

Chapter 7

CROSS-BORDER INTERBANK CONTAGION RISK ANALYSIS FOR PAPUA NEW GUINEA

By
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1. Introduction

The objective of this research is to highlight the contagion risks faced by banks with respect to their cross-border dealings and establish the networks through which potential contagion can spread from one country to another country. The research also attempted to identify the various sources of contagion risks, both domestic and external and estimate the size of their impacts on the domestic banks through the banking network. Another key aspect of the research is to increase the Central Bank's understanding of the sources of contagion and contagion transmission channels so it can be able to undertake proactive micro and macro prudential measures to intervene and mitigate potential losses associated with the banks' exposures from their cross-border trading.

This study is necessary given the important roles played by the banks in the PNG economy and the development of the banking and financial system into a more complicated network, with products and services more complex than before. A more complex financial system can conceal risks and will make it hard to detect potential contagion across borders.

I employed the network simulation analysis, combined with a stress testing and simple ordinary least squares (OLS) regressions to trace bank linkages and connectivity for systematic important countries (SIC), establish the stability of domestic banks and estimate the size of foreign shocks, especially from Australia. The analysis showed that connectivity of banks are straight-forward, domestic banks are highly capitalized with limited impact of global commodity prices, interest rates and credits shocks from Australia. The network analysis showed an expansion in the network between countries, which reflected increases in both claims and liabilities of PNG against its trading partner countries.

The unprecedented changes in the global financial markets enabled the activities of banks and financial institutions to become closely linked and interconnected. The integration of financial markets nowadays provide opportunities for banks and financial institutions to expand and improve on sharing risks but the interconnectedness can pose threats as well. The growth in the banks' networks both domestic and across borders, combined with the growing complexity in the products they offer, can induce risks that can spread contagion across the entire financial system. This growing complexity in the financial system and products offered by financial intermediaries can make the detection of possible risks in the financial system very difficult. Central Banks, as regulators should be concerned about what is going on in the financial markets to ensure financial

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system stability, an area that they directly regulate and supervise². Therefore, it is important that the Central Banks understand the classes of exposures, the risks and the possible transmission channels of the contagion so they can introduce mitigating mechanisms to prevent contagions.

Shocks elsewhere can be transmitted via these channels of network and may cause financial distress and imbalance in the domestic financial system that can affect the health of the economy. The great financial crisis (GFC) in 2008 and the 1997 Asian Contagion presented valuable lessons about how contagion can spread through different transmission channels and how to manage risks in an era of increasingly complicated financial system network. With rapid globalization and evolution in information technologies, financial products and services offered by the banks and finance companies are becoming increasingly complex as well, which can provide opportunities for growth and profitability but also pose risks. In such a case, it is important to have an efficient and reliable banking and finance model and a regulator with robust regulatory policy platforms. This is to detect and mitigate risks arising from the more integrated financial market and the complex products and services offered by the banks, and also to ensure that the general condition of banking industry is healthy.

The number of literatures on cross-border contagions around the world is growing and is contributed mostly by Central Banks, International Monetary Fund (IMF), Bank for International Settlement (BIS) and others. However, there are limited studies for PNG and the Pacific Island countries so this paper is intended to fill that gap in the existing literature by using BIS locational banking statistics for PNG. Thus this analysis aims to contribute to this body of knowledge by providing both a qualitative and quantitative analysis on cross-border and domestic risks faced by banks in PNG. It is the aim of this research that policy makers are fully aware and equipped with appropriate policy models to deal with risks emanating from cross-border and domestic activities by banks.

In the paper outline, the second section is dedicated to reviewing existing literatures on the topic to see why this topic is important and what we already know about the topic; the third part looks at the overview of the financial system of PNG; the fourth section focus on data and methodology; the fifth section is on empirical analysis on capital adequacy ratio, credits, asset quality, liquidity and bank failure; section six is on cross-border activities, section seven is on cross-border shocks followed by the conclusion.

2. Literature Review

A number of studies have been done on this topic on Cross-border Interbank Contagion Risk Analysis. For example, the paper by Degryse et al. (2008) which discussed “Cross-border Interbank Exposures and Financial Contagion” noted that even though financial markets are integrated which enhanced global financial market intermediation, they also pose as threats for contagion. They cited the crises in Mexico in 1994, Asia in 1997-1998, Russia in 1998, Brazil in 1999 and the Long Term Capital Management (LTCM) in 1998 as examples of what can go wrong if the channels of financial contagion are not understood properly. Experiences in these countries showed that it is worthwhile to study the channels through which the contagion is transmitted. Therefore, they proposed that on the back of banks resorting to cross-border relationships and holding more international assets and liabilities, the banking sector require special attention because of the importance of their roles in the financial markets and the economy.

2. Bank of PNG regulates and supervises the Banks and Finance companies in PNG.

Empirical studies by Halden and May (2011), Allen and Gale (2000), Yellen (2013) and Cerutti (2015) on the impact of the global financial crisis and the role of SIBs point to cross-border interbank exposures as the main factor affecting the systemic stability of the individual banking system through the transmission of shocks. According to Genberg (2017), the financial integration and network has become more complicated, especially in emerging market economies in Asia. Accelerated economic growth in the emerging markets is normally financed by banks, and the cross-border interbank linkages could have played a role in their growth. This type of interconnectedness can allocate funding efficiently on the back of innovation and competition, while posing higher contagion risk through systemic instability within the banks and financial institutions. The paper done by Glasserman and Young (2015) indicated that contagion risks can cause higher losses in a more strongly integrated and linked financial system. The complexity of the financial network is such that it can be hard to detect contagion risk related to interbank activities across borders. This is made even worse when banks are linked through off balance sheet financial activities. Therefore, with a complex financial cross-border interbank linkage, shocks are often concealed and potential for spill-over to other financial systems exist without being known.

According to the BIS statistical release (2018), there was a pickup in international banking activity between 2017 and first quarter of 2018. The fastest growth was in cross-border credit to non-bank financial borrowers, especially Governments in emerging and developing market economies. Cross-border lending also expanded across emerging economies in Asia, Africa, Latin America, Middle East and emerging Europe. The Asia-Pacific region saw rapid growth in financial flows since the GFC, which included the use of currencies of Asia-Pacific countries to trade that represented 40% of global trades (BIS, 2014). Cross-border financial integration captures capital flows as well as trade linkages, incipient flows, remittances, price arbitrage and risks. Financial integration offers enormous benefits but it can also present challenges. This is where macroprudential policy and liquidity management strategies becomes important and can play a role in reducing systemic risk in financial markets (BIS, 2014).

According to a number of literatures on the GFC, high capital inflows to emerging market and developing economies can be traced back to excessive global liquidity. The excess liquidity provided cheap dollars while at the same time forced global investors to seek higher yields and returns by shifting their portfolios towards emerging markets with higher interest rates and better economic prospects. This is the reason why there was strong capital flows into emerging market and developing economies. This means that a high and unstable capital flows can lead to macro and financial stability concerns, and managing capital flows to minimize such concerns can disturb macroeconomic management in emerging market and developing economies.

The paper by Remolona and Shim (2015) noted the intensification of the cross-border banking activity within the Asia-Pacific region after the GFC. Before the GFC, much of the cross-border activity in the region had been driven by dollar credit intermediated largely by banks, which have had origins in advanced economies. Banks within the Asia-Pacific region stepped in and dominated the cross-border banking activity after the crisis. The rise in the intra-regional trend was further boosted by the ASEAN member governments which adopted a regional banking integration framework, with the aim to balance the efficiency gains of regional integration against the risks of financial instability. The authors analysed the proliferation of regional bank branches and subsidiaries in the region, how these units fund themselves, and what the implications are for

their lending behaviour. They raised some specific issues relating to financial stability: vis-a-vis the potential for concentration of lending to a few creditors and systemic risks involving foreign branches; liquidity risks in foreign currency funding; and the increasing share of short-term foreign currency loans in Asia-Pacific banks' intraregional lending.

The GFC shook the foundations of the international banking and financial system and put the banks under immense stress. Cross-border bank lending proved to be one of the major financial channels through which stresses in the international financial system were transmitted to individual emerging markets and developing economies (Takáts, 2018). During the GFC, cross-border lending by banks fell affecting economies and banks which relied heavily on cross-border lending. The catch was that although cross-border lending in dollars declined, lending by international banks in local currencies increased in the emerging market and developing countries (Takats, 2018). This indicated that foreign banks became major players in the domestic financial markets of most emerging market and developing economies because they operated almost as local banks with foreign ownership and expanded their credits in local currencies. Other regions, like the Euro continued to rely on cross-border lending that exposed their banking sector to risks such as currency mismatches (Takats, 2018).

Cihak and Ong (2007) examined the scope for cross-border spill overs among major EU banks and found that spill overs were more likely to happen within domestic banking systems, but cross-border links were expanding more than the domestic banks, which evidently supported the need for strong cross-border supervision. One important funding source was parent-bank lending during and after the crisis when other funding sources dried up. By 2007, domestic savings dried up and was insufficient to finance the growing credit creating funding gaps in many countries. Some economies lived with it for longer period, in other countries, credit stock was above deposits, while in others, deposit coverage was high. During the crisis, these financial gaps widened further due to the depreciation that increased the weight of forex loans in the stock of credit, lifting debt burdens of borrowers more (Cihak and Ong, 2007). Therefore, parent-bank lending accounted for a significant and increasing share of financing of these funding gaps in many countries. The growth in foreign currency lending was mainly to borrowers in the private sector who did not hedge, which resulted in a build-up in vulnerabilities during the run-up to the crisis. The main risks facing the financial stability were insufficient domestic funding base, deteriorating quality of bank's assets and increased exposures to the property market (Cihak and Ong, 2007).

Battiston et al. (2015) acknowledged that the global financial system has become increasingly large and interconnected, which is a key factor in precipitating the financial crisis as troubles in one financial institution spread quickly to others. In their work, and in the economic literature, network theory was used to study the financial sector as a complex system of interlinked agents, where they assessed the likelihood of systemic contagion, the different channels through which a contagion can spread, the linkages between the network and the resilience of the financial system.

Benelli et al. (2011) mapped out the cross-border financial linkages and identified key factors that drive them and the complexity that aided instability in the global financial system. This can underscore the value of safety net designed to prevent risks from spreading through the financial network and turn into a large-scale systemic crisis. In terms of mapping out the linkages, financial linkages increased and became more complex, with advanced economies still dominating the network of links across asset classes and regions, both as sources and recipients. From this,

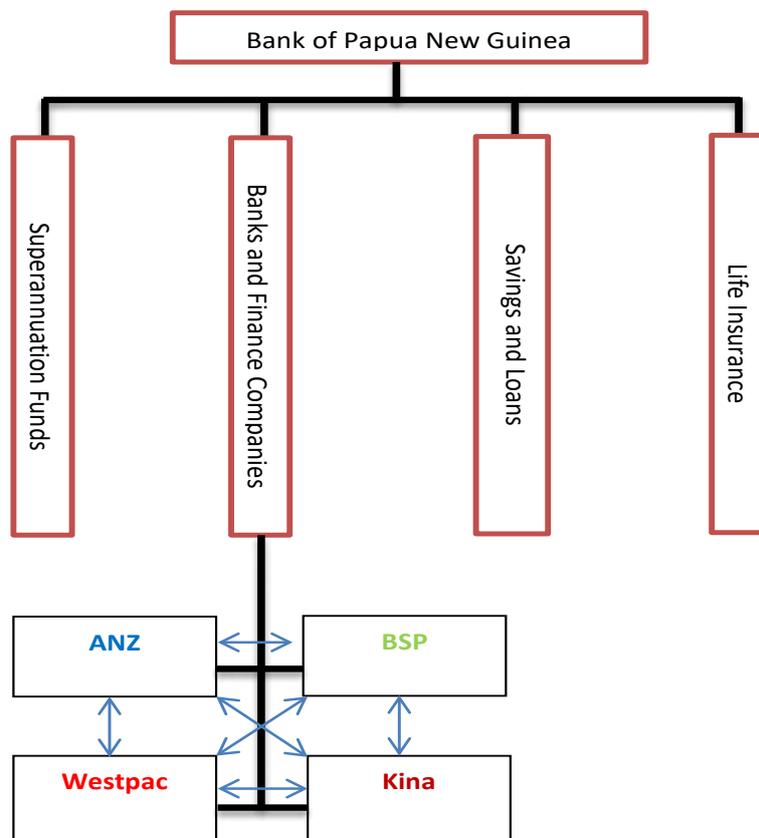
emerging markets' strongest links remain with advanced economies, although linkages among the emerging economies increased rapidly during the last decade. One of the key aspects of increased cross-border financial linkages is the diversification of risks for individual country, which tend to reduce exposure to local shocks. On the other hand, increased interconnectedness can facilitate the transmission of shocks throughout the financial network and make the global financial network more prone to systemic risk. The extent and complexity of cross-border financial linkages grew; with investor information on exposures becoming less certain that amplified systemic risks from panic respond to shocks. Benelli et al. (2011) pointed out that countries with shallow domestic financial markets and have their exposures concentrated in a few lenders are prone to drastic changes in the cross-border flows. Risk aversion can drive global financial markets and tend to intensify sharply during the crisis which amplified the transmission of shocks. These features highlighted that the costs of systemic shocks to others not affected by the crisis are high, which reinforced the case for policy-makers to design macroprudential policies to help ring-fence such countries from systemic shock contagion. Benelli et al. (2011) showed that geography and history played a key role in determining linkages between neighbouring economies and with those that are larger, developed, and financially advanced.

According to Upper (2007), creating a detailed mapping of links in the interbank trading across borders can simulate a credit default or liquidity contraction on the banks. Also, Nier et al. (2008) showed how the transmission of market and idiosyncratic shocks can be simulated, which become important in identifying the triggers of the contagion risk from market or idiosyncratic shocks. This is useful in assessing the impact of risk-sharing on cross-border interbank activities, which addresses solvency, liquidity contagion risks and ensuring effective prudential management policies by regulators.

3. An Overview of the Financial System in Papua New Guinea

The Central Bank (Bank of PNG) plays an oversight role in regulating and supervising the banking and financial system under the Banks and Financial Institution Act 2000 (BFIA), apart from its other functions. The financial system includes banks, savings and loans societies, superannuation funds, finance companies, micro-banks and life insurance companies. The overarching goal of such a supervisory and regulatory function is to maintain a sound market-based financial system and a risk-based supervision to achieve the stability objectives of the Bank of PNG. As part of the regulatory and supervisory roles, the Bank of PNG issues licenses to the banks and other financial institutions to conduct banking and other financial services in PNG.

Figure 1
A Simple Overview of the Structure of the Banking and Financial System in PNG



To operate a bank or finance company requires a license from the Bank of PNG. There are minimum regulatory requirements the licensee must meet. For example, meeting the minimum capital requirement; banks pay around US\$4.6 million, while for financial company is US\$0.46 million to obtain the license to operate. Apart from this, there are also other supplementary regulatory requirements. For example, the banks’ top management have to meet the ‘Fit and Proper’ requirement. Figure 1 above shows the general regulatory structure of the whole financial system in PNG, having Bank of PNG as the regulator.

3.1 Domestic Banking Activity

One of the major objectives of the Bank of PNG, as the regulator is to ensure that the financial system in PNG is stable. The PNG financial system is worth over 50% of PNG’s gross domestic product (GDP), thus it is important that stability is maintained to secure its integrity and the health of the PNG economy. The Bank of PNG drafts and implements appropriate legislations, regulatory and supervisory policies to achieve stability. The benefits of having these regulatory and supervisory policies are that the risks that would otherwise pose as threats to the financial system stability are detected early and mitigated or if they materialise, they are addressed appropriately to manageable levels. They also ensure that the financial and operational soundness of banks and financial companies are maintained, the interest of depositors, superannuation contributors and holders of life insurance policies are protected, as well as maintaining the general stability of the whole financial system to generate confidence about the financial system and economy.

The banking industry consists of four commercial banks and a number of micro-banks. The four banks are; Bank South Pacific Ltd (BSP), Australia and New Zealand Bank (ANZ), Westpac and Kina bank. BSP, a locally owned bank is the largest, with branches and agents right across the country and the Pacific region; in Fiji, Samoa, Tonga, Solomon, Islands, Cook Islands, Vanuatu and a subsidiary in Cambodia. ANZ and Westpac are subsidiaries of Australian-based banks, while Kina is a new foreign bank, which bought off May bank in 2015. The micro-banks are very small players in the financial market.

The major challenges that are currently confronting the banking industry are the lack of foreign currency and trading in the interbank forex market. The banks are short in forex due to the growing demand for foreign currency spurred by increased import demand, combined with a drop in foreign currency inflows from lower prices of export commodities and foreign direct investments (FDI). There is access liquidity in local currency in the domestic banking system because banks have reached their exposure limits on lending to certain sectors of the economy, hence contributing to liquidity hangover in the system. The holding of liquidity is distributed unevenly across the banks with bulk of it is in the hands of only 1 or 2 banks, while others resort to borrowing in the domestic interbank and repo markets. Generally, the provision of banking services in the country present opportunities as well as challenges. The country's topography is rugged and remote and rolling out the banking and associated services such as telecommunications, roads etc. to other regions continue to remain major hindrances.

Despite the challenges, the banks have been performing strongly with huge profits. Arguably, the profits from their operations in PNG subsidize the costs of other branches in the Pacific. Their balance sheet is healthy, with positive net assets. Adequate capital is maintained and credit is also growing and is extended to all sectors of the economy. While lending to some sectors like the real estate dropped, home and personal loans increased, offsetting the fall in the real estate and commercial lending. However, credit as a fraction of GDP has fallen since April 2013. Declines in bank credit, GDP growth, commodity prices, and interest and exchange rates are seen as shocks in domestic banks' activity and can escalate to contagion in the banking network. For example, a liquidity shortage faced by a SIB both in the forex and domestic markets can lead to shortages in other banks that can spread and infect other healthy banks.

3.2 Early Warning Indicators

Contagion by definition is the spreading of disturbances from one market to other markets and comes in different forms and sources. Early warning indicators provide advance signals of an impending crisis. These can be in the form of excessive credit growth and asset prices, real economy, monetary aggregates, inflation, interest rates and others. It is important in PNG and elsewhere to establish protocols to identify early warning indicators of financial and macroeconomic risks and the necessary actions to mitigate them.

There must be advance warning signals about an impending underlying financial or real sector probable crisis so that policy makers are aware in advance and adopt pre-emptive measures to mitigate potential damages to the economy. This is because a crisis, when it occurs, is very expensive to restore the damages it caused. For example, building a counter cyclical capital buffer will go a long way in safeguarding the banks if there are signs that the banking sector is in distress. Some of the indicators identified by the International Monetary Fund (IMF) that may be used to generate early warning signals for crisis are listed in Table 1 below.

Table 1
Early Warning Indicators

Credit Developments	Private Sector debt burden	Overvaluation of Property Prices	External Imbalances	Mispricing of Risks	Health of Bank Balance Sheet	Real Economy	Monetary Aggregate	Inflation	Others
Total Credit to Private sector	Real Mortgage Interest rate	House prices	Current Account/GDP	Short-term interest rates	Leverage ratio	GDP	M1	Commodity Prices	Income Inequality
Bank Credit to Private sector	Debt service ratio	Ratio of House Prices and Income	Trade Balance	Long term interest rates	Bank profits	Global GDP	Global M1	Inflation	Deposit Insurance Schemes
Household Credit	Household debt service ratio	Ratio of House prices and Rent	Trade/GDP	Yield curve	Bank deposits	Real GDP per Capital	M2	Global Inflation	Financial Deregulation
Mortgage Loans	Corporate debt service ratio	Global House prices	Exports	Lending rate/deposit rate	Loan/Deposits	Output Gap	M2/Reserves	Real Interest Rae	Capital Requirement
Corporate Credit		Ratio of global house prices and income	Imports	Stick returns	Non-core Liabilities	Unemployment	M3		Contagion
Public credit		Commercial Real estate prices	Capital Flows/GDP	Global stock returns	Banks Net Foreign Assets	Industrial Production			Fixed Exchange Rate
Global credit			Foreign Assets	Aggregate asset prices	Bank Reserves/Assets	Industry Share of GDP			Tax burden
Credit-to-GDP ratio			Foreign Liabilities	LIBOR OIS spread	Bank Liquidity	Consumption			
Bank credit-to-GDP ratio			Foreign Liabilities/Foreign Assets	Corporate bond spread	Banking Sector CDS Spread	Investment			
Household credit-to-GDP ratio			Foreign Direct Investment (Decline)		Financial Sector Size	Capital/Output			
Mortgage loans-to-GDP ratio			Foreign Portfolio Investments (decline)			Government Consumption			

Source: SEACEN workshop on Financial Cycles and Crisis (2018).

4. Data and Methodology

I used three approaches to estimate the impact of a macroeconomic shock on banking activities. Firstly, I used a simple stress testing model developed by Cihak (2007) to estimate the impact on banking activity by shocking some key macroeconomic variables. A shock from a credit default, non-performing loans (NPLs), credit and funding difficulties of a bank that causes a liquidity squeeze on other banks are also captured. Secondly, I used Gephi, a network simulation analysis software to trace the links between banks' claims and liabilities using the BIS locational banking statistics. In the third approach, I used a simple ordinary least squares (OLS) regressions using Eviews to estimate the extent to which a shock in commodity prices, GDP, interest rates and credit in Australia impacted domestic banking activity, especially credit, capital adequacy and liquidity in PNG. GDP, credit and interest rates in Australia are chosen because; (i) Australia is a major trading partner, (ii) two big banks operating in PNG have headquarters in Australia, and have operations in the Pacific and across Asia, and (iii) geographical proximity. The analysis is on the source of possible contagion spill-over and triggers in the domestic banking system and between banks in PNG and Australia.

4.1 Data

The quality of data is important in order to do a good empirical analysis. In this study, I used the commercial banks' 2017 financial statements, including monthly data for the active commercial banks obtained from the Bank of PNG for the period January 2011- June 2018. The following data were also sourced from the Bank for International Settlement (BIS) website; (i) 2018 March quarter data on cross-border positions by instrument, sector and currency, (ii) 2018 March quarter cross-border positions by location of banking office, and (iii) Consolidated positions on counterparties resident in Papua New Guinea for amount outstanding at the end of March 2018.

The monthly data for commodity prices were from the World Bank for the period January 2000 to June 2018. Crude oil prices are in US dollar per barrel and are the average of Brent, Dubai and West Texas Intermediate (WTI). The price for the Liquefied Natural Gas (LNG) is in US dollar per one million British Thermal Units (\$/mmbtu), the prices of coffee, cocoa, tea and oil palm are also in US dollar per kilogram (\$/kg), while the prices of gold is in US dollar per troy ounce ((\$/troy oz) and the price of copper is in US dollar per metric tonne (\$/mt).

The GDP data for PNG is available by year (not monthly). For this study, I used Eviews Quadratic match sum³ to convert the annual data into monthly data. This is useful to calculate the monthly credit-to-GDP ratio from 2011 to 2018. The actual GDP for 2011-2014 is from the National Statistical Office, while the estimates for 2015-2018 are sourced from the 2018 PNG National Government Budget.

The GDP, credit and interest rates data for Australia for the period January 2011 to June 2018 were sourced from Reserve Bank of Australia. These data are important because ANZ and Westpac, which operate in PNG have their headquarters in Australia and operations in New Zealand, Fiji and across the Asia - Pacific region. This is to ensure there is consistency in the story about the contagion being passed on to other countries through such networks.

For the network analysis, I used the December Quarter 2005 and June Quarter 2018 BIS Banking Location Statistics to do comparison between this 2 periods and the movement in their linkages.

All the data were converted into US\$ using the end of period exchange rates, PGK/US\$ and AU\$/US\$.

4.2 Methodology

For the banks' stress testing, I used the same approach as in Cihak (2007) *Stress Testing Framework*.⁴ In this approach I shocked domestic credit, exchange rate, NPL and interest rate to see the impact on capital adequacy ratio, credit and liquidity.

3. It has the benefit of relatively few data points being interpolated and the source data is fairly smooth.

4. In this framework, there is a macroeconomic model where external shocks are linked to GDP, Interest rates and exchange rate that affect a satellite model that links the macroeconomic variable to the asset quality of banks. Both model mapped the shocks to the banks' balance sheets, its impact and the correction needed. This article can be found here: <https://www.imf.org/external/pubs/ft/wp/2006/wp06163.pdf>.

The OLS equation to estimate the extent of the impact on PNG domestic credit from external shocks, especially interest rates and credit in Australia, which is given by:

$$\Delta C_{tp} = \Delta R_a + \Delta C_{ba} + \Delta C_{iha} + \Delta C_{ooha} + \Delta C_{ta} + \Delta I_u \quad (\text{Equation 1})$$

where: ΔC_{tp} = Total Credit Extended by banks in PNG, ΔR_a = Overnight Call Rate in Australia, ΔC_{ba} = Business Credit in Australia, ΔC_{iha} = Credit for investor housing in Australia, ΔC_{ooha} = Credit for Owner Occupied Housing in Australia, ΔC_{ta} = Total Credit for Australia, and ΔI_u = Unsecured lending rate in Australia.

The OLS equation to estimate the extent of the impact on PNG domestic credit from commodity price shocks is given by:

$$\Delta C_{tp} = \Delta M_{pi} + \Delta CLNG_{pi} + \Delta A_{pi} \quad (\text{Equation 2})$$

where: ΔC_{tp} = Total Credit Extended by banks in PNG, ΔM_{pi} = Mineral price index⁵, $\Delta CLNG_{pi}$ = Crude oil and liquefied natural gas price index, and ΔA_{pi} = Agriculture commodity price index⁶

For the network simulation, the concepts explained are specific for this paper. The cross-border exposures are represented as a visual network, in which the network consists of nodes and the connection between them is represented by links. The number of nodes (n) defines the size of the network. The links can be directed or undirected and it is said to be directed when the link from one node to the other node is known and meaningful, and a node represent a country. From a sequence of nodes, where a node is linked to the next node is called walk, and a walk is referred to as a path if all links are directed. The length of a path between two nodes is measured by the number of links between the two nodes (Hattori and Suda, 2007).

The BIS Banking Location Statistics was used to cover individual countries and the amounts outstanding of cross-border bank exposures in terms of asset and liability between PNG and other countries. Given the definitions above and in the literature on network analysis, a node represents a country in the database, while a link represent the exposure from one reporting country to another country. A link in these statistics is treated as a directed link; a path and length of a path still retain their definitions as above. The size of the nodes represents the size of the exposure; that is, the bigger the nodes, the bigger the exposures, while the size of the links represents the importance and closeness of the nodes to each other. The cross-border bank exposure network is visualised in Figures 11 and 12. We see that the network is growing despite the low number of nodes and links.

In this paper, Gephi was used for the network simulation and visualization including using its properties of basic centrality measures such as indegree, outdegree and degree. According to Macpherson et al. (2001), and Wasserman and Faust (1994), a directed network is the sum of the indegree and outdegree and the average degree can be represented as:

average degree = $\frac{\text{Total number of links}}{\text{Total number of nodes}}$. Betweenness centrality measures the number of times a

5. Index is calculated using the prices of Gold and Copper.

6. Index is calculated using the prices of palm oil, coffee and cocoa.

node lies on the shortest path between other nodes and is represented by: $\text{betweenness centrality} = \frac{\text{Total number of shortest path through a node}}{\text{Total number of shortest paths between each node}}$. Closeness centrality measures the average length of the shortest path (d) between the node (i and j) and all other nodes and is represented by: $\text{Closeness centrality (c)} = \sum \frac{d}{d(i,j)}$. Network simulation can be represented as in Espinosa-Vega and Sole (2010):

$$\sum_n X_{nm} + a_n = k_n + b_n + d_n + \sum_m X_{mn}$$

where: X_{nm} stands for bank n lending to bank m , a_n stands for bank n 's other assets, k_n stands for bank n 's capital, b_n are long term and short-term borrowing, d_n stands for deposits, and X_{mn} stands for bank n borrowing from bank m . Network connectivity is calculated as; $p = \frac{m}{n(n-1)}$, where: p = probability of connectivity between two nodes, m = the number of links, n = nodes.

5. Empirical Analysis

The empirical part is divided into three sections. In the first part, I used a stress testing model to shock the banks' sectoral credit, NPLs, exchange rate and interest rates to see their impact on capital adequacy ratios, credit, liquidity and the probability of default. The purpose of a bank stress test is to ensure that banks have enough capital on their balance sheets to counteract a severe economic downturn and that they maintain strong capital levels. This will make sure that the banks retain their ability to lend to households and businesses during a downturn. The following shocks were applied concurrently to see the impact on the banks' capital adequacy ratio (CAR), probability of default, liquidity, asset quality and sensitivity to market risks; (i) a 30% increase in non-performing loans (NPL), (ii) a 5% depreciation in the kina exchange rate, (iii) a 10% shock in the agriculture/forestry/fishery, (iv) a 15% shock in real estate, and (v) a 5% shock in commerce trade, and a 4% shock in the other sectors. In the second part, I used the network simulation analysis to study the linkages between PNG and other countries through their claims and liabilities using the BIS banking locational statistics. In the third part, I used a simple OLS regression to estimate the correlation between a shock in global commodity prices, GDP, credit and interest rates in Australia and credit in PNG and by how much the bank activities in PNG are impacted.

5.1 Capital Adequacy

The balance sheet contains information about the asset and liability of the banks that reveals the underlying health of the bank. Part of this is the capital base of the banks, which is critical to the banks, financial system and economy because they act as cushion to absorb any unforeseen shocks. It reveals the source of the banks' credits and debts, non-performing loans and bad debts, which are important in identifying the sector/industry that the bank borrows or lend money to. For banks in PNG, the total asset/liability gap is positive and showed a positive trend, indicating a more robust capital base. This can act as a buffer against unforeseen shocks. However, a banking crisis in Australia or elsewhere will spread quickly because of the integrated financial network between Australia and PNG. As shown by the correlation between credit and interest rates in Australia and PNG, prudential measures remain important to ensure domestic banks maintain their capital buffers.

Table 2
Regulatory Minimum Capital Requirements

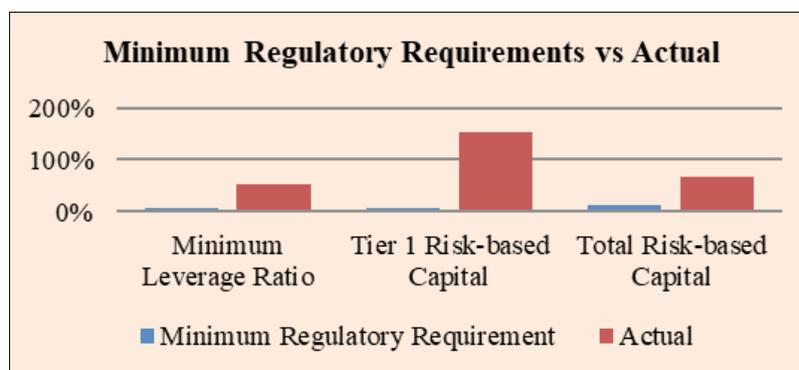
Capital Threshold	Minimum Leverage Ratio	Tier 1 Risk-based Capital	Total Risk-based Capital
Well Capitalized	≥ 8%	≥ 10%	≥ 14%
Adequately Capitalized	6% < 8%	8% < 10%	12% < 14%
Undercapitalized	4% < 6%	4% < 8%	8% < 12%
Significantly Undercapitalized	2% < 4%	< 4%	< 8%
Critically Undercapitalized	< 2%	Not relevant anymore	

Source: Bank of PNG.

Table 2 above shows the regulatory threshold minimum capital requirements for banks operating in PNG. Figure 2 below shows the actual capital held by banks against the minimum threshold required by the Bank of PNG, as the regulator.

The capital adequacy ratio measured as the ratio of ‘pre-shock capital and risk-weighted asset’ is used to reflect how much high-quality, highly liquid capital a bank has relative to a risk-weighted measure of assets. It is one of the critical elements of the prudential standards to maintain the capital buffers to absorb any potential losses. It prescribes the range of capital ratios to measure whether a bank is under, adequately or over capitalized.

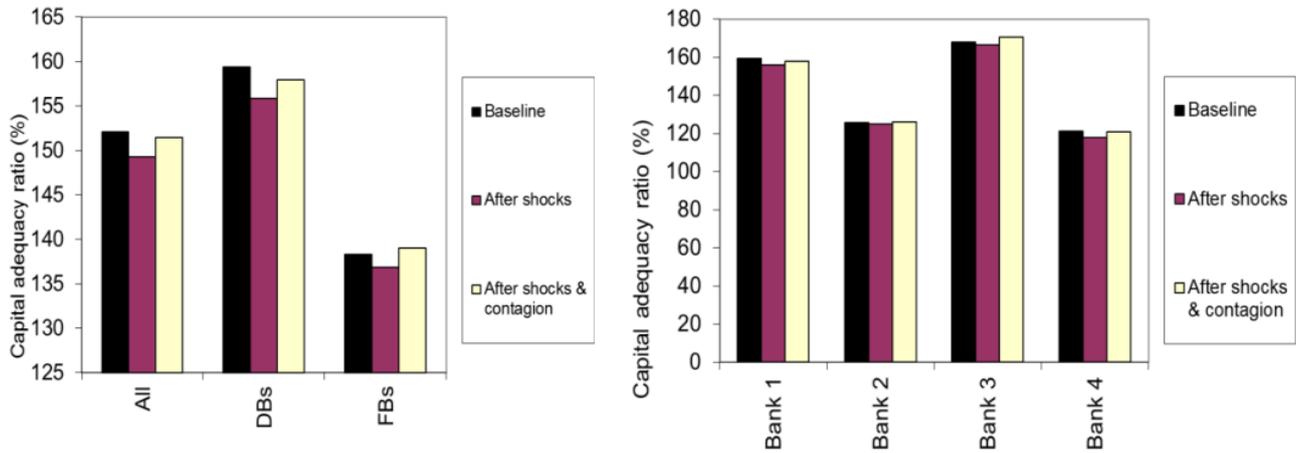
Figure 2
Minimum Capital Threshold Against Actual



Source: Bank of PNG.

Most of the banks in PNG are in the category of highly capitalized banks. Their position is way above the minimum regulatory requirement of 8% for Tier 1, total risk-based ratio of 12% and leverage ratio of 6% set by Bank of PNG. This means that a shock in non-performing loans, interest and exchange rates will have minimal shock to the banking system. However, this is not to say, the impact is the same on each bank. For example, the impact on foreign banks is larger than domestic banks. This may be explained by foreign banks being exposed to external risks. This is shown in Figure 3 below, where aftershocks and contagion are higher in foreign banks than domestic banks. In PNG, the Central Bank sets the prudential standards on their assets and liabilities, including placing 10% of deposits at the Central Bank.

Figure 3
Capital Adequacy Ratio (Total and by Banks)



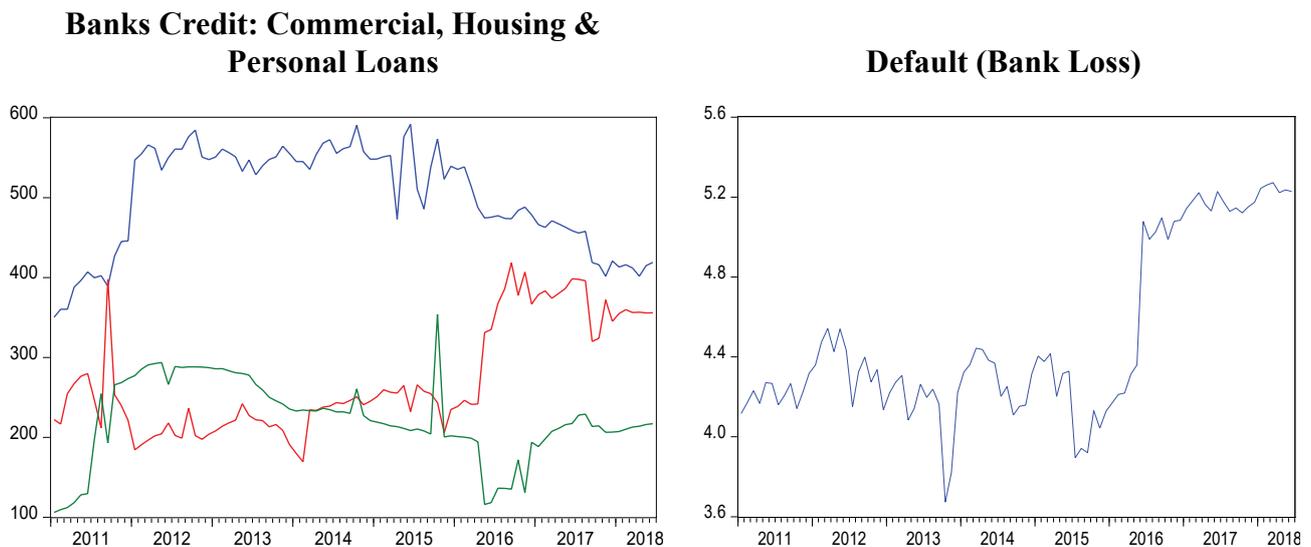
Source: Bank of PNG.

5.2 Credits and Asset Quality

The 2008 GFC was a red flag for financial institutions, more so banks in their approach to their credit lines and lending and the quality of asset they hold. Credit performance (loan portfolio) is one of the key indicators of a bank performance. Bad loans can lead to defaults and cause a bank into distress and eventually causing losses and affecting their balance sheets. If this is a SIB, others which are connected to it can be affected as well. Bank lending depends on the total amount of loanable funds available to the bank to lend and its success depends on the borrower’s ability to repay the loan. Generally, bank lending has shown mixed trends in PNG.

Figure 4 below show the trends in loan portfolios; personnel, housing and commercial as well as defaults. Commercial lending started to increase after 2010 and remained relatively flat until 2015, which started to decline. Housing and personal loans remained flat until after 2015 that started to increase. Defaulting loans remained relatively flat until mid-2015 when it soared dramatically, reflecting default on loans, mainly personal. This presents a fundamental underlying risk and if not addressed quickly, can lead to more defaults and potential stress in the banking system. NPLs extended by banks remained low against the total loans and regulatory capital.

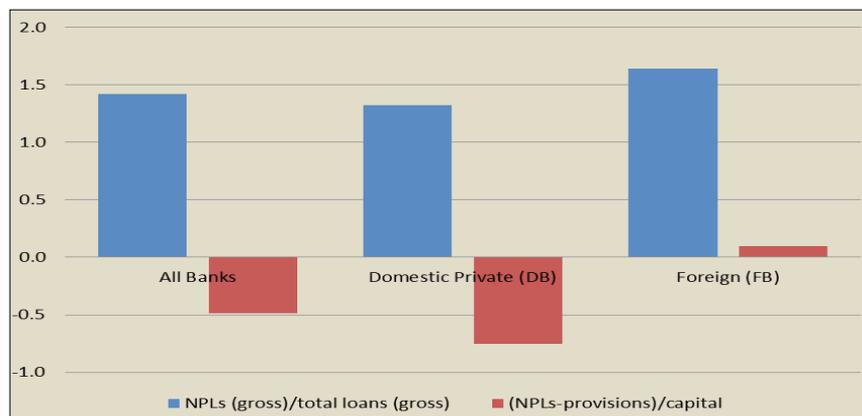
Figure 4
Bank Lending and Defaults



Source: Bank of PNG.

Figure 5 below shows that NPLs is low, which is only 1.4% of total loans, while NPLs provisions as a fraction of regulatory capital is negative, which reflect the low level of NPLs against a higher provision. This indicated sufficient buffer that any loss can be covered with higher provisions.

Figure 5
Non-performing Loans

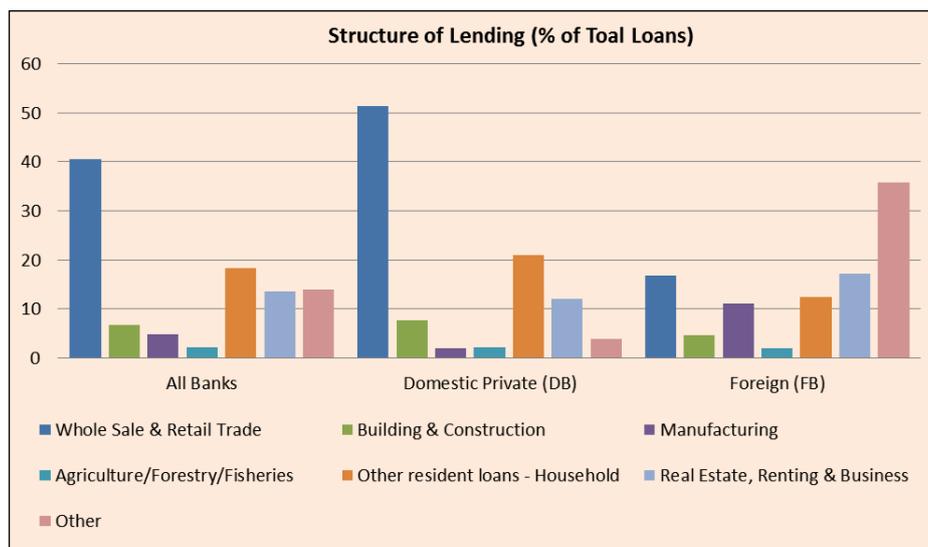


Source: Bank of PNG.

The banks' traditional focus is on extending credit and loans to customers therefore, credit risk remains the most important for banks. Banks mainly take deposits and provide banking and extend credit to households and firms. However, the risk is that if an increase in lending is concentrated in only one sector of the economy, firm or household and the borrower is unable to repay and default, the bank is going to be in serious trouble.

Figure 6 below shows the distribution of loans across different sectors of the economy, mainly in wholesale and retail, households, others and real estate sectors. Domestic banks extended 51% of their lending to the wholesale and retail, 21% to the household, 12% to the real estate and the remaining 16% to other sectors. On the other hand, foreign banks concentrated their lending in other sectors by 36%, wholesale and retail and real estate with 17% apiece, household by 12%, manufacturing by 11%, and the other remaining sectors by 7%. Generally, bulk of the total lending is extended to wholesale and retail, and household sectors, while equal and sizeable amount is extended to the real estate and other sectors.

Figure 6
Banks' Lending to Different Sectors of the Economy



Source: Bank of PNG.

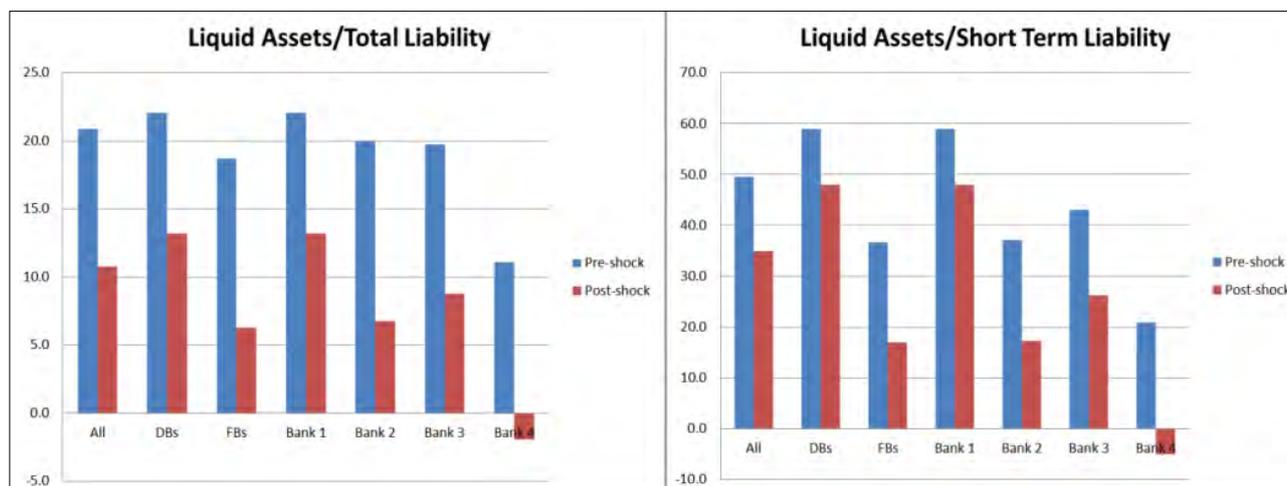
Each sector presents its own unique risks and as part of the banks' management of risks, they have to distribute their lending fairly across the various industries. The decision to lend should be based on the borrower's ability and willingness to repay the loan. Banks should not only rely on the value of collateral or some other guarantee offered by the borrowers to approve a credit. Although collateral is important, the primary factor should be the ability to repay the loan. Collateral and guarantees may not be enough to prevent financial losses when the customers fail to repay their loans. Therefore, knowing your customers and assessing their creditworthiness is critical to the banks because their ability to repay is important to ensure banks extend credit to the right customers and remain profitable. Banks in PNG do have mechanisms to monitor credit exposures in line with the Bank of PNG prudential standards that require loans are classified into various grades of default risk to which, the banks have to comply.

5.3 Liquidity and Bank Failures

Banks, by virtue of their operations are exposed to liquidity risks where they are unable to meet their financial obligations as they fall due. The key to eliminate these risks is to have sufficient funds available to meet all financial obligations. Therefore, it is important that banks match and control mismatch their maturities and interest rates on assets and liabilities. Although, unmatched position can enhance profitability, it can also increase the risk of losses.

In PNG, the banks are required by the Central Bank to hold a fraction of customers’ deposits as Cash Reserve Requirement (CRR) with the Central Bank on a daily basis. It is 10% of total deposits. With respect to the stress test, their ratio of liquid assets and liabilities dropped but remain positive. Individually, all but only one bank dropped by 1.9%. This can be seen in Figure 7 below where liquid asset as a fraction of total liability remain positive, over US\$10 million.

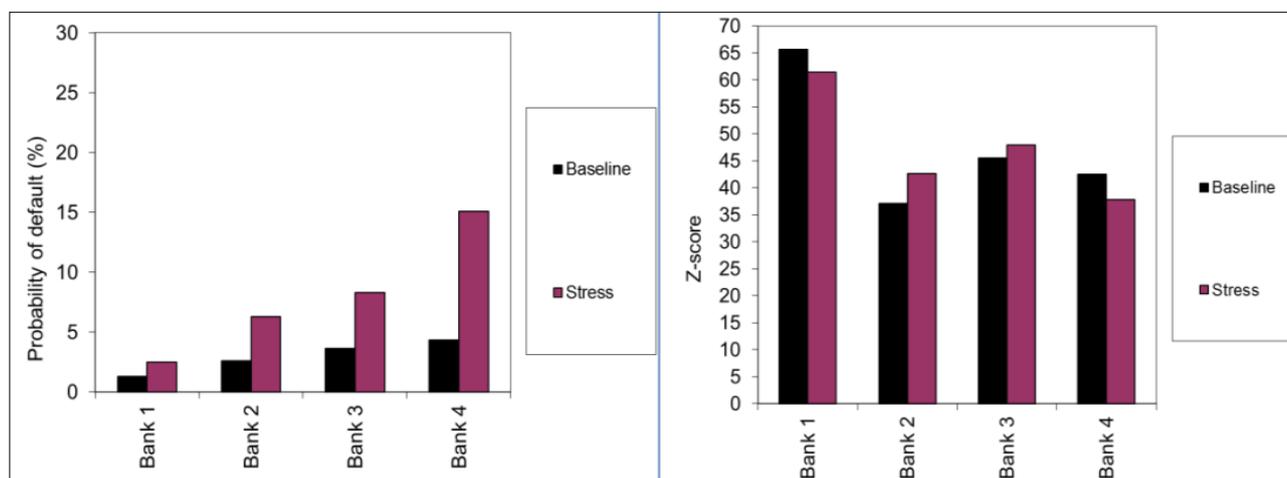
Figure 7
Liquidity and Liability



Source: Bank of PNG.

According to Cihak (2007), the z-score shows the probability of default by the banking industry, calculated as the weighted average of the z-scores of an individual bank in a country by comparing a bank’s buffers on capitalization and returns with the volatility of those returns. It provides a measure of bank soundness, i.e. the probability that the value of its assets becomes lower than the value of its debt. It also measures how much return has to fall in order to trigger depletion in equity. A higher z-score corresponds to a lower probability of insolvency risk. With the stress testing for banks in PNG, it shows that probability of default is more prominent in smaller banks than bigger adequately-capitalized banks.

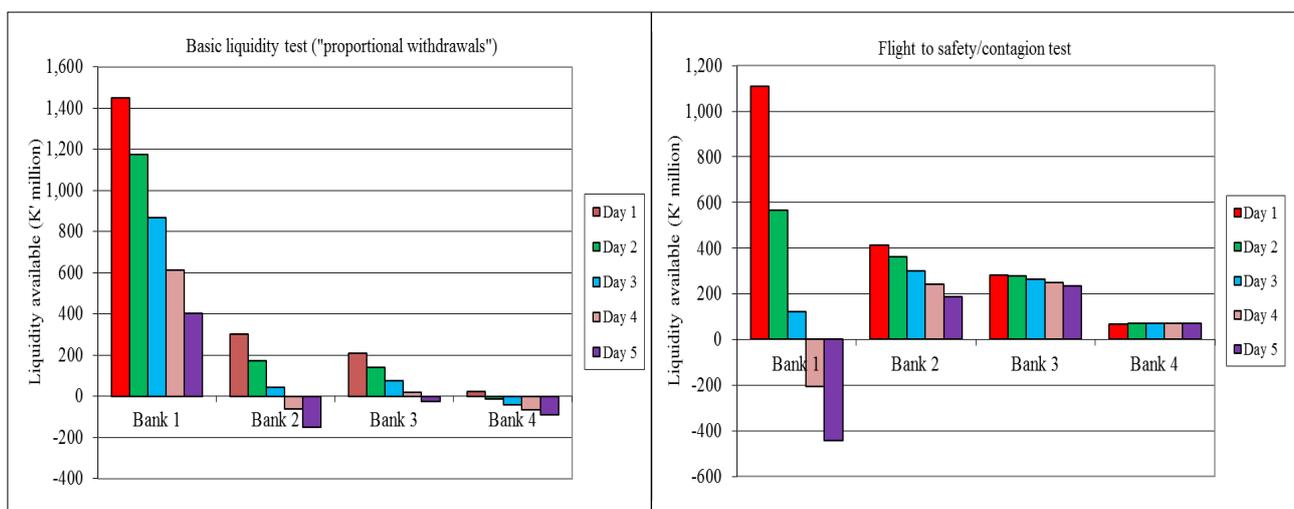
Figure 8
Probability of Default



Source: Bank of PNG.

In any banking crisis, the banking system can experience financial disturbance in the form of a large number of people withdrawing their money from the banks (bank runs) and that banks are making losses and/or are liquidated. These may result in the banks receiving help from either the Central Bank or the Government to bail them out. According to the International Monetary Fund (IMF), the situation becomes serious if at least three of the following take place: (i) liquidity support from the Central Bank is more than 5% of deposits and foreign liabilities, (ii) cost of restructuring the banks, including recapitalizing are at least 3% of GDP, (iii) large scale nationalisations of SIBs, (iv) significant guarantees by the Government on bank liabilities, (v) the Central bank purchases assets from financial institutions of at least 5% of GDP, and vi) the bank is placing a freeze on deposits. None of the above has happened or faced PNG banks yet.

Figure 9
Liquidity Test and Capital Flight



Source: Bank of PNG.

For PNG domestic banks, liquidity was still adequate 5 days after the shocks were introduced. However, flight to safety was enforced after the third day. For foreign banks, liquidity was reduced after 3 days, while there was limited capital flight.

6. Cross-border Activities

6.1 Foreign Exchange Interbank Market in PNG

The forex interbank market is where banks trade different currencies to facilitate trading of goods and services. An ideal interbank market ensures that there is competition for banks to buy and sell forex at a price that is fair to all dealers. The dealers can undertake forex deals for their clients or for themselves and are willing to offer prices to other participants as well as ask for prices. The forex interbank market in PNG has been dysfunctional, mainly from a lack of foreign exchange inflows since 2013 (Sampson, 2018) that resulted in an imbalance in the forex market. There was evidently imbalance in the demand and supply of foreign exchange in the interbank market, where the demand for US dollar was more than the supply of US dollar, leading to an oversupply of the local currency spurred by increased Government spending that led to an increase in import orders. The key reasons for the shortage in the forex were fall in prices of PNG’s export commodities since 2011 and the end of the construction phase of the PNG Liquefied Natural Gas (LNG) in mid-2014,

combined with rigidity in the exchange rate not adjusting fast enough to accommodate the fall in foreign exchange inflows into the economy. With the rigidity in the exchange rate, the role of the forex interbank market to set the price failed resulting in the local currency (kina) not adjusting to find its equilibrium level. With the lack of forex interbank trade and no alternative markets to access the forex, dealers that have a short position have no incentive to bid the kina exchange rate down. One of the main reasons why there is a bottleneck in the forex inflows is because only a small fraction of the export receipts is being repatriated back to PNG, because project development agreements allowed export proceeds to be held in offshore accounts.

Forex interbank trading is very critical in any economy as it facilitate international trade and ensures that external balance is achieved. At the forex interbank market, the demand for and supply of forex should interact to determine the price (kina exchange rate) and meet the needs of both importers and exporters. Since 2012, the forex interbank market in PNG has not been functioning as a normal market would otherwise do. According to Sampson (2018), there were four factors that caused the forex interbank market not to work. Firstly, there were absences of forex interbank transactions since mid-2012 to determine the value of the kina, which is an indication of the failure of the price-setting role of the forex interbank market. This caused the imbalance in the supply and demand for forex. Secondly, the forex dealers were unable to meet the demand for forex and resorted to selling kina in the interbank market, while controlling the forex they provided to their clients. Thirdly, the control of forex by dealers delayed resident firms from obtaining the foreign currency they need to pay for their imports and took a little longer for a few firms from sending any dividend payments abroad. Finally, there were some suggestions that real effective exchange rate is overvalued from its equilibrium level, hence the need for flexibility and adjustment. A dysfunctional forex interbank market can limit the movement of capital between countries, especially making repatriation of profits and dividends difficult.

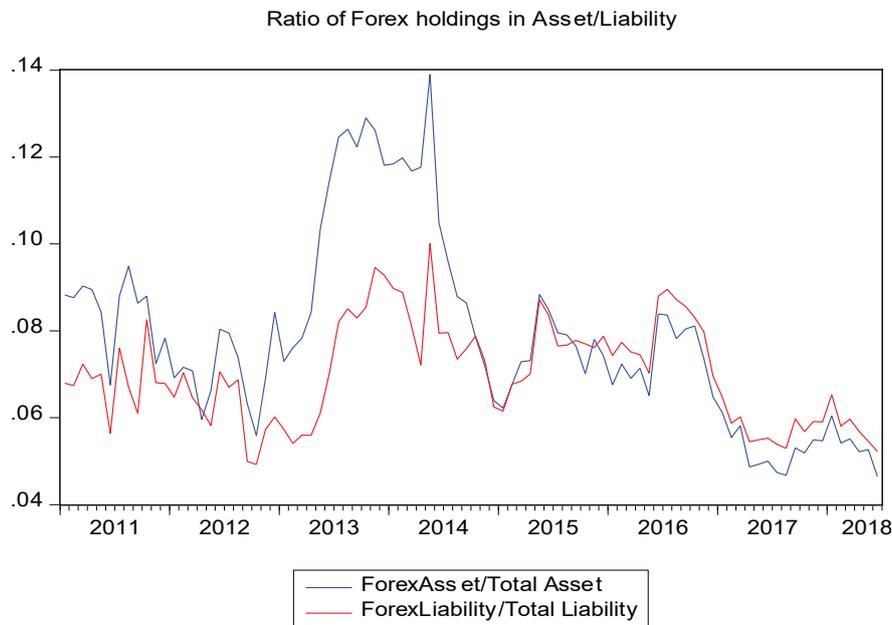
Maintaining external balance leads to minimizing risks associated with the exchange rate and settlement for banks. Most banks have netting agreements that require the offset of transactions in the same currency pair that settle on the same date with the same counterpart. This reduces the amount of money that changes hands and the settlement risk involved. The Central Banks collect data from interbank market participants to assess whether there are any economic implications arising from the forex interbank transactions. The importance of the forex interbank market cannot be underplayed because it is very critical to the economy as it facilitates international trade and ensures that external balance is achieved. Because it is a channel through which potential contagion can be transmitted, achieving external balance is key to mitigating these potential risks. Therefore, regulators need to ensure that the trading of currencies in the forex interbank market is supervised and monitored so that negative external shocks are mitigated and not transmitted easily.

6.2 Domestic Banks' Foreign Exchange Holding

After 2011, the interbank forex market was a one-sided market where the local currency was flooding the domestic forex market on the back of a shortage in foreign currencies, especially US dollar. To support their forex needs, domestic banks resorted to borrowing from their counter parties abroad or accessed the forex supplied by the Central Bank through its intervention to support the market. On an average basis, the holdings of foreign assets constitute around 7.9 % of total assets, while liabilities constitute 7.0 % of total liability. Both forex assets and liabilities declined over the period from 2010 to 2017. After 2013, forex liability has matched foreign assets and continued to

remain above the forex assets, reflecting the shortage of US dollars in the domestic forex interbank market. This indicated that the domestic banks have been borrowing forex from their counterparties abroad to meet their forex needs. The increase in forex liability can pose a threat to the domestic banks if the shortage in forex is not addressed by the Government.

Figure 10
Forex Holding of Banks



Source: Bank of PNG.

6.3 Cross-border Network Visualization

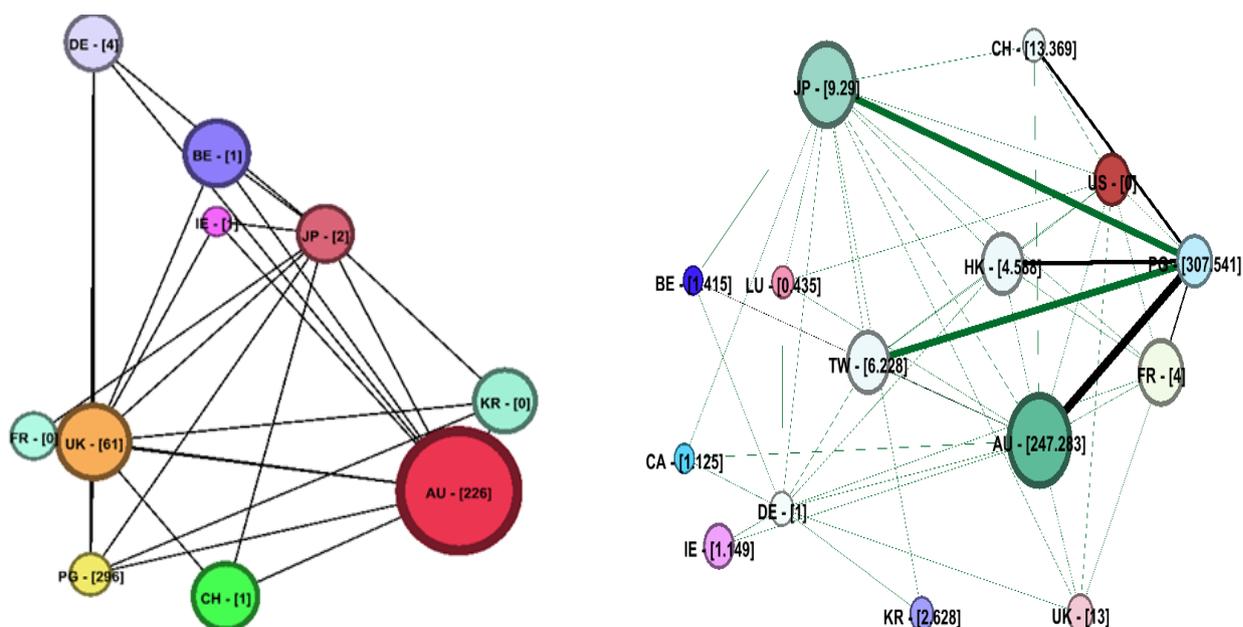
I used the Gephi software to visualize the network of claims and liabilities of banks by using the BIS banking locational statistics. Between December quarter of 2005 and June quarter of 2018, the network expanded with the inclusion of five new countries in terms of foreign liabilities, while it increased by 3 countries in foreign claims. Interbank trading by banks in PNG is only limited to banks within PNG and to some extent Australia. The other claims and liabilities relates to non-banking activities, especially in derivative contracts, extended guarantees and credit commitments. The expansion in the foreign claims network related to increase in PNG registered companies' investments in France, Switzerland, Chinese Taipei, Hong Kong, apart from their traditional investment destinations of Australia, Japan, Germany and Korea. This has somewhat increased the foreign exposure of PNG, and the likelihood of a contagion spreading quickly to PNG through such a well-connected network.

6.4 Foreign Liabilities

PNG claims (foreign liabilities to PNG) increased from US\$296.0 million in December quarter of 2005 to US\$307.541 million in the June quarter of 2018. The traditional countries which were linked to PNG are Australia, Japan, United Kingdom and Korea. The increase in PNG claims reflected the liberalization of the foreign exchange controls, which gave PNG-registered foreign companies, especially mineral and petroleum companies to use the project development agreements to invest their earnings in financial markets abroad. Combined with the higher price

of commodities, the firms diversified their investments that led to an expansion in the network to include other countries such as France, China, United States, Chinese Taipei, Hong Kong and Switzerland. Figure 11 below show the visual network of PNG claims and its expansion in the network over time from December 2005 to June quarter 2018. Australian-based banks have the largest share of 41.2% in liabilities.

Figure 11
Foreign Liabilities (PNG Claims) - December Quarter 2005 Vs June Quarter 2018



6.5 Foreign Claims

The network of foreign claims on PNG expanded to US\$913.0 from US\$540.00. This reflected the expansion in the size of the networks as PNG attracted foreign direct investments (FDIs) from other countries, apart from its traditional lender countries, Australia and Japan. PNG has become one of the new frontiers for investments in mining and petroleum projects from the USA, France, Chinese Taipei, Korea, Hong Kong and Japan. Most of the expansion in financial network happened in 2008 and thereafter, which directly relates to financing of the Exxon Mobile led PNG Liquefied Natural Gas (LNG), which commenced construction in 2008, the construction of the Ramu Nickel/ Cobalt mine in 2012, and other mineral and petroleum investments in the country. The other factor included the liberalization of the PNG foreign exchange controls in 2005/2006, which paved the way for the flow of funds. Figure 12 below shows the network of PNG liabilities over time from December quarter of 2005 to June quarter of 2018.

Japan and Australia both have assets worth over 10%, while China has 4.4%, Hong Kong has 6.4%, France has 1.3% and Korea 2.3%.

Figure 12
Foreign Claims (PNG Liabilities) - December Quarter 2005 Vs June Quarter 2018

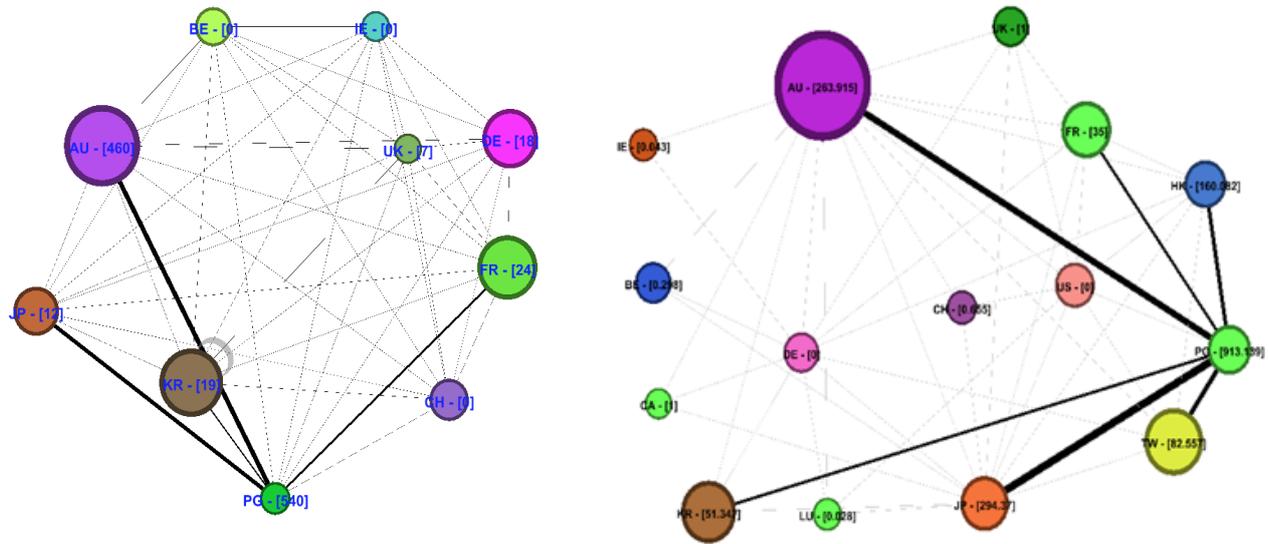
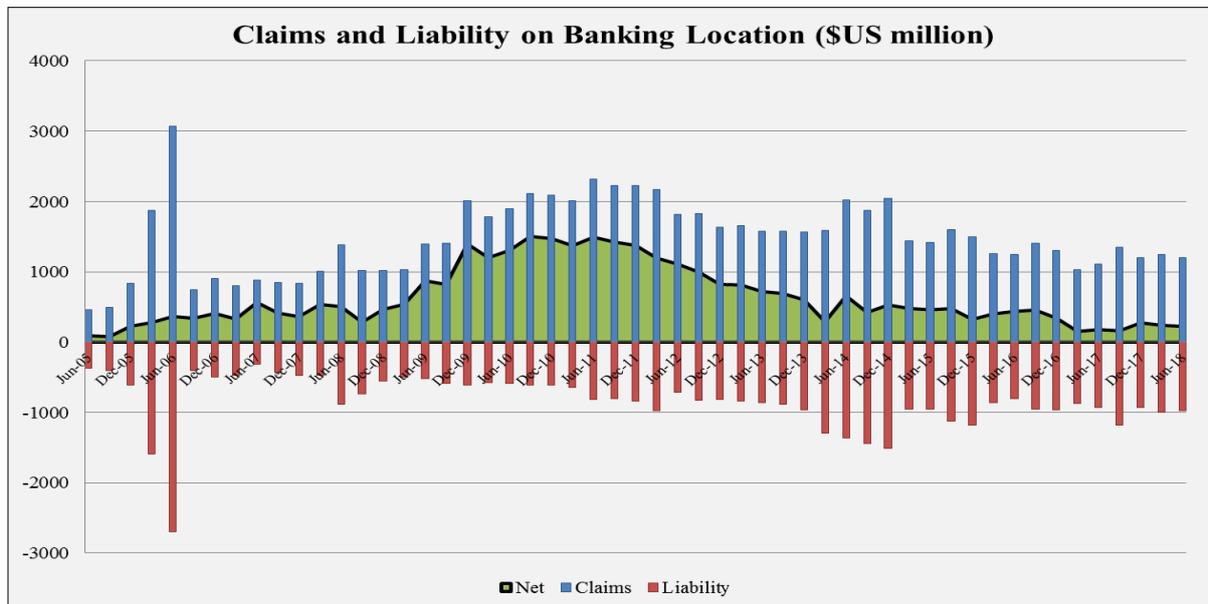


Figure 13 shows the claims and liabilities with respect to the banking location from June quarter 2005 to June quarter 2018. From the chart we can deduce that PNG’s largest exposure was between June quarter 2008 and June quarter 2014. This is the period when the financing and construction of the PNG LNG project started and ended and FDIs flowed into the country.

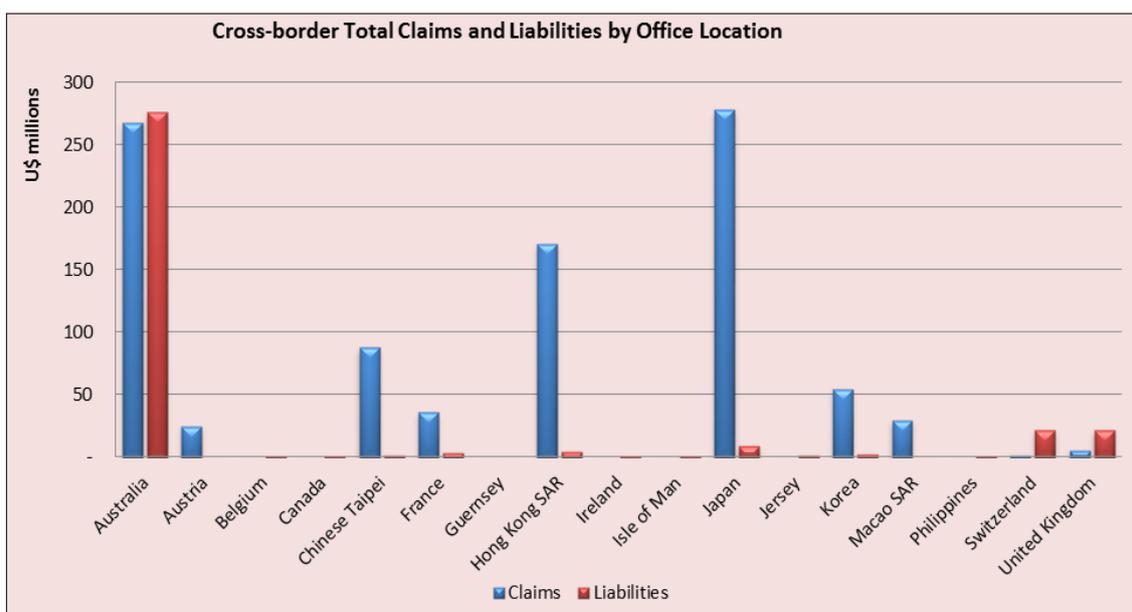
Figure 13
Claims and Liabilities on Banking Location June Quarter 2005 - June Quarter 2018



Source: BIS.

According to the cross-border position by banking location, Japan and Australia have the highest deposits in the PNG non-banking sector, while only Australia has the highest liability, both in the banking and non-banking sector. This indicates Australia’s increased interest and dominance in the banking and non-banking sectors in PNG. There are also growing interests from Hong Kong and Chinese Taipei.

Figure 14
Cross-border Position by Location of Banking Office



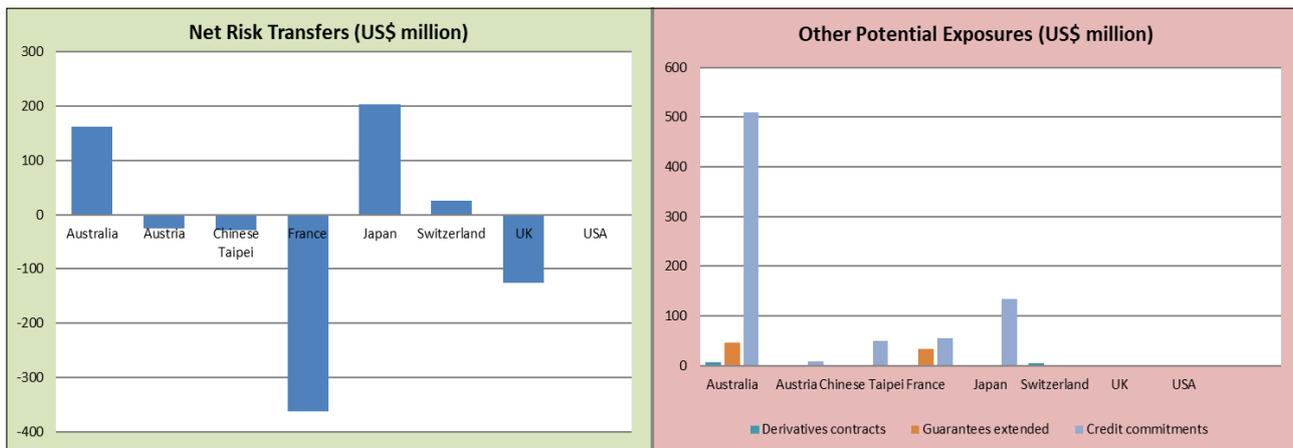
Source: Bank for International Settlement.

6.6 Cross-border Position Instrument, Sector and Currency (US\$ million)

The bulk of the cross-border positions is in loans and deposits denominated in US dollar, held mostly by non-banks. Deposits are greater than their liability, which means that if there is a domestic shock, for example, a bank run or interest rate dip, the chances of repatriation are high and this could cause trouble for the domestic banks, especially those banks which are not adequately capitalized as it present currency, exchange rate, sectoral and other associated risks. Therefore, mitigation measures by the Central Bank are critical.

Figure 15 below show the net risk transfers, claims on an ultimate risk basis and other potential exposures not included in claims on an ultimate risk basis, especially derivative contracts, extended guarantees and credit commitments. Transfer of risks between banks and non-banks in one country to another country remains the focal point of creditor banks and countries managing risks across counterparty countries. The transfer of risks reallocates a bank’s exposure from the immediate counter party country to the country where the obligor is located. There are outward risk transfers that reduce risk exposure to a given counterparty country, as well as inward risk transfers that increase risk exposures. The difference between the inward risks and outward risk is called the net risk transfer. A negative risk transfer indicate that inward risk exposure is higher than outward risk exposure, while a positive risk transfer indicate a higher outward risk transfer. Hence, for PNG, there are more inward risk transfers from France, United Kingdom, Chinese Taipei and Austria. While, outward risk transfers are to Australia, Japan and Switzerland. On average, there is net inward risk transfer reflecting investments in petroleum and LNG in PNG.

Figure 15
Net Risk Transfers and Other Potential Exposures



Source: Bank for International Settlement.

7. Cross-border shocks through Interest Rates and Credit from Australia and Commodity Prices

PNG banks, apart from domestic activity conduct their activities with other banks across borders. The few banks in PNG have forex deals with other banks in Australia and across the Asia Pacific region. Most of the cross-border transactions by PNG banks are between banks in PNG and Australia as two of the large banks in PNG, have headquarters in Australia and have operations across the Pacific, Asia and globally. Therefore, any financial crisis in Australia, Japan or elsewhere will be transmitted quickly to PNG because of the financial and banking linkages between the banks in these countries. In assessing the banking network and trading, I will concentrate on analysing how shocks in credit and interest rates in Australia and global commodity prices impact bank credit and real sector activity in PNG.

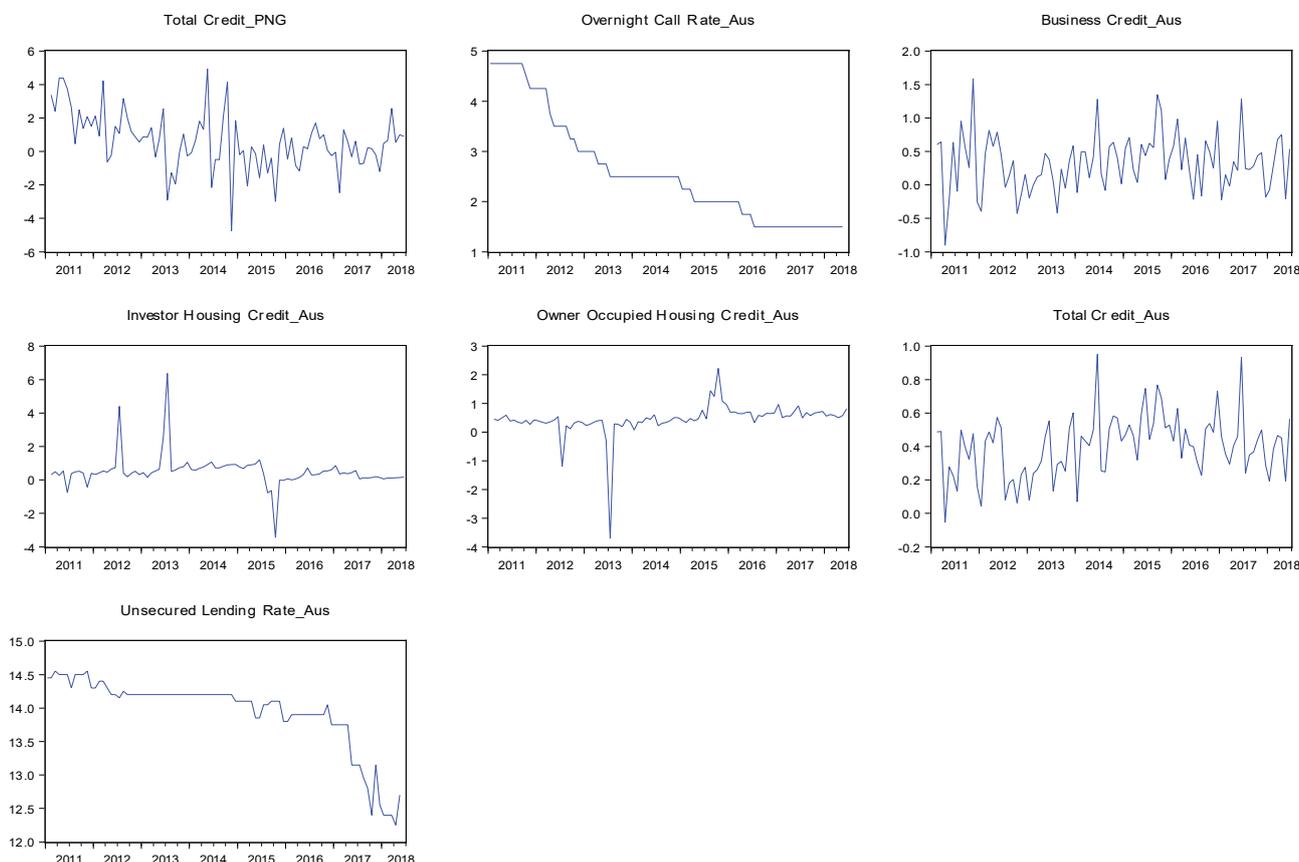
7.1 Cross-border shocks through Interest Rates and Credit from Australia

Eye balling the variables and the regressions show that total credit extended by banks in Australia is somewhat unrelated to the credit extended by banks in PNG as they trend in the opposite direction. This could mean that the banks in PNG are operating independently from their Australian counterparts. However, individual credits for business, housing investment and owner-occupied housing tend to have positive correlation with credit extended by banks in PNG, which implied positive correlation as shown by their positive coefficients. The results although inconclusive, indicate that in the event of a credit and interest rate shock in Australia, it will have positive but minimal impact on credit extended by banks in PNG in the short run.

The regression result showed that a 1% shock to credits for business, investor housing, and owner-occupied housing in Australia affect credits in PNG by 2.1%, 1.4% and 2.9%, respectively. A 1% change in the OCR in Australia will lead to a 3.6% change in the credit extended by banks in PNG. It also showed that unsecured lending rate is also significant and may also have some influence in lending in PNG. Lending to household and private sector are also significant at 5% significance level. This indicates the links between banks operating in Australia and their subsidiaries operating in PNG as shown by the positive correlation. This is a possible transmission channel a contagion

can occur. Australia’s GDP was not significant while interest rates⁷ were significant and negative, indicating a negative correlation. The regression results contained in Table 3 below, as expected confirmed a negative correlation between interest rates in Australia and credit in PNG.

Figure 16
Eyeballing the Credit in PNG and Interest Rates and Credits in Australia



Source: Reserve Bank of Australia.

Table 3
OLS Regression Results, Dependent Variable: *Total_Credit*

Variable	Coefficient	Standard Error	t-Statistics	Probability
OCR_AU	-3.573	1.874	-1.907	0.060
Credit_Business_AU	2.051	0.955	2.147	0.035
Credit_Investor_Housing_AU	1.353	0.572	2.364	0.021
Credit_Owner_Occupier_Housing_AU	2.852	1.051	2.714	0.008
Total_Credit_AU	-6.708	2.616	-2.564	0.012
Unsecured_Rate_AU	-0.132	0.060	0.060	0.031
Treasury_Note_Rate_AU	4.660	1.967	1.967	0.020
R2 = 0.3572, Adjusted R2 = 0.3096, σ = 1.4326, DW = 2.2978 AIC = 3.633 SIC = 3.8301				

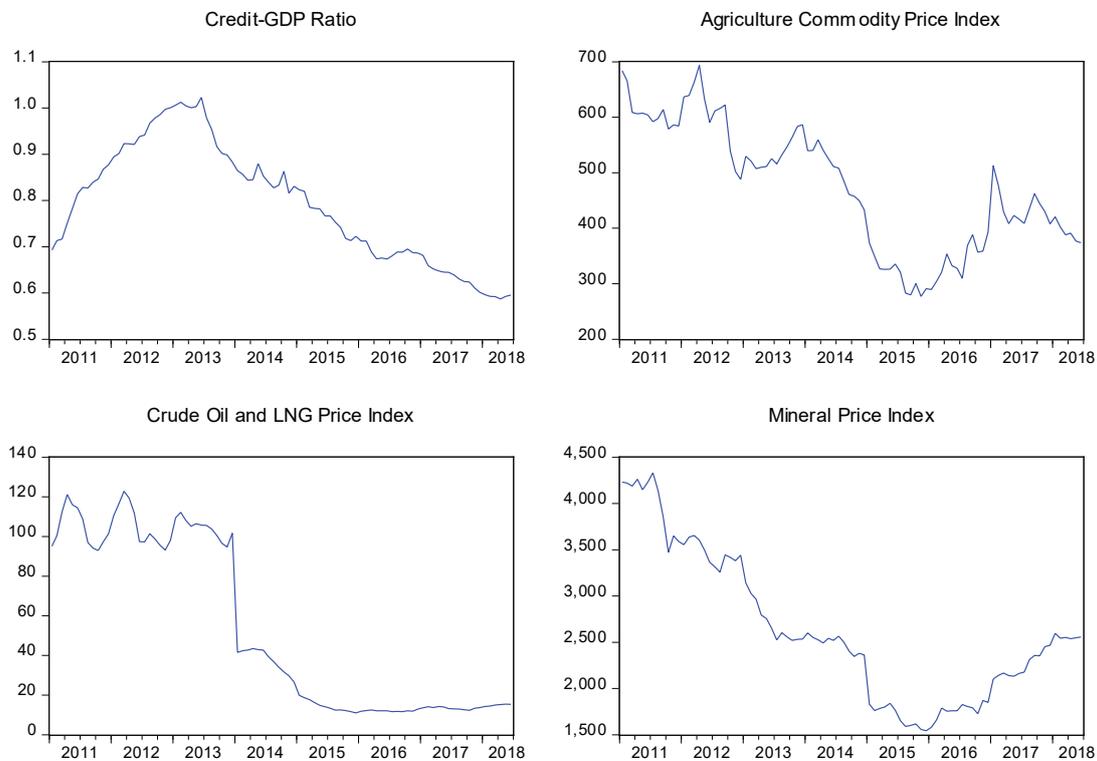
Source: Author’s calculation using Eviews.

7. It refers to the Overnight Call Rate (OCR) and unsecured lending rate.

7.2 Commodity Prices

As a small open economy and an exporter of commodities, PNG is exposed to shocks in the international prices of commodities. The impact can be positive or negative depending on the type of shock. A sharp decline in the price of commodities can induce a negative shock to the economy via a fall in Government revenue, foreign reserves and exchange rate depreciation. Its impact on the domestic banking sector can be direct through a decline in their forex holdings. This could lead to an imbalance in the forex interbank market and domestic banks may resort to forex borrowing leading to an increase in the exposures of domestic banks. In the same manner, a sharp increase in prices of commodities will have positive shock on the economy, via an increase in Government revenue, foreign reserves and exchange rate appreciation. High commodity prices can also lead to high inflation.

Figure 17
Commodity Prices



Source: World Bank.

Table 4
OLS Regression Results (Credit/GDP against Commodity Prices):
Dependent Variable_Credit_GDP_Ratio

Variable	Coefficient	Standard Error	t-Statistics	Probability
Mineral_Index	-0.037	0.049	-0.751	0.455
Crude_LNG_Index	0.045	0.024	1.819	0.072
Agri_Price_Index	-0.011	0.034	-0.312	0.756
R2 = 0.041, Adjusted R2 = 0.007, $\sigma = 1.829$, DW = 1.551 AIC = 4.089 SIC = 4.201				

Source: Author’s calculation using Eviews.

Figure 17 above show the trend in the prices of PNG's major export commodities. Although commodity price shocks can be transmitted to domestic bank credits, results of the regression were insignificant, except crude oil and LNG price index. Only crude and LNG price shock is significant at 10% confidence level. However, the impact is very limited at only 0.04%. Commodity prices display their swings frequently while not impacting the PNG domestic credit directly; the impact of commodity price shocks could be transmitted via other channels.

8. Conclusion

The banks in PNG are highly capitalized, over and above the minimum regulatory threshold, therefore shocks emanating from NPLs, credit, interest rates, liquidity and exchange rate will have minimal impact on the banking industry and the financial institutions. Banks are also flushed with liquidity but unfairly distributed among the banks, while accessing forex continue to remain a challenge.

On cross-border positions and risk transfers, most of the claims against PNG are held by non-bank firms from Australia, Japan, France, Hong Kong and Chinese Taipei. This is where most of the risks are coming from. There are more inward risk transfers than outward. The networks in liabilities and claims have increased since 2005 and continue to remain high. The network visualizations gave clear idea about which country is connected and on what purpose.

Credit and interest rates in Australia have some correlation on credit and banking activity in PNG because of the links of domestic banks to Australian banks. However, the magnitude of the impact was not very big to cause an upset in the event of a shock in Australia. Even if there is a shock, PNG banks have adequate capital buffers to withstand the shock. However, the potential for domestic and external shocks are real and present a number of risks for the domestic banks. Therefore, it is the job of the Central Bank as the regulator and supervisor of the banking industry to ensure that banks operate with adequate capital and take risk that they understand and can measure, while at the same time intermediate banking and financial service to earn enough income to compensate for the risks they take.

In so far as regulation and supervision is concerned, the Bank of PNG, the authority responsible for regulating and supervising the banks and finance companies in PNG, including issuing of prudential standards⁸ on the deposit taking institutions, ensures that banks are adequately capitalized and remain profitable. This is to protect the health of the banking system, protect depositors' funds and the economy. Prudential standards become very critical because of the complexity of the networks of banks and the products and services they offer. This requires the use of financial regulations to take control of the banks and financial institutions exposed to risks and hold adequate capital as buffers, specified in the capital requirements to mitigate shocks.

8. The Central Bank issued the following prudential standards: Single Borrower and Large Exposure Limits; Fit and Proper Requirements; Transactions with Related Parties; External Audits; Capital Adequacy; Asset Classification, Provision and Suspension of Interest; Limits on Loans to Related Parties; Limits on Inter-Bank Placements; Foreign Currency Exposure Limits; Mobile Banking and Mobile Payments; Compliance Function Requirements; Corporate Governance; Customer Due Diligence Standard; Business Continuity Management and Outsourcing of business activities, functions and processes.

The Central Bank has in place robust prudential policies in regards to regulating and supervising the banking industry in PNG. Apart from the various prudential standards and ensuring compliance by the banks, the Central Bank conducts onsite inspections and audits. The advancement in technology and introduction of a lot of new online banking products and e-money, apart from enhancing banking experience, also reinforces the need to strengthen regulation and supervision in these areas of banking. They could be the next biggest threats, if not harnessed properly.

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Appendix 1

Countries' Initials Used in the Network Visualization

Subject	Initial
Austria	AT
Australia	AU
Belgium	BE
Canada	CA
Switzerland	CH
Germany	DE
Denmark	DK
Spain	ES
France	FR
United Kingdom	UK
Hong Kong SAR	HK
Ireland	IE
Isle of Man	IM
Japan	JP
Korea	KR
Luxembourg	LU
Philippines	PH
Chinese Taipei	TW
United States	US
Total Liabilities	L
Total Assets	A