Scientific Research Publishing

Theoretical Economics Letters, 2018, 8, 2157-2168
http://www.scirp.org/journal/tel
ISSN Online: 2162-2086
ISSN Print: 2162-2078

# Systemic Risk and Productivity of the Major Australian Banks

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**How to cite this paper:** Avkiran, N.K. (2018) Systemic Risk and Productivity of the Major Australian Banks. *Theoretical Economics Letters*, **8**, 2157-2168.
https://doi.org/10.4236/tel.2018.811141

**Received:** June 19, 2018
**Accepted:** August 4, 2018
**Published:** August 7, 2018



## Abstract

We measure the domestic systemic risk of the Australian major banks. We report systemic risk along five categories, namely, size, inter-connectedness, non-substitutability, complexity and domestic sentiment. We then carry out sensitivity analyses by changing equal weights in the categories, and examine the capital adequacy and inter-connectedness of the majors focusing on key ratios. In terms of sensitivity analyses, changing the equal weights do not influence systemic risk considerably, which indicates that the results are robust. Comparing systemic risk to productivity, we find that level systemic risk across time and high productivity are compatible, and rising systemic risk causes some inefficiency.

## Keywords

Australian Major Banks, Domestic Systemic Risk, Sensitivity Analyses, Capital Adequacy, Inter-Connectedness, Productivity

## 1. Introduction

Reference [1] states that as of 2016 international regulators started using data on systemic risk to require additional capital for large banks with cross-jurisdictional operations. Large banks normally function in an inter-connected global financial system. Nevertheless, it is difficult to quantify systemic risk in integrated markets because it changes dynamically [2]. Systemic risk is comprehensively defined by Gart, A. [3] as "the clear and present danger that problems in financial institutions can be transmitted rapidly to other institutions or markets, inflicting damage on those institutions, their customers, and, ultimately, the economy at large". In essence, when systemic risk rises, troubled banks reduce lending, the bank clients invest less in their businesses, and unemployment rises—affecting

the wider economy.

Jin, X. and De Simone *et al.* [4] state that tracking systemic risk is a core activity in macroprudential regulation. Group of Twenty [5] recommends extending the international framework for systemic importance to the domestic level. Thus, we initially follow Brämer, P. and Gischer, H. [6] methodology developed for the Australian banks on measuring domestic systemically important banks (D-SIBs). We extend this methodology by sensitivity analyses, explore capital adequacy and inter-connectedness of the top D-SIB banks, and investigate potential links between systemic risk and productivity.

The key findings indicate that the Australian major banks account for 76.02% (2011) to 80.05% (2017) of domestic systemic risk in the banking system for the study period. In terms of capital adequacy, the majors exceed the minima laid down by the international regulators by a comfortable margin. Regarding inter-connectedness, the major banks are net liquidity buyers. In terms of global linkages, the majors are well-connected overseas and exposed to problems from other countries. Comparing systemic risk to productivity, we find that *level* systemic risk across time and *high* productivity are compatible, and increasing systemic risk leads to some inefficiency.

Conceptual framework (Section 2) further outlines systemic risk, describes domestic systemically important banks, and summarises the regulatory framework in Australia and compliance with international regulations. Section 3 outlines the methods used and data, and Section 4 analyses and reports the results. In Section 5, we offer some concluding remarks and comments for regulators based on this study's findings.

## 2. Conceptual Framework

### 2.1. Overview of Systemic Risk

It is important to examine individual banks before making macroprudential policies because such an approach can clarify the impact of a bank on the stability of the financial system. What is more, regulators can negotiate changes required with the management of a bank in order to minimise the impact of systemic risk. Unfortunately, it is well known that supervision that focuses on individual banks without examining their connections with other banks is destined to neglect banks' contributions to systemic risk in the financial system [7]. This highlights the downside of systemic risk where banks are largely unprotected due to the asset portfolio interactions with other banks, and cannot guard themselves from exogenous shocks [8]. Furthermore, bank systemic risk is closely related to default risk, and default risk is related to differences in portfolio volatility [9]. A shock can easily cross borders due to uncontrollable losses on bank lending to overseas counterparties [10]. For those who wish to read further on systemic risk, Bisias, D., Flood, M., Lo, A.W. and Valavanis, S. [11] provide a detailed overview of systemic risk analytics.

## 2.2. Domestic Systemically Important Banks (D-SIBs)

Basel Committee on Banking Supervision (BCBS) identifies global systemically important banks (G-SIB) based on the categories *size*, *inter-connectedness*, *non-substitutability*, *complexity*, and *cross-jurisdictional activity* [12]; BCBS method uses indicators. Analysis is based on *loss-given-default*, rather than probability of default. Brämer, P. and Gischer, H. [6] follow these categories for identifying D-SIB banks but use publicly available indicators, rather than those available to regulators only (see **Table 1**). The main difference among the categories of BCBS [12] and Brämer, P. and Gischer, H. [6] is the category of *cross-jurisdictional activity* is replaced by *domestic sentiment* under D-SIB.

Financial Stability Board [13] and Basel Committee on Banking Supervision [14] have put forward a minimum framework for identifying D-SIBs. This framework accommodates the structural characteristics of individual jurisdictions but also focuses on making D-SIB approach compatible with the G-SIB approach. Principles outlined in this minimum framework are 1) local authorities should establish a methodology to identify domestic systemically important banks; 2) the methodology should acknowledge the externality imposed by a bank's failure; 3) the reference system should be domestic economy for determining the impact of a D-SIB; 4) assessment should be at both the consolidated group level and at the level of subsidiaries; 5) D-SIB failure should be assessed at bank-specific factors such as size, inter-connectedness, substitutability and

**Table 1.** Indicators by Basel Committee on Banking Supervision [12] and Brämer, P. and Gischer, H. [6].

| Category (equally weighted) | Indicators (equally weighted) | |
|---|---|---|
| | [reference [12], G-SIB] | [reference [6], D-SIB] |
| Size | Total exposures | Total resident assets |
| Inter-connectedness | Intra-financial system assets<br>Intra-financial system liabilities<br>Securities outstanding | Loans to financial corporations<br>Deposits from financial corporations |
| Non-substitutability | Payments activity<br>Assets under custody<br>Underwriting activity | Loans to households<br>Loans to non-financial corporations<br>Loans to community service and non-profit organisations |
| Complexity | Over-the-counter derivatives<br>Adjusted trading and available-for-sale securities<br>Level 3 assets | Investment securities<br>Trading securities |
| Cross-jurisdictional activity | Cross-jurisdictional claims<br>Cross-jurisdictional liabilities | n.a. |
| Domestic sentiment | n.a. | Deposits from households |

Basel Committee on Banking Supervision; D-SIB, domestic systemically important banks; G-SIB, global systemically important banks.

complexity; 6) regular assessments to synchronise D-SIB and G-SIB; 7) local authorities should publicly disclose the assessment methodology, and so on.

### 2.3. Regulatory Framework in Australia and Compliance with Basel Framework

Australian Prudential Regulation Authority (APRA) supervises banks. APRA establishes and enforces prudential standards and practices to make sure promises made by banks are met within a stable, efficient and competitive environment. APRA publishes Annual Reports that outline financial sector developments, APRA's activities, resources, risk management and performance, including the financial statements. Other publications include *Insight*, covering key industry issues and current topics, research working papers, international assessments, statistics, and so on. The Australian government established the Regulator Performance Framework in July 2015 to make sure APRA functions as expected.

APRA regards bank boards as primarily responsible for financial soundness and prudent risk management. The framework for prudential supervision is designed to identify risks and ensure that appropriate supervisory measures are put in place. The Probability and Impact Rating System (PAIRS) and the Supervisory Oversight and Response System (SOARS) work together within this framework. Three main objectives of risk assessment are to 1) determine the probability that an institution will not meet its financial promises, *i.e.* PAIRS, 2) measure the impact of the potential consequences of the above, *i.e.* PAIRS, and 3) determine an appropriate supervisory action plan, *i.e.* SOARS. PAIRS develops a net risk position for strategy and planning, liquidity, operational, market and investment, credit, and insurance risks; PAIRS is applied at the licensed entity level rather than at the industry level. SOARS is for determining how concerns based on the PAIRS analysis should be addressed. SOARS helps allocate resources to key risk areas based on four supervision stances, namely, *normal*, *oversight*, *mandated improvement*, and *restructure*. APRA does not publish the results of PAIRS or SOARS analyses.

A report by International Monetary Fund [15] on Australia's financial system stability states that the system is sound, resilient and well managed, but Australia's financial sector is vulnerable to volatility in the global markets (residential mortgages remain a source of risk).Stress testing by IMF indicates that the banking system is likely to survive shocks, a higher capital threshold for systemic banks is desirable, and so on. High priority recommendations from IMF include devoting more resources to stress testing, higher loss absorbency for systemic banks, more on-sight supervision of bank liquidity, crisis simulations, and so on.

Similarly, International Monetary Fund [15] and Basel Committee on Banking Supervision [16] report that APRA implemented the Basel III risk based capital regulations in January 2013. BCBS team finds the Australian regulation to be compliant with the Basel Framework. During the regulatory consistency assess-

ment programme executed by BCBS, while some minor deviations were spotted from Basel standards, the conclusion was 'no material effect'.

## 3. Methods and Data

The five categories of systemic risk already mentioned carry an equal weighting of 20% and indicators within each category are also equally weighted (see **Table 1**). Given equal weightings and five categories, the maximum total score is 5. Each systemic risk value is calculated by dividing a bank's indicator amount by the total for the sample.

Regarding the D-SIB approach, we generate systemic risk scores using the indicators in the last column of **Table 1**. Data can be found on APRA's website by following through ADI Statistics and Monthly Banking Statistics. Sensitivity analyses are also undertaken. In determining D-SIB scores under sensitivity analyses, the category weights are doubled one at a time, *i.e.* from 20% to 40%, with other categories' weights reduced equally [6]. The outlined D-SIB sensitivity analyses test the robustness of the systemic risk scores.

We go beyond the D-SIB approach to investigate capital adequacy of the four major banks (Westpac Banking Corporation, Commonwealth Bank, National Australia Bank, and ANZ Banking Group) through five ratios: common equity (core) tier 1 ratio, tier 1 ratio, total capital ratio, impaired loans/average risk-weighted assets, and impaired loans/equity (see the discussion in [17]). We compare these ratios against the required minima, and offer some comments on inter-connectedness (based on loans and advances to banks; deposits from banks; interbank ratio), and global linkages (based on overseas presence). If the capital adequacy ratios are too high, they could reduce operational efficiency [18]. The above-mentioned ratios/variables are sourced from Orbis Bank Focus.

The above ratios capture capital adequacies in different ways. For example, the difference between common equity tier 1 ratio and tier 1 ratio is that the latter includes retained earnings in the numerator (a higher ratio). Total capital ratio (defined as tier 1 capital, plus tier 2 capital, divided by risk-weighted assets), is higher than the tier 1 ratio because it includes tier 2 capital (less secure supplementary capital). The remaining two ratios including impaired loans, measure the proportion of impaired loans against risk-weighted assets and equity. Basel Committee on Banking Supervision [19] and Basel Committee on Banking Supervision [20] requires a minimum of 4.5% on common equity tier 1 ratio, whereas tier 1 ratio and total capital ratio must be at least 6% and 8% of risk-weighted assets at all times, respectively.

Productivity of the full sample of Australian banks is examined on a monthly basis starting with January 2011 (after the Global Financial Crisis) and ending at March 2017. Data envelopment analysis (DEA) is used to follow the productivity of the banking sector across time. DEA is a non-parametric technique that generates a comparative ratio of weighted outputs to inputs (*i.e.* a relative efficiency score) for each decision-making unit (DMU). The time-series analysis with

exponential smoothing constructs 75 DMUs based on the monthly totals (April 2017 drops out as a result of exponential smoothing). Data are exponentially smoothed with alpha (smoothing constant) of 0.25, *i.e.* recent observations are given relatively more weight than the older observations.

Productivity analysis starts with the reference [21], *i.e.* the BCC model. This approach measures technical efficiency without scale efficiency. We opt for *pure technical efficiency* (the BCC model) given the large size differences between the major banks and the rest of the sample. We approach BCC from both angles, *i.e.* input minimisation (BCC-I) and output maximisation (BCC-O). Under input minimisation, optimisation proceeds with holding output levels while minimising inputs; under output maximisation, inputs are not changed while outputs are maximised. Those keen on reading more on DEA can access the online book at http://www.users.on.net/~necmi/financesite/.

The key *input* variables are deposits from non-financial corporations, deposits from financial corporations, household deposits, and total deposits. The key *outputs* are total resident assets (defined as all assets on the banks' domestic books that are due from residents), loans and advances to non-financial corporations, loans and advances to owner-occupied housing, and total gross loans and advances. We execute a robustness test with DEA by removing the key input *total deposits* and key output *total gross loans and advances* because these totals overlap with other variables.

## 4. Analyses and Results

The Australian banking sector is highly concentrated. The four major banks dominate the market by holding 79.10% of *total resident assets*, 79.61% of *total gross loans and advances*, and 77.40% of *total deposits* in the banking system as at April 2017. **Table 2** reports the systemic risks of the major banks with categories. Major banks' percent systemic risk increased from 76.02% to 80.05% between January 2011 and April 2017. The ranking of the majors also changed between these periods, while ANZ remains in the fourth place with the smallest systemic risk. The largest change was NAB's systemic risk moving from 16.43% to 22.86% due to substantial rises in the categories of *non-substitutability* and *complexity*. In terms of sensitivity analyses, **Table 3** reveals that changing the equal weights does not impact systemic risk by a large amount.

**Table 4** shows the major banks compared to a small commercial bank. In terms of the minima laid down by the BCBS on capital adequacy, Australian banks exceed them by a comfortable margin (Panel A). Regarding inter-connectedness, ANZ, CBA and NAB have similar interbank ratios, and WBC's interbank ratio is much lower; the majors are clearly *net liquidity buyers*. Liquidity risk can be measured by the interbank ratio, defined as "money lent to other banks" over "money borrowed from other banks" (%). A ratio greater (less) than 100% implies that the bank is a net liquidity provider (buyer) to the banking sector. Large banks are usually net liquidity buyers. Bank of Queensland

Table 2. Domestic systemic risk of Australian major banks with categories.

| Rank | Bank | Size | Inter-connectedness | Non-substitutability | Complexity | Domestic sentiment | Total Score | Percent systemic risk |
|---|---|---|---|---|---|---|---|---|
| | | | | January 2011 | | | | |
| 1 | Commonwealth Bank of Australia (CBA) | 0.21 | 0.21 | 0.31 | 0.14 | 0.27 | 1.13 | 22.70% |
| 2 | Westpac Banking Corporation (WBC) | 0.22 | 0.23 | 0.17 | 0.28 | 0.23 | 1.13 | 22.68% |
| 3 | National Australia Bank Limited (NAB) | 0.17 | 0.17 | 0.17 | 0.17 | 0.14 | 0.82 | 16.43% |
| 4 | Australia and New Zealand Banking Group Limited (ANZ) | 0.15 | 0.17 | 0.15 | 0.11 | 0.14 | 0.71 | 14.21% |
| | Totals | 0.74 | 0.77 | 0.80 | 0.69 | 0.79 | 3.80 | 76.02% |
| | | | | April 2017 | | | | |
| 1 | National Australia Bank Limited (NAB) | 0.19 | 0.20 | 0.27 | 0.33 | 0.14 | 1.14 | 22.86% |
| 2 | Commonwealth Bank of Australia (CBA) | 0.21 | 0.24 | 0.21 | 0.15 | 0.29 | 1.11 | 22.11% |
| 3 | Westpac Banking Corporation (WBC) | 0.22 | 0.19 | 0.17 | 0.22 | 0.23 | 1.04 | 20.88% |
| 4 | Australia and New Zealand Banking Group Limited (ANZ) | 0.16 | 0.13 | 0.18 | 0.11 | 0.14 | 0.71 | 14.21% |
| | Totals | 0.79 | 0.76 | 0.83 | 0.82 | 0.80 | 4.00 | 80.05% |

Table 3. Pearson's correlation between sensitivity scores and original scores (major banks).

| | Correlation of the original scores with sensitivity analyses | | | | |
|---|---|---|---|---|---|
| Bank | Size (40%) | Inter-connectedness (40%) | Non-substitutability (40%) | Complexity (40%) | Domestic sentiment (40%) |
| January 2011 | 1.00 | 1.00 | 0.96 | 0.95 | 0.99 |
| April 2017 | 0.99 | 0.99 | 0.97 | 0.94 | 0.92 |

emerges as a *net liquidity provider*. When we observe the first two indicators in Panel B of Table 4 (also see Table 1, D-SIB *inter-connectedness* indicators), clearly the majors are borrowing much more from other banks; for BoQ, the relationship is the reverse.

In terms of global linkages, the four D-SIB banks are well-established overseas. For example, by the end of 2016 (based on annual reports), ANZ had outlets across 11 countries and overseas markets stood at AUD 44,085,000,000; CBA's overseas markets was AUD 83,170,000,000 and operated across New Zealand, the Asia Pacific Region, UK and USA; NAB's overseas markets was AUD 118,000,000,000 and operated across New Zealand, Europe, UK and USA;

**Table 4.** Capital adequacy and inter-connectedness of the major banks versus a small bank (2016) (Source: Orbis Bank Focus).

(a)

| PANEL A | | |
|---|---|---|
| Major D-SIB banks | Capital adequacy ratios | Level |
| Australia and New Zealand Banking Group Limited (ANZ) | Common equity (core) tier 1 ratio | 9.60% |
| | Tier 1 ratio | 11.80% |
| | Total capital ratio | 14.30% |
| | Impaired loans/Average risk-weighted assets | 0.65% |
| | Impaired loans/Equity | 3.93% |
| Commonwealth Bank of Australia (CBA) | Common equity (core) tier 1 ratio | 10.60% |
| | Tier 1 ratio | 12.30% |
| | Total capital ratio | 14.30% |
| | Impaired loans/Average risk-weighted assets | 0.78% |
| | Impaired loans/Equity | 4.90% |
| National Australia Bank Limited (NAB) | Common equity (core) tier 1 ratio | 9.77% |
| | Tier 1 ratio | 12.19% |
| | Total capital ratio | 14.14% |
| | Impaired loans/Average risk-weighted assets | 0.67% |
| | Impaired loans/Equity | 5.44% |
| Westpac Banking Corporation (WBC) | Common equity (core) tier 1 ratio | 9.50% |
| | Tier 1 ratio | 11.20% |
| | Total capital ratio | 13.10% |
| | Impaired loans/Average risk-weighted assets | 0.56% |
| | Impaired loans/Equity | 3.32% |
| Bank of Queensland Limited (BoQ) | Common equity (core) tier 1 ratio | 9.00% |
| | Tier 1 ratio | n.a. |
| | Total capital ratio | 12.29% |
| | Impaired loans/Average risk-weighted assets | 0.85% |
| | Impaired loans/Equity | 6.47% |

(b)

| PANEL B | | |
|---|---|---|
| | Inter-connectedness | |
| Australia and New Zealand Banking Group Limited (ANZ) | Loans and advances to banks | 57,331,000,000 |
| | Deposits from banks | 74,770,000,000 |
| | Interbank ratio | 76.68% |
| Commonwealth Bank of Australia (CBA) | Loans and advances to banks | 34,820,000,000 |
| | Deposits from banks | 45,895,000,000 |
| | Interbank ratio | 75.87% |
| National Australia Bank Limited (NAB) | Loans and advances to banks | 50,159,000,000 |
| | Deposits from banks | 61,278,000,000 |
| | Interbank ratio | 81.86% |
| Westpac Banking Corporation (WBC) | Loans and advances to banks | 13,211,000,000 |
| | Deposits from banks | 22,572,000,000 |
| | Interbank ratio | 58.53% |
| Bank of Queensland Limited (BoQ) | Loans and advances to banks | 1,025,000,000 |
| | Deposits from banks | 209,000,000 |
| | Interbank ratio | 490.43% |

D-SIB, domestic systemically important banks.

and WBC's overseas markets amounted to AUD 102,595,000,000 and the bank operated across New Zealand, UK, USA, Asia and Pacific. Clearly, the majors have a substantial presence overseas and they are exposed to risks from other countries.

Under BCC-I and BCC-O productivity approaches, 42 DMUs out of 75 (monthly totals) emerge as slightly inefficient. In both orientations (*i.e.* input minimisation and output maximisation), inefficiency is clustered between June 2011 and April 2015 (the period examined was January 2011 to March 2017 for productivity) and the lowest efficiency score is 0.98 (more details are available from the corresponding author), *i.e.* DMUs are mostly efficient, except NAB. Given the dominance of the four major banks in the Australian banking system, we explore the possible links between systemic risk and productivity. Figure 1 indicates that the systemic risk is level across time, with the exception of NAB. NAB displays a rising systemic risk between June 2011 and April 2015, thus linking to small relative inefficiency observed. Therefore, level systemic risk and high productivity go hand-in-hand, whereas rising systemic risk leads to some inefficiency.

Robustness testing DEA by removing the key input *total deposits* and key output *total gross loans and advances* give very similar results. The number of inefficient DMUs slightly rises to 44 but the inefficiency observed is still clustered between June 2011 and May 2015 (rather than April 2015), and the lowest score is the same, *i.e.* 0.98.

## 5. Concluding Remarks

We embarked on measuring the domestic systemic risk of the Australian banks, focusing on the four major banks. We reported systemic risk along five categories, namely, size, inter-connectedness, non-substitutability, complexity and

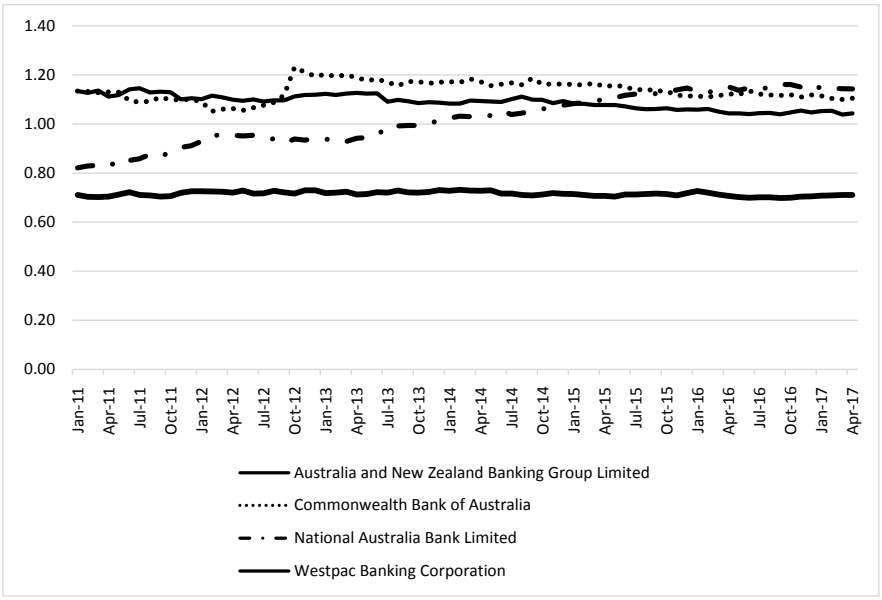


Figure 1. Systemic risk of major banks across time, January 2011-April 2017.

domestic sentiment. We then carried out sensitivity analyses by changing equal weights in the categories, and examined the capital adequacy and inter-connectedness of the majors focusing on key ratios, including overseas connections.

The findings indicate that the Australian major banks account for 76.02% to 80.05% of the domestic systemic risk in the banking system for the study period of January 2011 and April 2017. While the systemic risk of three of the major banks do not change by a substantial amount across the study period, NAB's systemic risk climbs due to rises in the categories of *non-substitutability* and *complexity*. Regarding sensitivity analyses, changing the equal weights do not impact domestic systemic risk substantially, which indicates that the results are robust.

In terms of capital adequacy, the majors exceed the minima laid down by BCBS by a comfortable margin. The major banks are net liquidity buyers regarding inter-connectedness. The majors are also well-connected outside Australia given their overseas markets in billions of dollars and exposed to crises in other countries. Comparing systemic risk to productivity, we find that *level* systemic risk across time and *high* productivity are compatible, whereas increasing systemic risk causes inefficiency.

There emerge some regulatory messages from the above findings. If we re-visit **Table 2**, we observe that at January 2011 *non-substitutability* was the highest contributor to total score, followed by *domestic sentiment* and *inter-connectedness*. In April 2017, while *non-substitutability* is still the major category, *complexity* emerges as the second most important category, followed by *domestic sentiment*. Clearly, APRA needs to supervise investment and trading securities more closely (see **Table 1**). Given its percent systemic risk rise from 16.43% to 22.86%, APRA also needs to closely monitor the National Australia Bank.

If we look at the total domestic systemic risk accounted by the four major banks, over six years the majors maintain their dominance. Returning to reference [15] key recommendations, Australian regulators need to focus on stress testing, crisis simulations and higher loss absorbency for the major banks, in particular, the National Australia Bank. Furthermore, rising systemic risk and the ensuing contagion during crises have direct impact on the economic activity via interbank lending markets, and leads to increasing cost of capital [22].

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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