1 = \theta_2 = 0$, against the alternative that H_0 is not true or H_a: $\theta_0 \# \theta_1 \# \theta_2 \# 0$ is tested. The rejection of H_0 implies that there is a long-term relationship.

The lower and upper bounds on the critical values for the asymptotic distribution of the *F*-statistic are provided by Pesaran et al. (2001): The lower bound is based on the assumption that all of the variables are I(0) while the upper bound is based on the assumption that all of the variables are I(1). If the calculated *F*-statistic falls below the lower bound, we would conclude that the variables are I(0), so no cointegration is possible, by definition. If the *F*-statistic exceeds the upper bound, we conclude that we have cointegration. As a final point, if the *F*-statistic falls between the two bounds, the test is inconclusive.

The Granger causality tests (Wald tests) are carried out under the VECM in the case of cointegration among variables (Equation 2), and under the vector autogressive model (VAR) (Equation 3) in the absence of cointegration.

$$\Delta y_t = \gamma_0 + \Sigma\gamma_{1i}(L)\Delta y_t + \Sigma\partial_{1j}(L)\Delta x_{1t} + \Sigma\delta_{1k}(L)\Delta x_{2t} + \varphi ECT_{t-1} + \mu_{jt} \qquad (2)$$

$$\Delta y_t = \alpha_0 + \Sigma\gamma_{2i}(L)\Delta y_t + \Sigma\partial_{2j}(L)\Delta x_{1t} + \Sigma\delta_{2k}(L)\Delta x_{2t} + \varepsilon_{jt} \qquad (3)$$

In Equations 2 and 3, Δ is the difference operator, L is the lag operator where $(L)\Delta y_t = \Delta y_{t-1}$. ECT_{t-1} in Equation 2 is the lag error correction term originating from the VECM. μ_{jt} and ε_{jt} are serial independent random errors. For causality tests derived from the VECM, we use *F*- and *t*-statistics for ECT_{t-1} in Equation 2 and the *F*-value of VAR in Equation 3. Equation 2 enables analysis of the long-run causal relationship between the variables

[7] As pointed out by Pesaran and Pesaran (1997), the advantage of using the ARDL approach to cointegration compared to other methods such as the Engle-Granger (1987) the Johansen (1991; 1995) and Johansen-Juselius (1990) tests is that it can be applied even if the variables are not all stationary at first difference, i.e. I (1).

through the error correction term. Equation 3 allows investigation of the short-term relationship between the variables.

The analysis of the short-term relationship among the variables is further undertaken with the application of the impulse response analysis (IRA) within the VAR to scrutinise the dynamic effects of the system when the model receives the impulse. More generally, an impulse response refers to the reaction of any dynamic system responding to some external changes. $\partial y_{i\,t+s}/\partial \dot{\varepsilon}_{jt}$ as a function of s is called the impulse response function. It describes the response of y_{it+s} to a one-time impulse in y_{jt} with all other variables dated t or earlier held constant. In this study, we employ generalised impulse analysis to explore how quickly and how well mortgage lenders respond both to the changes in the monetary policy or domestic funding costs as cash rate proxy, and to the changes in the international cost of funding (the 90-day AUDLIBOR). According to Pesaran and Shin (1998), the generalised impulse responses are unique and take full account of the historical patterns of correlations observed among the different shocks.

Furthermore, we also analyse the movement of the relationship among mortgage rates, international funding cost and the cash rate across time. In order to do this, we employ the Dynamic Conditional Correlation (DCC) model developed by Engle (2002) to assess correlations between mortgage rates and the costs of funding series. We first examine the correlation between the effective mortgage rate and the cash rate, and then the linkage of the mortgage rate with the international funding costs, during the sample period. Details of the DCC procedure can be found in Engle (2002).

Understanding the distributional properties of a data series before employing the econometrics models is essential. In this regard we conduct three standard unit root tests: Augmented Dickey and Fuller (ADF, 1979), Phillip and Perron (PP, 1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, 1992)[8]. The purpose of the unit root tests is to determine whether the time series we are working on are stationary at first difference – i.e. I(1). The ADF and PP unit roots are based on the null hypothesis that the respective time series are stationary, while the KPSS unit root test is constructed to test the null hypothesis of trend stationary. In this study, we employ the lowest value of the Akaike information criterion (AIC) as a guide for determining the optimal lag length.

3.2. Measures of Variables and Data

We use the effective mortgage rate (WAAPR) as the proxy for the mortgage rate. For the international funding cost, we represent this with USD LIBOR RATE (USDLIBOR) as

[8] Detailed discussion on these unit root tests is not included, due to space limitation

this is the major input cost of Australian lenders when sourcing funds in international financial markets (Deans and Stewart, 2012).

To examine the response of Australian mortgage interest rates to the cash rate and to the offshore funding costs, we use data covering a 16-year period (1996:11–2012:08), which includes 6,850 weekly observations obtained from official sources. We employ a weekly dataset for 20 individual Australian commercial banks belonging to three groups: Four major banks, three foreign banks, and thirteen local banks (see Appendix A). We construct the mortgage rates of each subsample by taking the simple average of the effective mortgage rates (WAAPR) of the individual banks belonging to each group. We select only standard adjusted rate mortgages (ARMs) with 25 to 30 years' maturity to construct the comparable data among the sampled lenders. The standard ARMs or the interest rates of home-loans are gathered in various ways because these data sources are unavailable in data sets. For the period 1996:11–2012:12, the mortgage rates are taken from Cannex's survey of the Australian lenders.

Prior research in relation to cash rate pass-through on mortgage rates in Australia has mainly been done with the individual lender pricing behavior (Karamujic, 2011; Valadkhani, 2013, 2014; Valadkhani and Worthington, 2014). Other researchers only focus on taking the whole banking sector into account (Lim et al., 2013; Valadkhani and Anwar, 2012; Valadkhani and Bollen, 2013). Differing from previous studies, we split our sample of the 20 banks[9] into four sample sets – major bank group, foreign bank group, regional group and the whole sector – to examine the mortgage rate movement of each of these four groups to changes in funding costs. Our sample division stems from the distinguishing feature of the Australian banking system: Their oligopoly, compared with a strong regional aspect of the US banking sector (Lim et al., 2013). Valadkhani (2013) validates this by providing the detail: 85% of the outstanding mortgages are held by the Big-4 banks: the ANZ bank (ANZ), the Commonwealth Bank of Australia (CBA), the National Australia Bank (NAB), and the Westpac Banking Corporation (WBC).

Although the growth rate of overseas borrowing by Australian banks has been decreasing after the 2007 GFC, the volume is still remained high, equivalent to 22% of GDP in 2012, according to Bailey et al., 2012. However, these authors contend that most of that debt is held by the four major banks and Macquarie Bank, whereas the regional banks (small ones) have a negligible amount. Hence, we expect that the Big-4 bank group is highly likely to respond more strongly than the regional group to changes in offshore funding costs. Also, after the GFC, the proportion of deposits has increased in the balance sheets of the four major banks and the local ones (Deans and Stewart, 2012), so we

[9] See Appendix A

believe that these two groups are still affected by the cash rate. Moreover, foreign banks in Australia source over 25% of their funding from overseas deposits through their parent banks and offshore intragroups, while Australian-owned banks have only about 6% offshore deposits (Bailey et al., 2012). This group has also shifted their funding from short-term wholesale debt to long-term source (David, 2011; Bailey et al., 2012; Stewart et al., 2013). We therefore anticipate that the foreign group will tend not to follow the cash rate cycle, but will be strongly affected by offshore funding costs.

The weekly cash rate (CR) is the interest rate paid[10] on overnight funds or the policy rate obtained from Table F01 of the Reserve Bank of Australia (RBA) database. The purpose of the RBA monetary policy is to manipulate the cash rate in order to transmit its effect to market interest rates, where those interest rates affect economic activities. Several empirical studies have examined the monetary transmission mechanism in the US and other developed markets. Prior research has found incomplete pass-through of the federal fund rate to the mortgage lending rates in the U.S. (Payne, 2006a; Payne, 2006b, 2007; Payne and Waters, 2008). Similar results in the Australian market (Lim, 2001; Lim et al., 2013); (Valadkhani, 2013, 2014; Valadkhani and Anwar, 2012) confirm the theory of monetary transmission. Following the literature, we use the weekly cash-rate data to be as the proxy for the domestic funding costs.

The weekly 90-day London interbank offer rate, hand-converted into AUD as AUDLIBOR, is used to proxy the international funding rate. We retrieve the 90-day LIBOR in USD from DataStream which we then converted into AUDLIBOR based on the average weekly spot exchange rate of AUD/USD.

4. Empirical Results

4.1. Descriptive Statistics and Preliminary Analysis

The sampled descriptive statistics of the whole banking sector and the three bank groups are illustrated in Table 1.

[Insert Table 1 here]

Table 1 shows that the regional group is clearly the most competitive in average effective mortgage rates (7.296%) within the three bank groups, while the foreign group has the most expensive charge (7.383%); their rates are higher than those of the average sector (7.324%) and of the major group (7.337%). The major lenders set their effective rates

[10] http://www.rba.gov.au/statistics/tables/index.html#interest-rates

higher than that of the sector (7.337% compared to 7.324%). For the first of the two independent variables, the CR (cash rate), the median values are around 5.00%. By contrast, the second independent variable, the cost of international funding (AUDLIBOR), fluctuates from 0.22% to 4.76%, with a lower median of 2.25%.

Figure 1 shows the movement of mortgage rates (represented by WAAPR), the domestic funding cost, (being as a proxy by the cash rate), and international funding costs (represented by AUDLIBOR), over the period 1996 to 2011. At first glance, these time series seem synchronous over the sample period, although mortgage rates have moved more closely with the cash rate. It appears therefore that mortgage rates seem to be driven by changes in domestic funding cost.

[Insert Figure 1 here]

Table 2 shows the results of the pairwise unconditional correlation tests of the whole bank sector and the different bank groups.

[Insert Table 2 here]

Generally, in relation to the whole sector, there is a relatively high correlation between mortgage rate and cash rate (around 0.57). Among the different groups, regional group has the strongest correlations (>0.56) between mortgage rates and the cash rate similar to that of the whole sector, whereas the major bank group shows the weakest correlations (0.38). The correlation between the mortgage rates and the cash rate for the foreign group is lower than that of the whole banking sector (0.42 as against 0.57). For the offshore funding variable, the mortgage rates of all the subsamples are relatively weakly correlated to AUDLIBOR at around 0.20. The signs of all correlations within the whole industry, or for each group, are positive, implying that these variables move together in general.

The unconditional correlations test results seem to support what we observed from the graph of the movement of mortgage rates, cash rates and AUDLIBOR: that international funding cost affects mortgage rates and that mortgage rates move together with the cash rates. It is well known, however, that unconditional correlations suffer from a number of weaknesses, including their assumption of linearity and their static state. Hence, there is a need for a more robust analysis of the relationship of these variables. We conduct more advanced time series regression techniques, where results are presented in the next subsections.

In performing these regressions, we note that among the independent variables for each group, as well as for the whole sector, there are positive correlations between CR and AUDLIBOR, at around 0.67. Thus, due to the moderately high correlation between these two independent variables we cannot include both in one regression because this would be highly likely to trigger multicollinearity problems that would result in spurious regression results. As a result of this situation, we run separate single regressions.

Before performing these regressions, we perform unit root tests. Table 3 presents the results of the augmented Dickey-Fuller (ADF, 1979), Phillips-Perron (PP, 1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, 1992) unit root tests. The unit root test results indicate that the variables are a mix of I(1) and I(0).

[Insert Table 3 here]

4.2. Long-term Relationships

Given that the variables are a mix of I(0) and I(1), the use of the ARDL cointegration technique is therefore more appropriate. Hence, we use the ARDL model and the Wald test (or Granger causality test) originating from the VECM to find the long-term relationship of the cash rate and international funding cost with mortgage rates. Due to the high correlation between the CR and AUDLIBOR variables, we run Equations (1) to (3) separately, with regard to each independent funding cost variable. For example, for the bounds test equations, we have the following where AUDLIBOR and CR appear in separate equations.

$$\Delta WAAPR_t = \beta_0 + \sum \beta_i \Delta WAAPR_{t-i} + \sum \gamma_i \Delta CR_{t-i} + \theta_0 WAAPR_{t-1} + \theta_1 CR_{t-1} + \varepsilon_t \quad (1.1)$$

$$\Delta WAAPR_t = \alpha_0 + \sum \alpha_i \Delta WAAPR_{t-i} + \sum \delta_i \Delta AUDLIBOR_{t-i} + \omega_0 WAAPR_{t-1} + \omega_1 AUDLIBOR_{t-1} + v_t \quad (1.2)$$

In these equations, $WAAPR_t$ is the mortgage rate; CR_t is the cash rate; and $AUDLIBOR_t$ is the 90-day London Interbank Offer Rate in AUD; β_i and α_i denote the short-run mortgage rate lag parameters; γ_i, δ_i, are short-term coefficients of funding variables; θ_0, θ_1, ω_0, and ω_1 are the coefficients for testing the absence of a long-term equilibrium relationship between mortgage rates and funding costs; and v_t, ε_t are the residual terms.

We first perform the ARDL test suggested by Pesaran et al. (2001) to explore whether the variables co-integrate or not. Table 4 gives the results of the Bounds test for cointegration between the dependent variable (WAAPR) and the two independent variables (CR, AUDLIBOR) for Australian mortgage lenders without the deterministic trends. Critical

values for *F*- and *t*-statistics taken from Pesaran et al. (2001) are to be used in Tables 4 and 5 in this paper. The above equations have been presented already in Section 3.2. Below, we report and discuss results of the tests.

[Insert Table 4 here]

From the results shown on Table 4, the bounds *F*-test of the ARDL indicate the existence of a relationship between mortgage rate (WAAPR), the dependent variable, and its regressor, since the null hypotheses of H_0: $\theta_0 = \theta_1 = 0$ and H_0: $\omega_0 = \omega_0 = 0$ are rejected at the .05 level, except in Equation 1.1 for the regional group. This means that the WAAPR of the whole banking sector and of the groups are well correlated in the long run to the domestic funding cost, denoted by CR, and also to international funding, AUDLIBOR, except for the regional group. The presence of cointegration between the effective rate (WAAPR) and the costs of funding variables (CR & AUDLIBOR) indicates a long-term relationship between these variables among the sampled bank groups as well as across the whole banking sector. The VECM is applied to confirm the findings. The results of the Granger Causality test or the Wald test originating from the VECM for long-run causality are presented in Table 5.

[Insert Table 5 here]

It can be seen from Table 5 that the independent variables have a long-term effect on the dependent variable since the error correction term (ECT_{t-1}.) is negative and significant. From the results, all the error correction terms have negative signs, and are significant at 5% level; hence, some causality relationships exist. We find a long-run causality relationship running from the cash rate to the effective rates for the whole sector and for the two bank groups, but not for the regional group. The whole sector shows a sluggish pace of adjustment towards the long-run equilibrium state of its WAAPR at 7.8%; its long-run pass-through of CR to WAAPR is 0.66. For the major and foreign groups, a long-run causality running from the cash rate running to effective mortgage rates is found, with these movements gradual at 7% and 6.3%, respectively. It is clear that the adjustment speed towards the equilibrium for the foreign group is lower than for that of the major bank group. Also, the pass-through coefficient of the former is smaller (0.64) than the latter (0.70). Overall, we confirm the uncompleted pass-through of CR on WAAPR. Our finding is consistent with that of prior studies (De Graeve et al., 2007; Hofmann and Mizen, 2004; Lowe, 1995; Payne, 2006a; 2006b, 2007).

Regarding the offshore funding variable, AUDLIBOR, we detect a long-run causality running from AUDLIBOR to WAAPR for the whole sector and all the three bank groups. These major and regional bank groups show relatively faster rates of adjustment towards

their equilibrium (6.4% and 6.3% respectively) than the whole sector (at 6.0%), whereas the foreign group has a slower pace (at 5.9%) than the whole sector. The coefficients of AUDLIBOR are somewhat smaller than the cash rate coefficients. For example, the pass-through level of the offshore funding to the effective rate of the whole sector is nearly 0.20, while that of the cash rate is 0.66. The major bank group shows the highest level (0.19) of offshore funding pass-through among the three groups. The regional bank group has a slower pace at 0.17, while the foreign group has the lowest pass-through coefficient (0.16).

In brief, for both the whole banking sector and the three groups of banks, we discover strong evidence of the long-term influence of offshore funding costs on the effective mortgage rate. We also find that the cash rate affects WAAPR, except for the regional group.

4.3. Short-term Relationships

To examine the short-term relationship between funding costs and mortgage rates, we perform VAR, Granger Causality and Impulse Response Analysis test. The Granger Causality test or the Wald test of joint significance of the lagged difference terms in the VECM and the VARM (Equations 2 and 3) is a technique for determining whether one time series is useful in forecasting another. It can determine whether there is a causality relationship between variables. The null hypothesis of the Granger Causality test is that there is a no causal relationship between variables. This study uses the *F*-statistics of the Wald test to measure causality between these variables (see Table 6). Significant probability values denote rejection of the null hypothesis. The null hypothesis is rejected if the probability value is less than 5%; the null hypothesis is not rejected if the value of probability is more than 5%.

The results of the Granger Causality tests originating from VAR and VEC models for short-run causality are presented in Table 6.

[Insert Table 6 here]

Overall, the Wald tests of joint significance of the lagged difference terms in the VEC and VAR models show that the mortgage rates have responded with strong significance to the changes in the cash rate in the short run, at the 1% and 5% levels, for the three groups as well as the whole sector. This result is consistent with previous studies (Payne, 2006a; Valadkhani and Anwar, 2012), meaning that the domestic funding cost, represented by the cash rate, affects mortgage rates significantly in the short term.

We find solid evidence of the offshore funding cost effect on the mortgage rate for the whole sector as well as for the major and regional bank groups. However, this effect is not found in relation to the foreign bank group. Generally, our findings confirm our second hypothesis, that the global financial market has recently influenced the pricing behaviour of Australian mortgage lenders and hence, we provide answers to the questions currently being debated in the media, as well as the questions raised in Bailey et al., (2012), and in Dean and Stewart (2012).

IRA is employed to examine the responses of the mortgage rates to changes in the costs of funding: how long they take, and how large they are. The results of the impulse responses test are shown in Figure 2.

[Insert Figure 2 here]

As shown in Figure 2, it generally takes four weeks for the whole sector and for all of the groups to adjust their mortgage rates in response to changes in the cash rate. In contrast, the average mortgage rates react to international funding rate changes within two weeks, significantly faster than those to the cash rate. In terms of the response degree, the weekly average mortgage rates of the groups, as well as of the sector, respond to the cash rate much more strongly than to offshore funding: (0.00 to 0.05), compared to (0.00 to 0.02), respectively, except for the regional group, which has the same responses of mortgage rates to both CR and AUDLIBOR (around 0.00 and 0.02). The response lines of the mortgage rates to cash rate and to AUDLIBOR are also above the zero line, meaning that these replies are positive. Major and Foreign groups respond more strongly to changes in offshore funding costs as their response lines are almost all above the zero line. However, the mortgage rates of the regional group and whole sector in some periods seem not to react to the changes in offshore funding costs (AUDLIBOR), since their lines lie on the zero line during some intervals.

4.4. Time Varying Relationships

In order to analyse the relationship between mortgage rates and the cash rates and international funding cost across time, we estimate the dynamic conditional correlations. The results of the DCC between mortgage rate and the cash rate and between mortgage rate and international funding costs are presented in Figure 3.

[Insert Figure 3 here]

Overall, the cash rate has positively affected mortgage rates, for the whole sector as well as for the three bank groups, confirming again our first hypothesis. More importantly, the

findings confirm that the cash rate has become decreasingly associated with mortgage rates since 2006, while AUDLIBOR (the proxy of foreign funding costs) has become increasingly linked to mortgage rates. In particular, the correlation of the average mortgage rate of the whole banking sector with the cash rate in 2006 was 0.60, dropping to around 0.20 in 2007, and then fluctuating between 0.0 and 0.20 in the following five years. It is clear that offshore funding has started to become positively correlated with Australian mortgage rates since 2008. Moreover, the three groups reveal similar positive associations of their mortgage rates with changes in international costs of funding since 2008, with correlations of around 0.0 to 0.5. Both major and foreign lenders show moderately high positive links between their mortgage rates and AUDLIBOR (correlations ranging from 0.10 to 0.50 with a few negative values) from 2008 to 2012. In contrast, the regional group experienced a high correlation between its mortgage lending rate and AUDLIBOR only in 2008, at 0.40; this correlation then plummeted to 0.10 in 2009, followed by a relatively low correlation ranging between 0.0 and 0.10 until 2012.

The correlations of the domestic funding cost (cash rate) and mortgage rates for each of these groups are quite different from those of offshore funding costs and mortgage rates. Both foreign and regional lenders' mortgage rates have been marginally correlated (0.0 to 0.10) to changes in the cash rate since 2002, whereas the major bank group mortgage lending rates have been highly correlated (0.10 to 0.80) with the cash rate during the sample. The strongest evidence that affirms our third expectation is found in relation to the foreign group and the major group. The latter shows the weakest correlation between the cash rate and mortgage rates, registering a correlation of only 0.10 during the period 2002–2011 after exhibiting high correlations ranging from 0.0 to 0.80 during the period 1997–2001; the strongest link is exhibited by the former with the correlations of around 0.4 to 0.8 in the same period.

Therefore, the DCC results further confirm the previous results of the ARDL, Cointegration, Granger causality and IRA tests: that the cash rate still drives mortgage rates and that foreign funding costs also significantly affect mortgage rates. The DCC results provide confirmation that the link between the cash rate and mortgage rates has weakened over the recent years while the association between foreign funding costs and mortgage rates has become stronger.

4.5. Robustness Test

To ensure that the results are not affected by the specific variable measures that we used, we also tested the linkage of mortgage rates with the cash rate and international funding cost using nominal mortgage rates (MRATE) as a proxy for mortgage rates. The results,

which are generally similar, are not reported here but they are available upon request. Hence, our results are robust irrespective of the measurement of mortgage rates.

5. **Conclusion**

We assess the impact of domestic and offshore funding costs on mortgage interest rates in the Australian residential housing market. The DCC model, the ARDL approach and the Impulse Response Function are employed to detect the short- and long-term effects for different bank groups and for the whole banking sector during the period 1996:11–2012:8.

First, our results show that cash rate shocks significantly affect the mortgage rates in the short term for the whole sector and all the three bank groups, and that statistical evidence for the long-term effect is apparent, except for the regional group. These findings confirm the first hypothesis: There is a positive effect of the cash rate on effective mortgage interest rates. Second, our findings show that Australian residential mortgage rates react strongly to international funding costs. In the short term, major and regional bank groups respond significantly to changes in international funding costs. We also find solid evidence of long-term interaction between effective mortgage rates and offshore funding costs for all three groups of banks, as well as for the whole banking sector. Our findings confirm our second hypothesis that international markets have recently influenced the Australian mortgage lenders' pricing behavior, as claimed in the media. Third, our results prove that the correlation of the cash rate with mortgage rates has decreased since 2006, while that of overseas funding costs with mortgage rates has increased. We confirm the last hypothesis that the cash rate has hitherto affected mortgage rates, both short term and long term, but this influence has been weakened by the presence of overseas funding costs.

The findings in this study are valuable to mortgage holders, lenders, and policy-makers. From the perspective of credit risk management, lenders should take the effect of offshore funding on the effective mortgage rates into account for their lending operations and borrowers should pay much concern about this influence for their investments, since these strong impacts are both short and long term. That the Australian mortgage market has been increasingly integrating with the global financial market is confirmed by our empirical results; therefore, the RBA needs to pay close attention to the volatility of the changes in offshore funding costs when setting their policy rate.

We intend to conduct more work on the influence of offshore funding costs in order to provide a deeper insight into the pricing behavior of Australian mortgage lenders. In the ongoing investigation, we will explore whether there is an asymmetry in the initial

response of lenders to changes in costs of funding. In addition, market competition will be taken into account.

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Table 1: Descriptive Statistics

Variables	Obs.	Mean	Median	Maximum	Minimum	Std.dev.
Panel A: Whole sector						
CR	825	5.124	5.000	7.250	3.000	0.917
AUDLIBOR	825	2.255	2.398	4.758	0.219	1.523
WAAPR	825	7.324	7.327	9.661	5.846	0.791
Panel B: Major group						
CR	808	5.130	5.000	7.250	3.000	0.924
AUDLIBOR	808	2.265	2.405	4.758	0.219	1.521
WAAPR	808	7.337	7.180	9.685	5.843	0.801
Panel C: Foreign group						
CR	824	5.124	5.000	7.250	3.000	0.917
AUDLIBOR	824	2.258	2.401	4.758	0.219	1.529
WAAPR	824	7.383	7.300	9.730	6.027	0. 794
Panel D: Regional group						
CR	825	5.124	5.000	7.250	3.000	0.917
AUDLIBOR	825	2.255	2.398	4.758	0.219	1.523
WAAPR	825	7.296	7.307	9.633	5.793	0.794

Notes: Variable definitions are as follows: CR represents weekly cash rate, the interest rate paid on overnight funds or policy rate obtained from the Reserve Bank of Australia (RBA) database; AUDLIBOR is the proxy of the offshore funding cost which is the weekly 90-day London interbank offer rate after hand-converting into AUD; WAAPR is the weekly effective interest rate of standard mortgages with 25-30 years' maturity.

Table 2: Unconditional Correlations

	Variables	1	2	3
Panel A: Whole sector				
1	WAAPR	1.00		
2	CR	0.57	1.00	
3	AUDLIBOR	0.19	0.67	1.00
Panel B: Major group				
1	WAAPR	1.00		
2	CR	0.38	1.00	
3	AUDLIBOR	0.10	0.68	1.00
Panel C: Foreign group				
1	WAAPR	1.00		
2	CR	0.42	1.00	
3	AUDLIBOR	0.15	0.68	1.00
Panel D: Regional group				
1	WAAPR	1.00		
2	CR	0.56	1.00	
3	AUDLIBOR	0.18	0.67	1.00

Notes: Variable definitions are as follows: CR represents the weekly cash rate, the interest rate paid on overnight funds or the policy rate obtained from Reserve Bank of Australia (RBA) database; AUDLIBOR is the proxy of the offshore funding cost which is the weekly 90-day London interbank offer rate after hand-converting into AUD; WAAPR is the weekly effective interest rate of standard mortgages with 25-30 years' maturity.

Table 3: Unit Root Test Results

Description	ADF		PP		KPSS	
	on level	1st diff	on level	1st diff	on level	1st diff
AUDLIBOR	-1.20	-16.98***	-1.08	-17.13***	1.18***	0.19
CR	-2.91**	-5.34***	-2.11	-31.58***	0.33	0.08
WAAPR						
Major Group	-3.72***	-4.68***	-2.75	-26.32***	0.464**	0.12
Foreign Group	-2.35	-27.80***	-2.50	-27.61***	0.53**	0.14
Regional Group	-3.21**	-22.76***	-3.41**	-26.39***	0.44*	0.09
Whole Sector	-2.86*	-10.04***	-3.38**	-28.21***	0.58**	0.10

Note: ***, and ** indicate that the corresponding null hypothesis of the ADF and PP tests: AUD Libor/cash rate/ mortgage rates has a unit root, is rejected at 1, and 5 percent level of significance, respectively. Critical values for ADF and PP unit root tests which include both a constant and trend are (1%) -3.970, -3.969; (5%) -.416, -3.415. The null hypothesis of the KPSS test: each variable is stationary, is rejected at 1 and 5 percent level of significance. Critical values for KPSS unit root test, which includes both a constant and trend, are (1%) 0.216, (5%) 0.146.

Table 4: The bounds test for Cointegration under bivariate system

Dependent Variables	Forcing variable	*F-stat.*	Conclusion (H_0)
Panel A: Whole sector			
WAAPR	CR	16.007[a]	Rejected
	AUDLIBOR	13.254[a]	Rejected
Panel B: Major group			
WAAPR	CR	8.522[a]	Rejected
	AUDLIBOR	8.685[a]	Rejected
Panel C: Foreign group			
WAAPR	CR	6.708[a]	Rejected
	AUDLIBOR	6.847[a]	Rejected
Panel D: Regional group			
WAAPR	CR	2.558[c]	Fail to reject
	AUDLIBOR	10.028[a]	Rejected

Notes: The lower and upper bound limits of 5% critical values for the *F*-test are 4.94 and 5.73; [a] denotes that the statistic lies above the .05 upper bound; [b] that it falls within the .05 bounds; [c] that it lies below the .05 lower bound; H_0 indicates no cointegration; The lower and upper bound limit of 5% critical value for the *t*-test is 2.86 & 3.22; ** indicates the significance at 5%. The critical values of *F*- and *t*-tests are obtained from (Pesaran et al. (2001))

Table 5: Granger noncausality test for a long-term relationship

	Long-run causality ECM	Long-run adj. speed	Long-run causality decision	Long-run coefficients	
Equations	*t-statistic*			X_1	X_2
Panel A: Whole sector					
Y	-5.660**	0.078**	$Y \leftarrow X_1$	0.661***	
Y	-5.148**	0.060**	$Y \leftarrow X_2$		0.159***
Panel B: Major group					
Y	-4.117**	0.070**	$Y \leftarrow X_1$	0.695***	
Y	-4.163**	0.064**	$Y \leftarrow X_2$		0.186***
Panel C: Foreign group					
Y	-3.656**	0.063**	$Y \leftarrow X_1$	0.639***	
Y	-3.692**	0.059**	$Y \leftarrow X_2$		0.164***
Panel D: Regional group					
Y			No		
Y	-4.462**	0.063**	$Y \leftarrow X_2$		0.172***

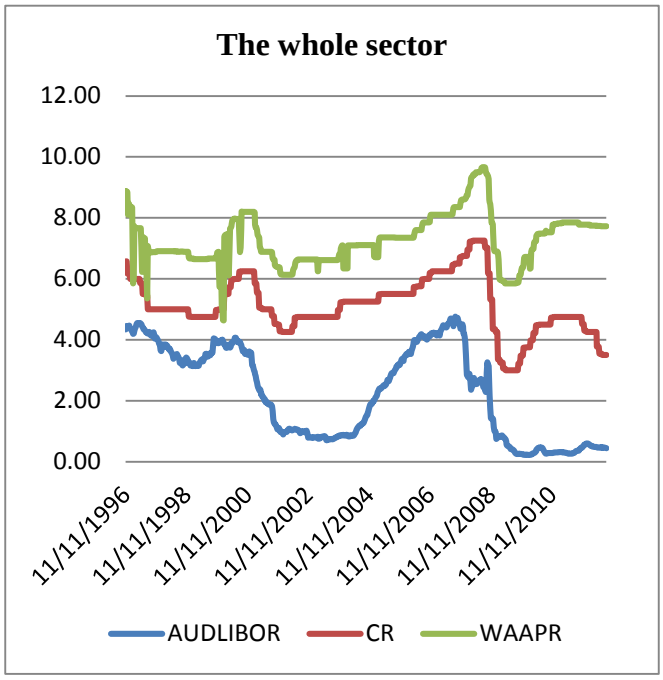
Notes: Y is the effective mortgage rate (WAAPR); X_1 is the cash rate; X_2 is the offshore funding cost (AUDLIBOR); ***, **, * significance at 1, 5 and 10% levels, respectively. The critical values of *F*-test are obtained from Pesaran et al. (2001)

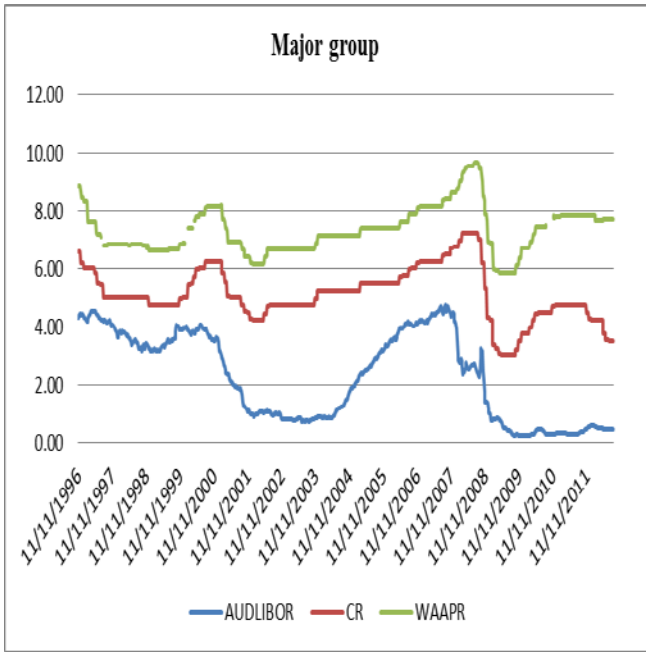
Table 6: Granger noncausality test for a short-term relationship

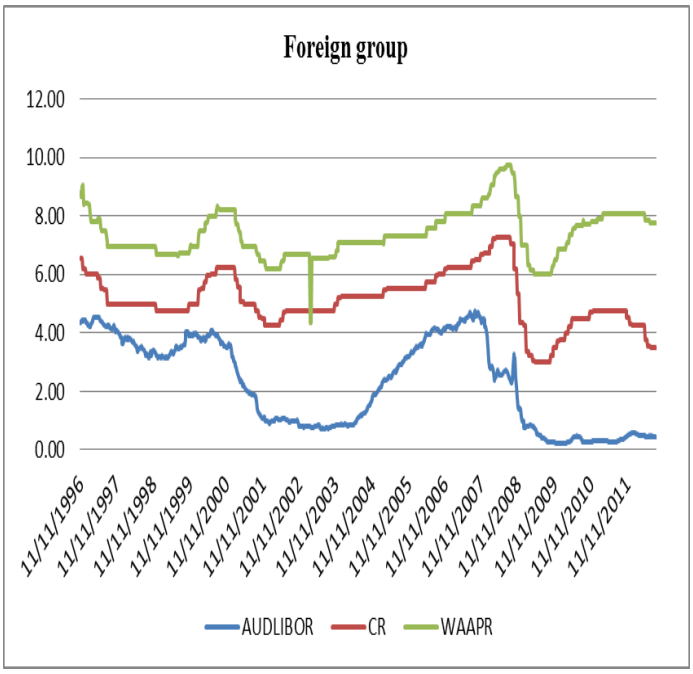
	Short-run causality (*F-statistic)*		Causality decision
Equations	X_1	X_2	
Panel A: Whole sector			
Y	18.018***		$Y \leftarrow X_1$
Y		6.061***	$Y \leftarrow X_2$
Panel B: Major group			
Y	2.648**		$Y \leftarrow X_1$
Y		3.009***	$Y \leftarrow X_2$
Panel C: Foreign group			
Y	3.899***		$Y \leftarrow X_1$
Y		0.244	No
Panel D: Regional group			
Y	19.336***		$Y \leftarrow X_1$
Y		6.111***	$Y \leftarrow X_2$

Notes: Y is the effective mortgage rate (WAAPR); X_1 is cash rate; X_2 is the offshore funding cost (AUDLIBOR); ***, **, * significance at 1, 5 and 10% levels, respectively.

Figure 1: Cash Rate, AUDLIBOR and Mortgage Rates of Whole Banking Sector and Different Bank Groups in Australia







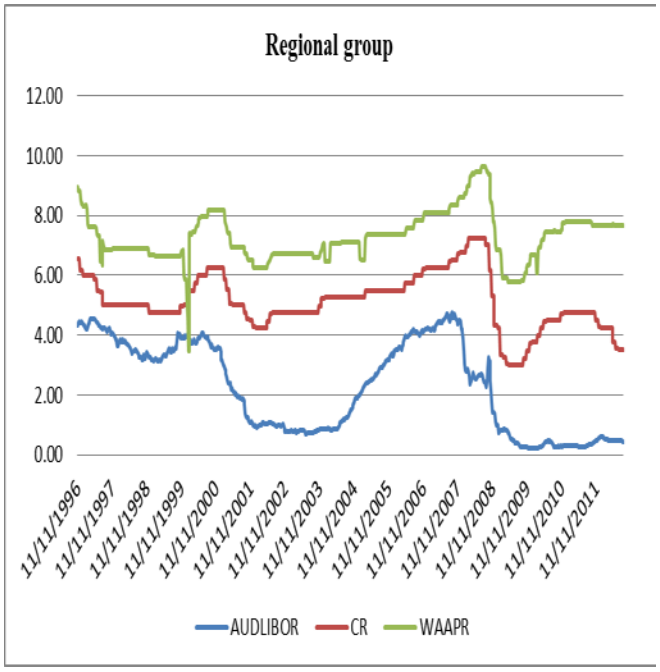


Figure 2: Impulse Responses

Response to Generalized One S.D. Innovations ± 2 S.E.

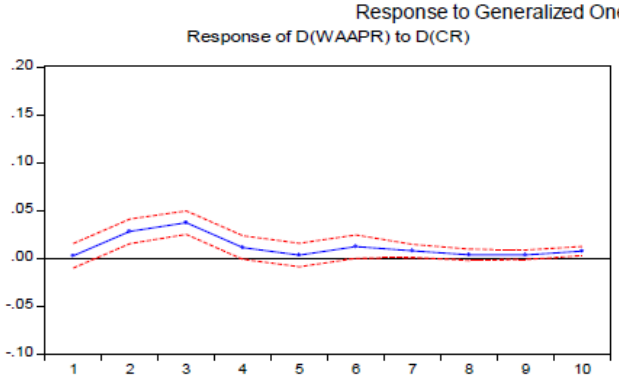


Fig. 2a: Response of the whole sector's effective rate to cash rate

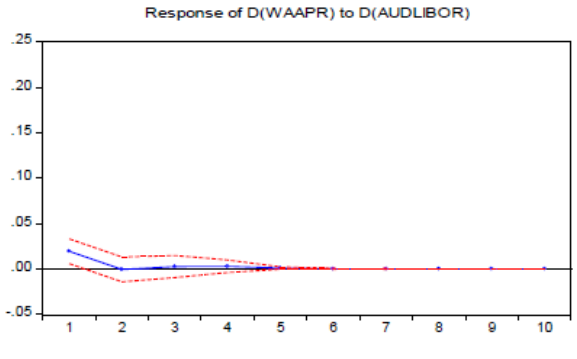


Fig. 2b: Response of the whole sector's effective rate to AUDLIBOR

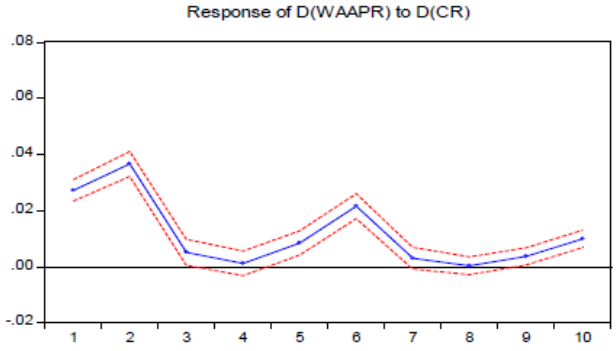


Fig. 2c: Response of the major group's effective rate to cash rate

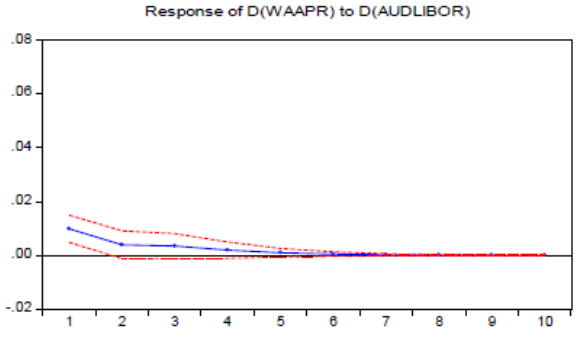


Fig. 2d: Response of the major group's effective rate to AUDLIBOR

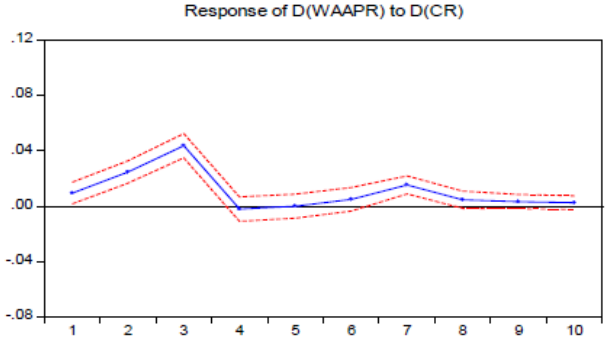


Fig. 2e: Response of the foreign group's effective rate to cash rate

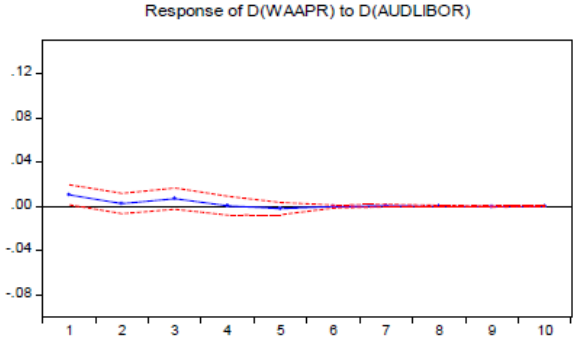


Fig. 2f: Response of the foreign group's effective rate to AUDLIBOR

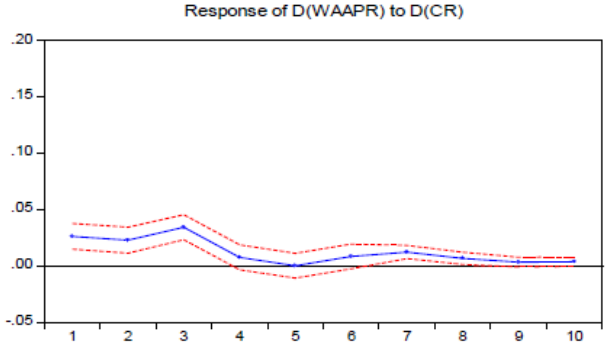


Fig. 2g: Response of the regional group's effective rate to cash rate

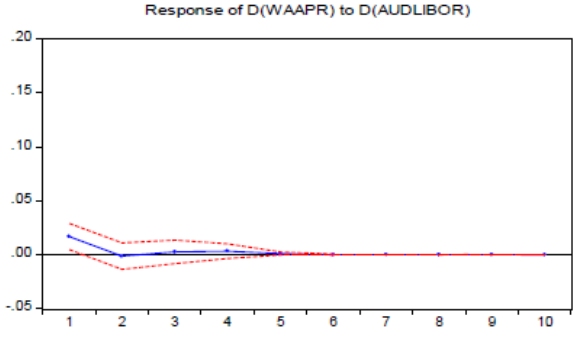


Fig. 2e: Response of the regional group's effective rate to AUDLIBOR

Figure 3: Dynamic Conditional Correlations

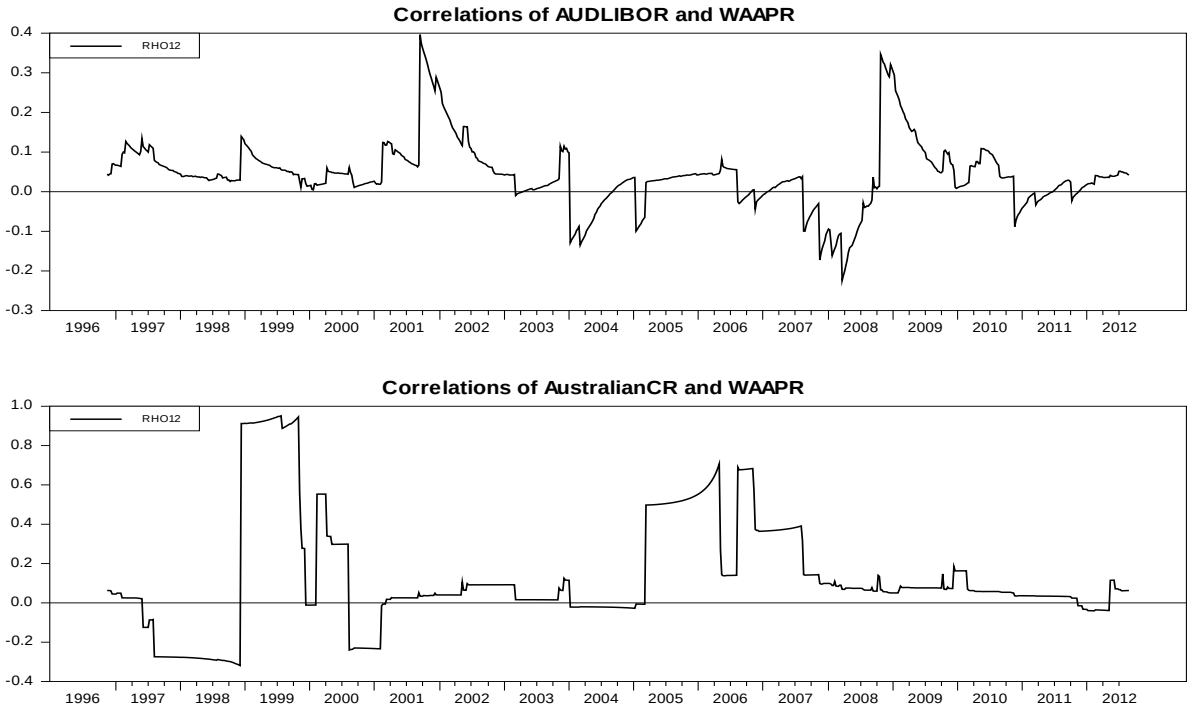


Fig. 3a: Dynamic conditional correlations of the effective rates and funding costs of the whole banking sector

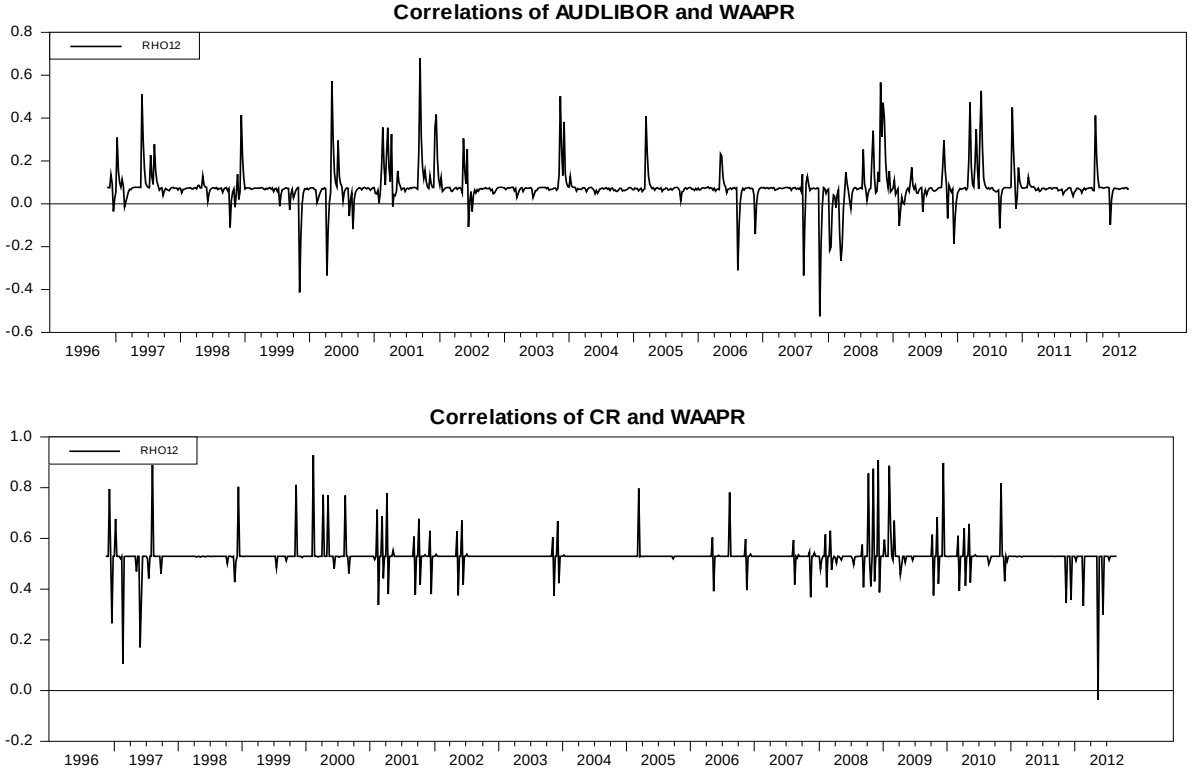


Fig. 3b: Dynamic conditional correlations of the effective rates and funding costs of the major group

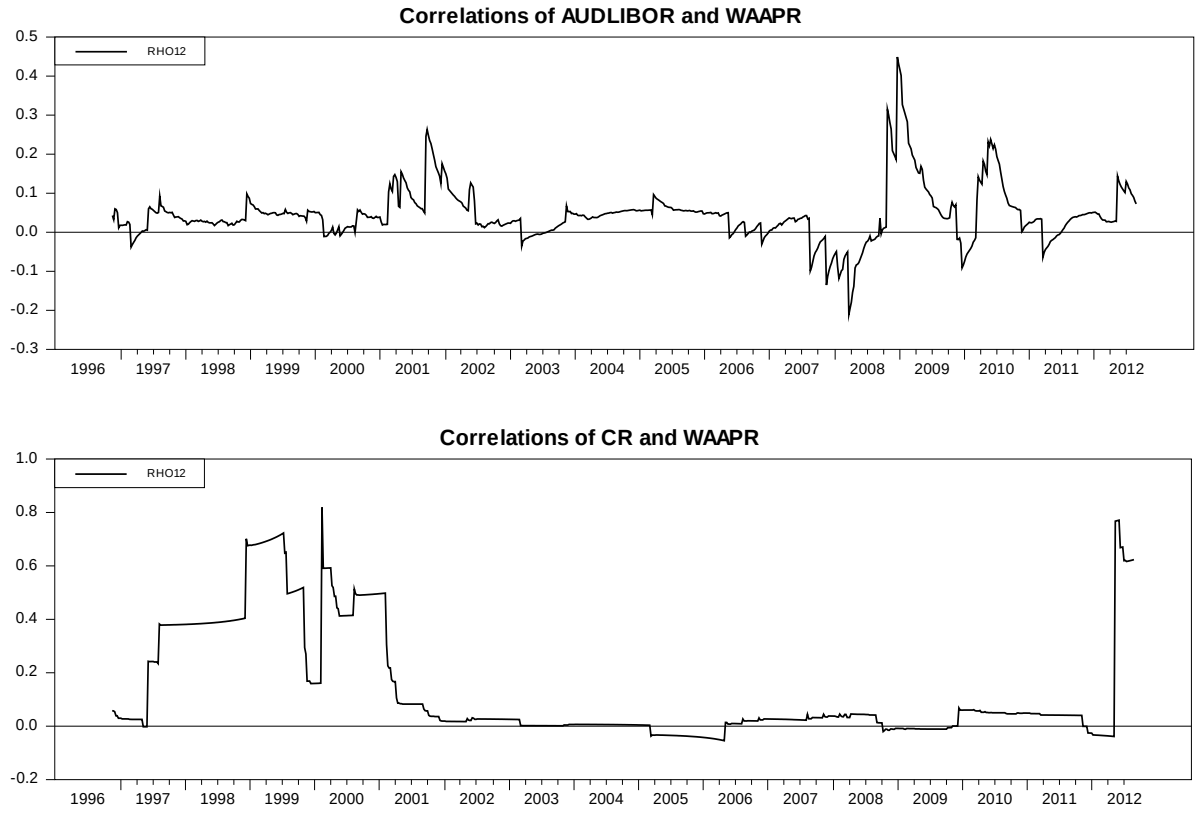


Fig. 3c: Dynamic conditional correlations of the effective rates and funding costs of the foreign group

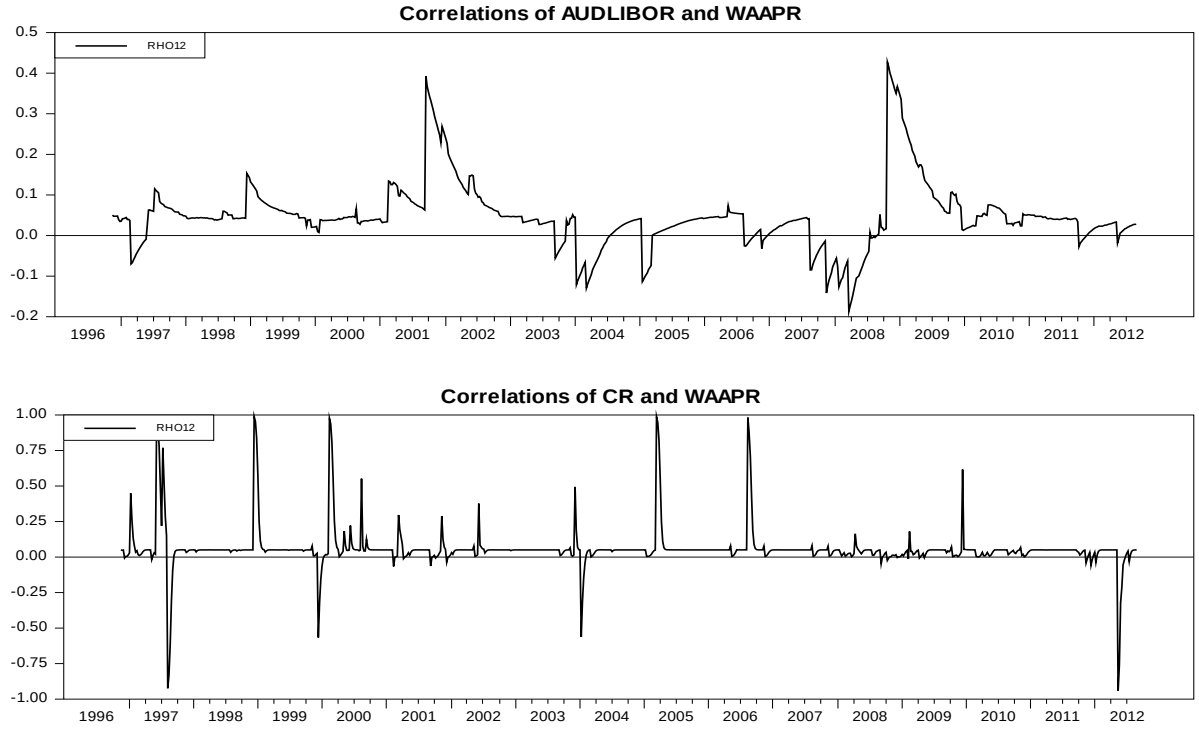


Fig. 3d: Dynamic conditional correlations of the effective rates and funding costs of the regional group

Appendix A: List of Twenty Banks in the Sample

Major banks:

1. ANZ Bank
2. Commonwealth Bank
3. National Australia Bank
4. Westpac

Foreign subsidiary banks:

1. Arab Bank Australia
2. Citibank
3. HSBC

Regional banks

1. Adelaide Bank
2. AMP Bank
3. Bank of Queensland
4. BankSA
5. Bankwest
6. Bendigo Bank
7. B & E Personal Banking
8. Colonial Bank
9. Heritage Bank
10. ME Bank
11. QT Mutual Bank
12. St. George bank
13. Suncorp Bank