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Estimating Excess Liquidity Demand for Papua New Guinea

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Abstract

In light of the persistent high level of excess liquidity in Papua New Guinea (PNG), estimation of its determinants is critical to understanding its sources and potential implication. This will enable policy makers to design appropriate policy measures to address this issue. This paper estimates a demand model for excess reserves in PNG. The approach is twofold; first, the paper establishes the determinants of excess liquidity and second, it uses the factors to construct precautionary and involuntary components of excess reserves, which is significant to determine if excess reserves pose a threat to price stability. Using monthly data from 2002 to 2016 and the General Methods of Moments (GMM) econometric model, the study established that excess reserve in PNG is mainly composed of involuntary excess reserves. The main involuntary excess reserve factors include private sector and government deposits, credit to private sector and government, investments in the domestic debt securities and an increase in foreign exchange reserves. Precautionary factors explained a smaller portion of excess reserves and include mainly the cash reserve requirement, currency risks, and volatility in the private sector deposits. Since higher proportion of excess liquidity is driven by commercial bank's involuntary motives of holding excess reserves, this poses threat to price stability and overall macroeconomic stability if aggregate demand conditions suddenly improve in the economy.

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I. Introduction

Surplus liquidity has been a prominent feature of the banking system in Papua New Guinea (PNG) for nearly a decade[2]. Surplus liquidity is defined as the amount of liquidity or reserves held by commercial banks at the Central bank in excess of the statutory required amount. For PNG, this statutory requirement, referred to as the Minimum Liquid to Asset Ratio (MLAR), requires commercial banks to hold a proportion of deposits and other prescribed liabilities, particularly, cash deposits and government securities with three years maturity period, with the Central Bank, the Bank of Papua New Guinea (BPNG). MLAR was used as one of the main tools for liquidity management from independence up to early 1990's (BPNG, 2006). MLAR was initially set at 15 percent on 1st March 1974, but was deemed non-operational on the 1st of October 2010. The disregard of MLAR reflected increased holdings of liquid bank reserves far above the statutory level, reflecting excess bank reserves. Consequently, the Bank introduced another special deposit facility, the Cash Reserve Requirement (CRR) in August 1998, which specifies a fraction of commercial banks' liquid assets, in particular, cash deposits, to be held at the Bank at no interest for purposes of liquidity management (BPNG, 2006). CRR was intended to assist reduce excess reserves which were held at high levels during that period. However, even with the introduction of CRR, the level of liquidity hoarded by the commercial banks continued to be excessive (See Chart 22 in the Appendix).

Whilst excess liquidity provides buffer to commercial banks against unanticipated liquidity risks, it could have adverse consequences on the banking system and the economy if persistently held at high levels without adequate sterilisation. For example, holding higher excess reserves as a precautionary measure against increased risks such as liquidity risks could hinder the allocation of credit to the private sector, thus affecting private investment and economic growth. In this case, the profitability of commercial banks would be affected as they prefer to hold non-renumerated excess reserves than to lend (Acharya and Naqvi, 2012). However, if banks accumulate excess reserves due to a decline in demand for credit, that is, involuntarily, it could pose threat to inflation if demand conditions in the economy improve (Saxegaard, 2006). In addition, high excess liquidity could weaken the transmission mechanism of monetary policy, especially the interest rate channel as interbank trading becomes inactive due to commercial banks holding surplus cash reserves (Nissanke and Aryeetey, 1998; Agénor, et al, 2004). Further, it could increase the cost of liquidity sterilisation by the Central Bank (Ganley, 2004).

Given the potential implication of excess liquidity, it is crucial that key determinants of excess liquidity is established for PNG as this would assist to identify its potential impact and to prescribe relevant policy measures to address it. Studies on the sources and impact of excess liquidity in PNG have been very limited. Although there is no published work on excess liquidity, the BPNG has done internal investigations into the underlying causes and its potential impact on monetary policy. The studies revealed that excess liquidity has been responsible for the weak transmission of monetary policy through the interest rate channel[3]. The investigations further observed that excess liquidity did not impact on inflation via private sector credit growth[4]. However, these preliminary studies did not formally establish the

[2] Excess reserves and excess liquidity is used interchangeably throughout the paper.

[3] These internal bank studies are unpublished and include Vellodi et al (2012), "Liquidity and Inflation in Papua New Guinea" and the Kina Facility Rate (KFR) Review (2014).

[4] March (2012) Monetary Policy Statement also discussed this.

determinants of excess liquidity which is essential to prescribing relevant policy measures to address the issue. This study intends to fill this gap. More formally, this study would answer two key questions: What are the factors driving excess liquidity in PNG? Is excess liquidity in PNG a demand–induced or supply driven phenomena? If excess liquidity is due to lack of demand for loanable funds, this would explain the decline in private sector credit, hence, lack of impact on inflation. In this case, in the event of an increase in aggregate demand conditions in the economy, private sector credit growth would increase, posing a threat to inflationary pressure. However, if excess liquidity is proved to be driven by the supply-side factors, it would imply that although banks had the ability to lend, they are not willing due to their precautionary motives. This component would be less inflationary even if aggregate demand conditions improve.

This paper follows the general approach by Saxeguaard (2006) in the estimation of the demand model for excess liquidity in PNG. It differs from Saxeguaard (2006) with the employment of General Methods of Moments (GMM) econometric methodology which was applied by other studies such as Devi (2016).The finding revealed that high excess reserve in PNG is mainly attributed to private sector and government deposits, credit to private sector and government, investment in the domestic debt market and the accumulation of foreign exchange reserves. The paper further constructed precautionary and involuntary series and concluded that excess liquidity in PNG is largely driven by involuntary motive, that is, it is demand-induced, hence could potentially impact on inflation given a sudden improvement in the aggregate demand conditions. Precautionary factors explained a smaller portion of excess reserves and include mainly reserve requirement, currency volatility and volatility in the private sector deposits.

The rest of this paper is structured in the following manner: Section 2 reviews existing literature on sources and implication of excess liquidity. Section 3 defines excess liquidity in the context of PNG. Section 4 estimates the demand model of excess liquidity and further decomposes it into precautionary and involuntary components. Section 5 concludes with summary of main findings and policy implications.

II. Literature Review

A vast amount of literature on excess liquidity focused on the optimum reserve management model of commercial banks, which follows the bank liquidity management theory (Agénor et al, 2004; Khemraj, 2007)[5]. The model, as postulated by Poole (1968), proposes that a bank will choose to hold a quantity of non-remunerated excess reserve, sufficient to maximize its profits and simultaneously reduce its associated costs. In essence, the model is based on the demand for excess reserves held for precautionary purposes, which concerns the funding and liquidity risks of commercial banks. Poole (1968) finds a negative relationship between demand for excess reserves and the short-term interest rates but a positive one between excess reserves and increased liquidity risk. Subsequent studies confirmed these relationships and identified additional factors that influence the demand for excess reserves (Dow, 2001). Agénor et al (2004) extended the model to account for the impact of reserve requirements to establish if credit crunch during the Asian Financial Crisis was a supply-side or a demand induced problem in Thailand. They reaffirmed Poole's (1968) work and further

[5] Nguyen and Boateng (2015) discussed the theories underpinning liquidity which includes the Quantity Theory of Money, Keynesian theory and the Bank Liquidity Management theory.

established an inverse relationship between reserve requirement and excess reserves. Later, Saxegaard (2006) augmented the model adopted by Agénor et al (2004) by apportioning excess liquidity into precautionary and involuntary reserves to differentiate the extent of their implication on monetary policy in Sub-Saharan Africa. He defined precautionary excess reserve as the component that is in excess of the statutory (required) reserve which the banks hold, particularly in conditions of uncertainties and involuntary excess reserve as the proportion that is held in excess of the precautionary excess reserve levels, mostly influenced by demand conditions. Saxegaard (2006) attributed the decline in lending to involuntary factors, particularly, weak demand for loans by the private sector and increase in government deposits. The increase in government deposits resulted from increased inflows from foreign aid and newly discovered oil revenues. In addition, Khemraj (2006a) pointed to large underground economy, inward remittances, and unsterilized foreign exchange market interventions as some underlying causes of involuntary excess reserves in Guyana. Further, Khemraj (2006b) discussed two alternative hypotheses for persistence of excess liquidity in Guyana. He first provided that commercial banks demand a minimum interest rates before investing in the loan and money markets. This minimum interest rate is a common feature for less developed and low income countries that has shallow and undeveloped financial system with oligopolistic banks whereby marginal transaction costs and risk premiums are added to the risk-free interest rates. He further explained that banks face unofficial foreign currency constraints which force them to accumulate excess reserves instead of channelling those funds to investments abroad.

Studies on the effects of holding high excess liquidity have been focused on both the banking sector and at the macroeconomic levels. At the bank level, the accumulation of involuntary excess liquidity by banks could affect their lending behaviour, hence, their profitability (Agenor and Aynaoui, 2010; Acharya and Naqvi, 2012). Involuntary excess reserves could also induce banks to relax strict lending requirements which could stimulate risky lending. More importantly, high involuntary excess liquidity could hinder the transmission of monetary policy, particularly, the interest rate transmission channel (Saxegaard, 2006). This is crucial for Central banks as they rely on the transmission channels to influence the real economy. For instance, if banks accumulate involuntary excess liquidity, this would imply that they may be willing but are unable to lend due to unfavourable aggregate demand conditions. However, if demand conditions improve suddenly, it could potentially lead to a sudden increase in private sector credit growth, hence, inflation. Further, attempts by the Central bank to lower interest rate to stimulate lending during this condition would prove ineffective. The holding of precautionary excess reserves, however, poses less threat to the effectiveness of monetary policy transmission. Nevertheless, if the cost of holding precautionary reserves increases in light of monetary policy tightening, banks could be forced to reduce their holding of precautionary reserves resulting in a simultaneous increase in the involuntary reserve levels (Agenor and Aynaoui, 2010). This stimulates additional lending, consequently lessening the effectiveness of monetary policy. Nguyen and Boateng (2013) supported this argument upon discovering that liquid-flushed banks in China were less responsive to monetary policy rate adjustments. Excess liquidity could also influence Central Banks' conduct in the money market, and their balance sheet and income (Ganley, 2004). In particular, the cost of liquidity sterilisation increases as Central Banks attempt to diffuse high liquidity overhang in the banking system through issuance of its securities.

At the macro level, involuntary excess reserve has the potential to spur inflation because it could be easily lent out by the banks when demand conditions improve (Saxegaard, 2006). In addition, excess reserves could have implications for the exchange rate if the public prefers to hold some of its liquidity in foreign currency or invest abroad resulting in higher demand for foreign currency. This could exert downward pressure on the domestic currency, which could be inflationary if a greater share of consumer and producer goods in the economy are imported (Ganley, 2004). Khemraj (2007) tested the impact of excess liquidity on the underlying macroeconomic relationships embedded in the International Monetary Fund's (IMF) Financial Programming model. The model postulates that excess money supply results in balance of payments deterioration, which in turn leads to depreciation in the exchange rate and subsequent rise in inflation. He, however, found contradicting results when testing the model calibrated effects on the Guyanese banking system. He found a positive and persistent response from inflation, but strikingly, zero and weak responses from private sector loans and exchange rate, respectively. On the contrary, Jayaraman and Choong (2012) found results that are generally consistent with prior expectations when they analysed the impact of excess liquidity on selected key macroeconomic variables in Fiji. The study revealed that the relationships between excess liquidity and loans, exchange rate and lending rate are statistically significant except with inflation.

As far as this paper is concerned, there is very limited literature on excess liquidity in PNG. Vellodi et al (2012) discovered that higher excess liquidity in PNG was due to increases in government deposits influenced mainly by increased mineral export earnings. The study also found that although there was a build-up of excess liquidity, this did not translate to inflation as real exchange rate remained appreciated with a decline in domestic demand after the construction of the LNG project. However, it impacted on the breakdown in the interest rate transmission channel as commercial banks were hoarding higher excess reserves resulting in an inactive interbank market. This finding was confirmed through an internal BPNG KFR Review (2014). Devi (2016) later estimated an excess reserve demand model and concluded that excess liquidity in PNG is predominantly precautionary. She further investigated the interest rate channel focusing on the interbank rate and its pass-through to domestic interest rates, in light of excess liquidity and found similar result; a weak transmission of policy rate to the retail interest rate. The need to validate these results to assist BPNG design appropriate policy measures to address the issue of persistent excess liquidity and its bearing on monetary policy transmission has motivated this study.

III. Stylised Facts

The definition and measurement of liquidity largely depends on how one defines a 'liquid asset'.[6] Liquidity can be defined formally in terms of the central bank's balance sheet as the net liabilities of the central bank to the private sector (NLDP). However, this does not disqualify other measures of liquidity that suit different purposes and analyses. In the case of BPNG, this is denoted by the following identity:

$$NLDP=ESA+ (CRD-CRR) + CBBs + T\text{-}bills + CC \qquad (1)$$

[6] A liquid asset is one which can be sold at short notice at almost market value.

Where,

ESA=Exchange Settlement Account balances at BPNG, CRD=Cash Reserve Deposit, CRR=Cash Reserve Requirement, CBB=Central Bank Bill, T-bills=Treasury Bills, CC=currency in circulation

When viewed from commercial banks' balance sheets, the definition of liquidity is similar except that all other privately-owned public debt is added to BPNG's debt issuance of CBB's and T-bills. Hence, this will be referred to, for purely differencing, as Total Liquid Assets (TLA) and is given by equation 2.

TLA=ESA+ (CRD-CRR) +Total Public Debt Stock +CC *(2)*

Where,

TLA= Total liquid asset, and all other variables are defined in equation 1.Total Public Debt= stock of Central Bank debt issuance and all other privately-owned debt

Since absolute measure of liquidity does not give an accurate representation of the magnitude of excess liquidity in the system, it is vital that excess liquidity is defined precisely. Saxegaard (2006) defined excess liquidity as the quantity of reserves deposited at the Central Bank by deposit money banks plus cash in vaults (cash for daily operations) minus minimum reserve requirement. For BPNG, a positive NLDP would reflect excess liquidity; otherwise, it would imply a shortage. However, Vellodi et al (2012) classified T-bills and CBBs as illiquid assets due to the fact that there are no secondary, interbank and repo markets for these money market instruments in PNG. Hence, the inclusion of these securities in the definition of excess liquidity could be misleading. Following this reasoning, this study adopts the definition of excess liquidity *(Exliq*)* as provided by Vellodi et al (2012) and is stated in equation (3) below:

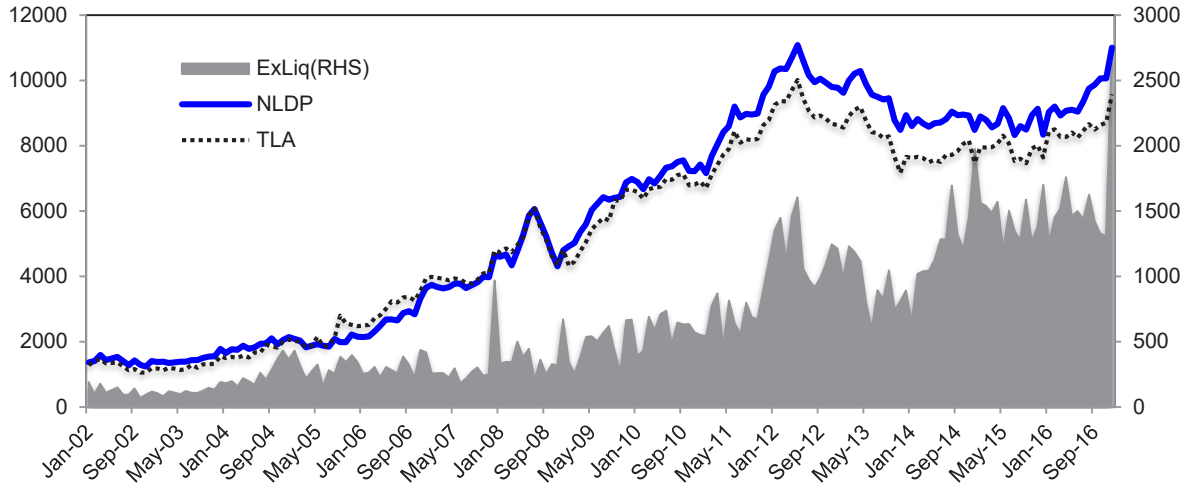
Exliq=ESA+ (CRD-CRR) +Cash in Vaults* *(3)*

Over the study period, January 2002 to December 2016, all the liquidity measures including NLDP, TLA, and excess liquidity broadly increased (Chart 1). The build-up in the excess reserves, particularly, from 2007 to 2012 reflected increased export earnings during the period. In addition, capital inflows mainly associated with the construction of the multi-billion dollar PNG LNG project added to the increased liquidity levels, particularly from 2011 to 2013. These export revenues and capital inflows, largely denominated in US dollars, were converted to kina and deposited in commercial banks which in turn, added to high excess reserves. In response, the BPNG utilised CRR and Open Market Operations (OMO) instruments to partly sterilise the excess liquidity from the banking system. The Bank raised CRR four times from 4.0 percent in 2010 to 10.0 percent in 2014. The liquidity sterilisation through OMO over the same period was minimal as the increased issuance of Treasury bills of around K2235.7 million was offset by an increase maturity of CBBs of around K2176.02 million[7]. The increased issuance of

[7] The amount of CBBs and T-bills calculated is the component classified as part of liquid asset, that is, those with maturities of less than 3 years.

Treasury bills reflected consecutive fiscal deficits over the period. Notwithstanding these efforts by the Bank to diffuse excess liquidity, the level of liquidity remained elevated.

Chart 1: NLDP,TLA & Excess Liquidity (K'millions)



IV. Empirical Analysis

This section estimates an excess reserve demand model based on Saxegaard (2006) approach. This approach encompasses the decomposition of excess reserves into precautionary and involuntary components. The main advantage of this method is that it clearly demarcates the impact of precautionary and involuntary excess liquidity on monetary policy and inflation. Agenor et al (2004) estimated the banks' demand for excess liquidity specifically for precautionary reasons by employing the precautionary factors. Thus, the proportion of involuntary reserves was taken as the residual of the model, that is, the difference between the total excess liquidity and the model predicted precautionary excess liquidity. However, Saxegaard (2016) argued that this approach underestimates the involuntary excess reserves as the model does not fully account for the factors affecting the demand for excess liquidity as involuntary excess reserve level is minimized by nature of the estimated model. Hence, he augmented the model developed by Agenor et al (2004) with additional variables thought to adequately explain the involuntary excess reserves.

i. Model Specification

The demand for excess liquidity is represented by equation (4), which consists of the factors perceived to affect the commercial banks' decisions to hold excess reserves involuntarily and for precautionary motives.

$$\phi_1(L)Xliq_t = \phi_2(L)X_t + \phi_3(L)Y_t + z_t \qquad (4)$$

Where; $Xliq_t$ is the ratio of excess reserves to total deposits; X_t and Y_t are vectors of explanatory variables denoting the determinants of precautionary and involuntary excess reserves, respectively; z_t is the error term that accounts for other factors not captured in the

model; $\phi j(L)$ are vectors of lag polynomials, such that $\phi_1(L) = 1 - \phi_{11}L$, and $\phi_j(L) = \phi_{j0} - \phi_{j1}L, j \geq 2$.

The vectors of precautionary and involuntary explanatory variables are specified as:

$$X_t = \{CRR, VOL_y, VOL_{cd}, VOL_{ps}, VOL_{gov}, PORT, Y_{hp}, REPO_R\} \quad (5)$$

$$Y_t = \{DEP_{ps}, DEP_g, CRED_{ps}, CRED_g, R_l, FXNGDP, BOND, AID, OIL\} \quad (6)$$

Where; CRR is the ratio of cash required reserves to total deposits; VOL_y and VOL_{cd}, are five year moving averages of the standard deviations of the output gap and cash to deposit ratio, respectively; VOL_{ps} and VOL_{gov} are five year moving averages of the standard deviation of private sector and government deposits divided by the five year moving average of these variables; $PORT$ is the ratio of demand to savings deposit and Y_{hp} is the output gap[8]; $REPO_R$ is the repo rate used as a proxy for Central bank discount rate; DEP_{ps} and DEP_g are ratios of private sector and government deposits to nominal Gross Domestic Product(GDP), respectively; $CRED_{ps}$ and $CRED_g$ are ratios of private sector and central government credits to nominal GDP; R_l is the weighted average lending rate for commercial banks; $FXNGDP$ is the ratio of foreign exchange reserves to nominal GDP; $BOND$ is the ratio of domestic debt securities to nominal GDP while AID is the ratio of aid inflow to nominal GDP. OIL is the ratio of oil export revenue to nominal GDP.

Precautionary factors X_t consist of measures of volatility or uncertainties that banks consider when accumulating excess reserves. These factors are based on the underlying theory of demand for excess reserves adopted by Agenor et al (2004). VOL_y and VOL_{cd} capture the precautionary motives of the commercial banks' to accumulate excess reserves. CRR, captures the impact of reserve requirement on excess liquidity – a negative relation is expected as increase (decrease) in reserve requirement reduces (raises) the level of excess liquidity. VOL_{ps} and VOL_{gov} are measures of volatility of deposits which prompts the banks to hold excess liquidity as buffer against unexpected large withdrawals if deposit base is volatile. $PORT$, represent the ratio of demand deposit to time and saving deposits, and is expected to positively correlate with the demand for excess reserves as higher short-term maturity structure of loans compared to the longer term requires the banks to hold excess reserves. Output gap, Y_{hp} is a proxy denoting the demand for cash. A positive relationship between Y_{hp} and demand for excess reserves is expected as during the boom (bust) period, demand for cash increases (falls) which increases (reduces) the banks' demand for excess reserves. The

[8] Output gap is constructed as the percentage deviation of output from trend using the Hodrick-Prescott (HP) filter of the Eviews program. Since Output is compiled only on annual basis for PNG, Quadratic Average Linear Interpolation operation in Eviews is used to splice the annual series to monthly before applying the HP filtering method to detrend the series. This could potentially lead to generation of inconsistent results; hence, results relating to variables with output and output gap should be interpreted with caution.

repo rate, $REPO_R$ proxies the discount rate or the penalty rate, and depicts the cost of holding liquidity by banks. The higher the cost of borrowing reserves implies that banks would prefer to hold larger excess reserves to cushion themselves against any short-falls, therefore a positive relationship is perceived.

In contrast, involuntary demand factors have less theoretical basis and are largely crude proxies mainly due to the unavailability of data. The involuntary factors are assumed to be largely influenced by risk taking behaviour of the commercial banks which entails mainly the structural, cyclical and political disturbances, and other related factors. These factors restrain the banks from channelling out excess reserves, even though they may be willing and able to. As a result, the banks often hold excess reserve beyond the level that would be deemed as precautionary. Structural factors such as underdeveloped financial markets, inactive interbank markets, poor capital markets, and inefficient payment system - are main features of developing economies - usually cause the banks to accumulate unwanted excess liquidity. For instance, difficulty in accessing credit for business extension could induce firms to maintain high volume of deposits, DEP_{ps} rather only transact to meet their operational expenses and minor investment expenditures. This could also be due to higher receipts of remittance from abroad or lack of alternative saving and investment options. Similarly, increase in government deposits DEP_g at the commercial banks can lead to the build-up of excess reserves. The decline in the lending to private sector $CRED_{ps}$ and government $CRED_g$ due to weak demand conditions in the economy can also lead to the build-up in commercial banks' holdings of excess liquidity. The opposite is true for increase in lending to the private and government sectors. Furthermore, in fragmented banking and financial sector environment, loans are priced with higher premium, R_l to compensate for high risk of default. This can discourage lending and thus, contribute to the build-up in excess reserves. The domestic debt securities market denoted by $BOND$ provides an investment avenue for the banks to channel their excess reserves. A negative relationship is expected between $BOND$ and excess reserves demand as higher interest rate on domestic securities reduces the commercial banks demand to hold excess liquidity. In small open economies like PNG, large external capital and current account flows can have significant implications on build-up of excess reserves in the domestic banking system. These could include aid flows AID, export receipts from mining and petroleum sector OIL and agricultural commodity exports. The foreign exchange reserve level $FXNGDP$ accounts for the impact of the accumulation of foreign reserves on commercial bank holdings of excess reserves.

Following Saxegaard (2006), excess reserve is decomposed into precautionary and involuntary using equations (8) and (9).

$$Xliq_t^{\ P} = a\hat{c} + \hat{\phi}_1^{\ P} Xliq_{t-1}^{\ P} + \hat{\phi}_2(L)X_t \qquad (8)$$

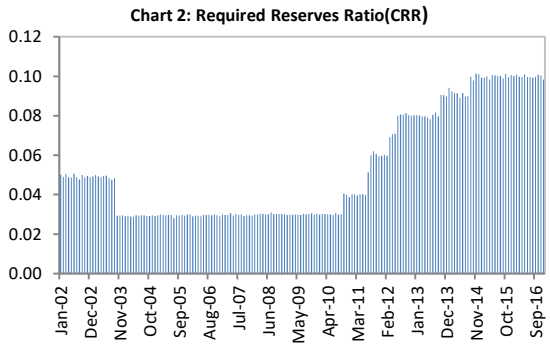
$$Xliq_t^{\ I} = (1-a)\hat{c} + \hat{\phi}_1^{\ I} Xliq_{t-1}^{\ I} + \hat{\phi}_3(L)Y_t \qquad (9)$$

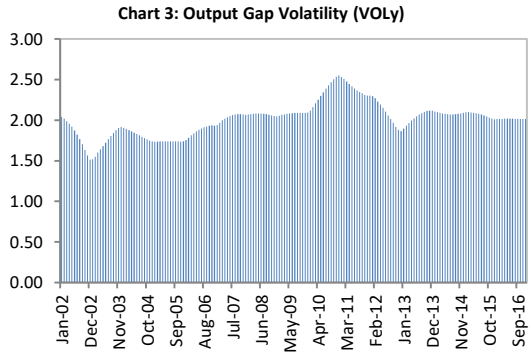
Where; $\hat{c}, \hat{\phi}_1, \hat{\phi}_2, \hat{\phi}_3$ are parameter estimates of the model; $Xliq_t^P$ is the precautionary reserves as a ratio of total deposit; $Xliq_t^I$ is the involuntary reserve component and a is a constant. Equations (8) and (9) are dynamic forecasts of $Xliq_t^P$ and $Xliq_t^I$ if estimated $\hat{\phi}_1 \neq 0$. In addition, the sum of $Xliq_t^P$ and $Xliq_t^I$ equals the dynamic forecast of $Xliq_t$. In essence, the fitted series from the estimation is decomposed with the assumption that z_t in equation 4 is set to zero.

Nonetheless, the approach adopted in this paper has some drawbacks; therefore, the results must be interpreted with care. First, the model is variable sensitive, therefore is as good as the data supplied. With problems of data limitations, this could have adverse implication on the results. Second, only the sum of the two constants is identified. Hence, any value of parameter a should be consistent with the sum of the constant terms of $Xliq_t^P$ and $Xliq_t^I$ which should equal to the model estimated constant term for $Xliq_t$[9]. The effect is such that only growth rates are generated for $Xliq_t^P$ and $Xliq_t^I$, not in levels. For the parameter estimates, precautionary $\hat{\phi}_1^P$ and involuntary $\hat{\phi}_1^I$ reserves are not identified. Hence, Saxegaard (2006) assumes that $\hat{\phi}_1^P = \hat{\phi}_1^I = \hat{\phi}_1$. Hence, any combination of $\hat{\phi}_1^P$ and $\hat{\phi}_1^I$ that satisfies the equation $\hat{\phi}_1^P \ Xliq_t^P + \hat{\phi}_1^I \ Xliq_t^I = \hat{\phi}_1 \ (Xliq_t^P + Xliq_t^I)$ is adequate.

ii. Data

The dataset consists of variables in monthly series, covering January 2002 to December 2016. The selection of the period of study was primarily due to the availability of data. The data was sourced from the Bank of Papua New Guinea research database and Quarterly Economics Bulletin (QEB) publications. The description of the data is defined in Table 3 in the Appendix. The following charts depict the trend of each of the variables employed in the model.





[9] Saxegaard (2006) suggested relying on commercial banks to determine the proportion of excess liquidity that is precautionary. For this study, due to unavailability of precise data on the precautionary proportion of excess liquidity, the prudential standard of 35 percent for liquid to asset ratio is applied as a ratio to construct the precautionary excess reserves series. Hence a=0.35.

Chart 4: Cash to Deposit Volatility (VOLcd)

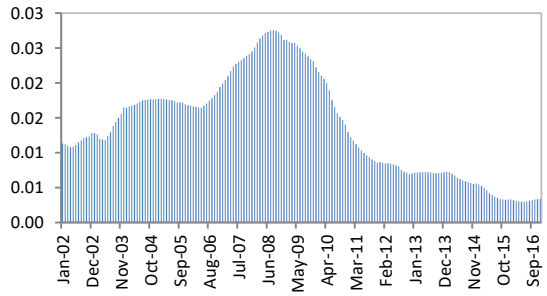


Chart 5: Volatility of Private Sector Deposit (VOLps)

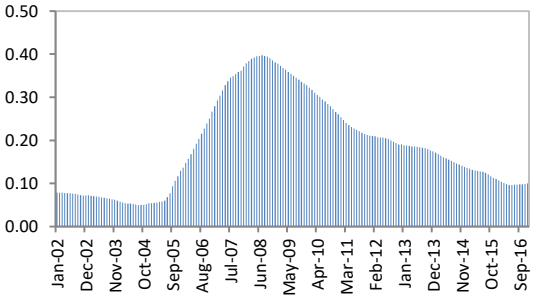


Chart 6: Volatility of Public Sector(Government) Deposits (VOLgov)

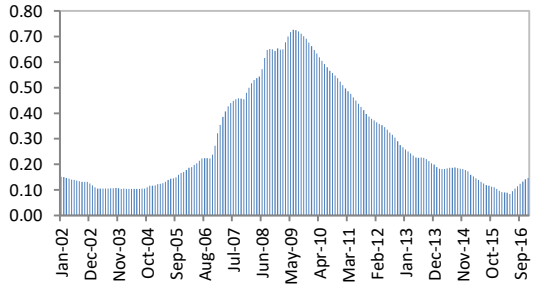


Chart 7: Ratio of Demand to Savings Deposits (PORT)

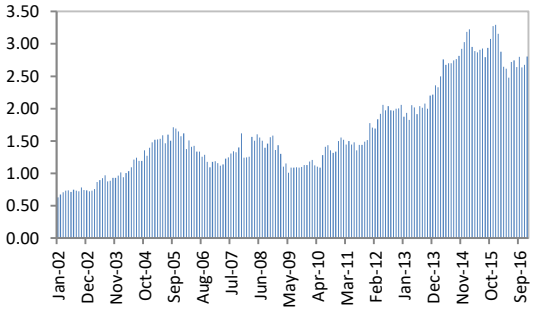


Chart 8: Output Gap (percentage) (Y_hp)

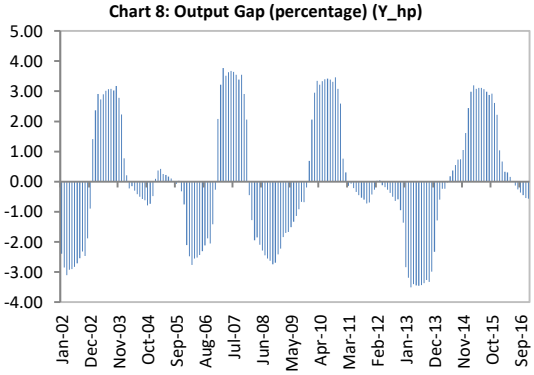


Chart 9: Repo Rate/100 (Repo_r)

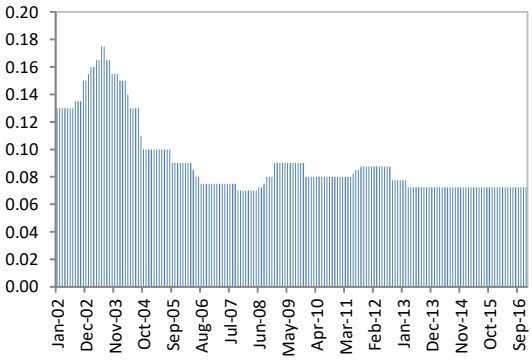


Chart 10: Ratio of Private Sector Deposit to Nominal GDP (Dep_ps)

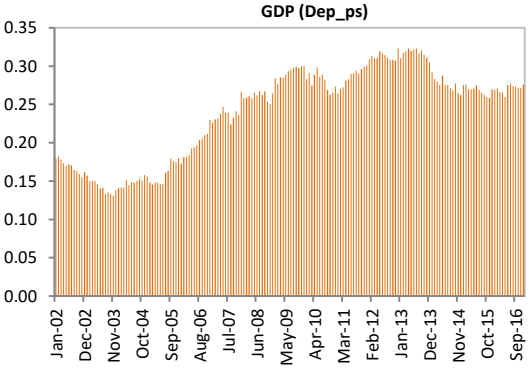


Chart 11: Ratio of Government Deposit to Nominal GDP (Dep_g)

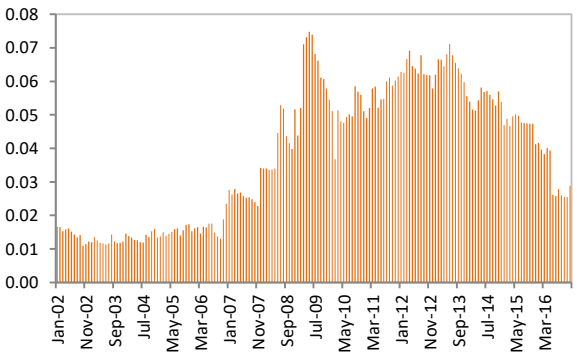


Chart 12: Ratio of Private Sector Credit to Nominal GDP(CRED_p)

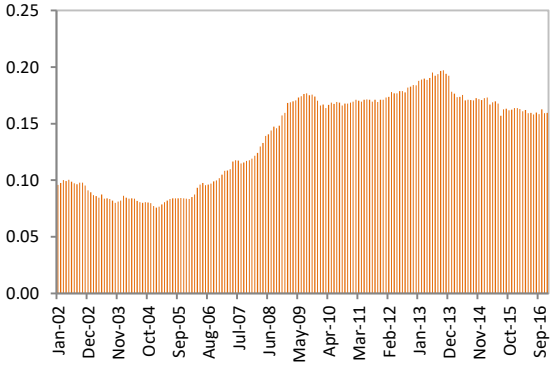


Chart 13: Ratio of Government Credit to Nominal GDP(CRED_g)

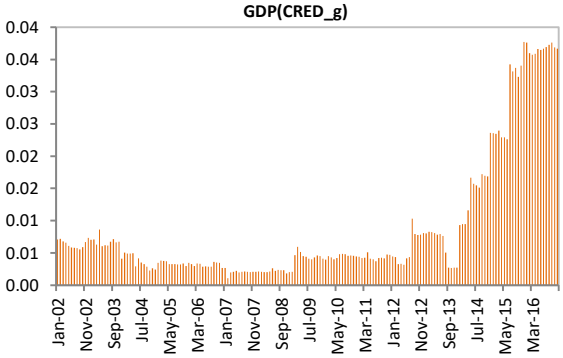


Chart 14: Ratio of Domestic Debt to Nominal GDP(BOND)

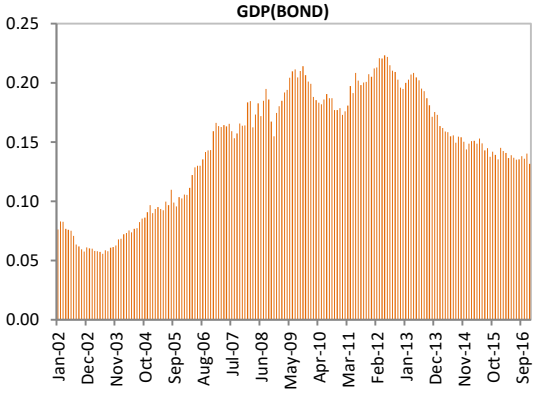


Chart 15: Ratio of Aid Inflow to Nominal GDP(AID)

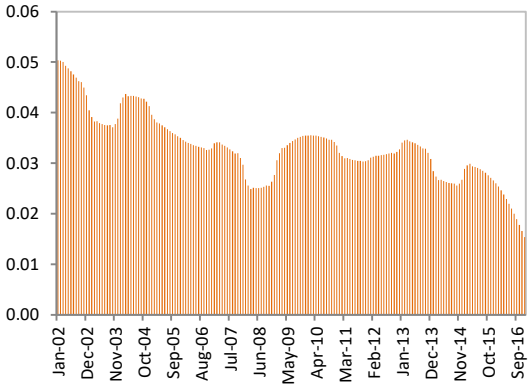


Chart 16: Ratio of Oil Export Revenue to Nominal GDP(OIL)

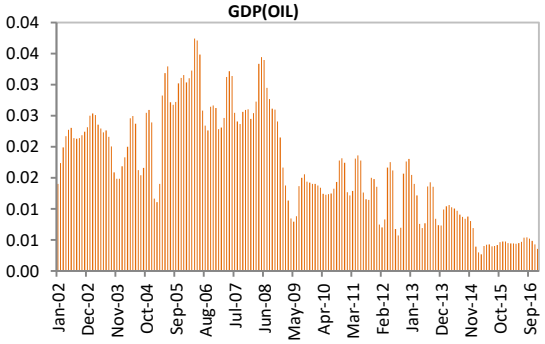


Chart 17: Weighted Average Lending Rate/100 (RL)

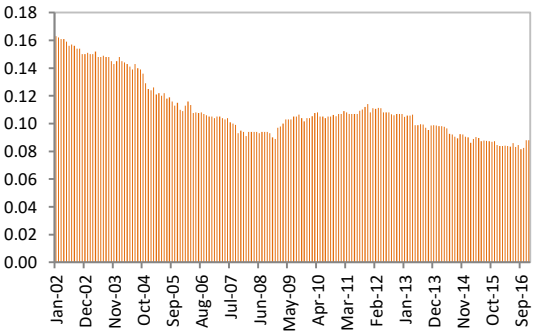
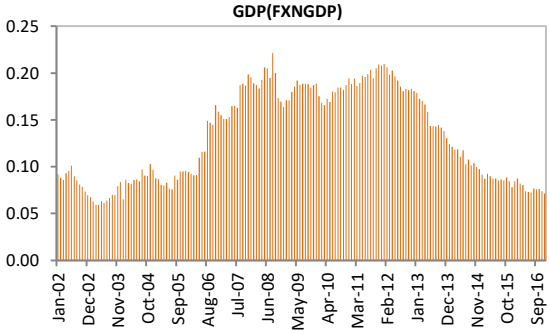


Chart 18: Ratio of Foreign Exchange Reserves to Nominal GDP(FXNGDP)



The required cash reserve ratio consecutively increased from 3 percent in 2010 to 10 percent in September 2014, and was maintained up to 2016. The consecutive increase in the cash reserve requirement reflected the Bank's direct policy response to assist diffuse high liquidity overhang in the banking system over the period. The repo rate which reflects the cost of funds from the Central bank declined from a high of about 18 percent in January 2003 to about 7 percent in June 2013 and was maintained up to 2016 following the movement in the monetary policy rate, the Kina Facility Rate. The trends of the cash to deposits volatility which reflected currency volatility, and the volatility of the private sector and government deposits are fairly similar. The cash to deposit volatility which is measured as the 5 year moving standard deviation of the cash to deposit ratio, broadly increased from 0.01 in January 2003 to about 0.03 at the end of 2008 before declining thereafter to reach less than 0.01 in December 2016. Volatility of private sector and government deposits, which are also measured in the same manner as volatility of cash to deposit, increased around 2005 and 2006 from as low as 0.10, to reach the peak of around 0.40 and 0.70, respectively in 2009, and subsequently declined to the same level as in 2005 and 2006. The ratio of demand to savings deposit generally increased from about 0.63 at January 2002 to about 2.81 at December 2016. This reflected the increasing trend of the short-term deposits relative to longer term liabilities of the commercial banks. The output gap which reflected the demand for cash has recently been negative. However, the output gap has undergone periods of both negative and positive over the study period. Output gap volatility, as measured by the 5 year moving standard deviation of output gap increased from 1.52 in January 2003 to 2.55 in December 2010 before declining to 2.0 in December 2016. This variable together with others discussed above reflected precautionary reasons for banks to accumulate excess reserves.

The trends of the involuntary excess reserve variables are mixed, although some follow somewhat similar trends. Private sector deposits as a proportion of nominal GDP increased starting around November 2003 at 1.3 percent to about 3.2 percent at the end of 2013, and remain elevated at around 2.7 percent until the end of 2016. The ratio of the government deposit also follows similarly, increasing from 0.1 percent in October 2006 to around 0.7 percent in June 2013, and then declined afterwards to 0.3 percent by the end of December 2016. The size of the ratio of the private sector deposits is more than doubled that of the government at the commercial banks. The ratio of private sector credit to nominal GDP also increased from 0.8 percent in January 2015 to about 2.0 percent in September 2013 before it gradually declined to 1.6 percent in December 2016. The government credit remained depressed for the most part of the study period before sharply increasing to 0.4 percent in December 2006 from 0.1 percent in January 2014 reflecting an increase in lending to the State-Owned Entities (SOEs). The ratio of domestic debt to nominal GDP increased starting in January 2003 from 0.6 percent to about 2.2 percent and then declined afterwards to about 1.4 percent in December 2016, reflecting the cumulative fiscal deficits undertaken by the government. More interestingly, the ratio of the foreign exchange reserves to nominal GDP also follows somewhat similar trend where it increased from 0.3 percent in February 2003 to about 2.1 percent in January 2012 and then decline again to about 0.7 percent at the end of December 2016. These similar trends in private sector and government deposits, and private sector and government credit, and domestic debt ratio, and the foreign exchange reserve ratio may indicate an underlying relationship between the variables. Mainly from 2005 upwards to 2012, PNG experienced consecutive years of economic growth mainly driven by a higher international commodity prices and an increase in its export volumes which assisted to generate an increase in its foreign exchange earnings. This resulted in the Bank intervening

in the foreign exchange market by supplying kina and diffusing the surplus foreign exchange reserves which was exerting upward pressure on the kina exchange rate. The kina equivalent deposited into the commercial banks formed the main source of the accumulation of high deposits, as well as private sector credit by the banks. This potentially led to the build-up of the excess bank reserves in the commercial banks. Other variables including the ratio of aid and oil revenue inflows and the weighted average lending rate from the banks broadly declined over the study period.

Unit Root Tests

The Augmented Dickey Fuller (ADF) and Kwiatkowski-Philips-Schmidt-Shin (KPSS) unit root tests were employed to check the stationarity of the variables. Whilst the ADF unit root test assumes a null hypothesis of no unit root, the KPSS tests a null of stationarity. Hence, a rejection of null hypothesis under ADF test implies stationarity of series whilst a rejection of null under KPSS implies non-stationarity of variables. Both tests show that all variables are stationary at first difference, that is, are integrated of order one, I (1), except excess liquidity and output gap, which are stationary at levels. Table 1 show that ADF test results while the KPSS test result is shown in Table 4 of the Appendix.

Table 1: AUGMENTED DICKEY FULLER (ADF) UNIT ROOT TEST

	LEVELS		FIRST DIFFERENCE		Stationarity
VARIABLE	INTERCEPT	TREND+INTERCEPT	INTERCEPT	TREND+INTERCEPT	
EXLIQ	-2.64(-2.58)*	-2.94(-3.14)	-14.77(-3.47)***	-14.74(-4.01)***	I(0)
CRR	0.41(-2.58)	-1.94(-3.14)	-13.38(-3.47)***	-13.66(-4.01)***	I(1)
REPO_R	-1.25(-2.58)	-1.05(-3.14)	-11.02(-3.47)***	-11.02(-4.01)***	I(1)
Y_HP	-2.74(-2.58)*	-2.73(-3.14)	-6.93(-3.47)***	-6.88(-4.01)***	I(0)
VOLY	-1.95(-2.58)	-1.45(-3.14)	-5.91(-3.47)***	-6.00(-4.01)***	I(1)
VOLCD	-1.21(-2.58)	-2.40(-3.14)	-2.96(-2.88)**	-3.21(-3.14)*	I(1)
VOLPS	-1.95(-2.58)	-1.45(-3.14)	-5.91(-3.47)***	-6.00(-4.01)***	I(1)
VOLGOV	-1.16(-2.58)	-1.04(-3.14)	-4.34(-3.47)***	-4.52(-4.01)***	I(1)
PORT	-0.86(-2.58)	-2.06(-3.14)	-14.75(-3.47)***	-14.71(-4.01)***	I(1)
DEPPS	-0.90(-2.58)	-0.75(-3.14)	-16.11(-3.47)***	-16.09(-4.01)***	I(1)
DEPG	-1.44(-2.58)	-0.97(-3.14)	-13.39(-3.47)***	-13.44(-4.01)***	I(1)
CREDPS	-0.92(-2.58)	-0.05(-3.14)	-7.01(-3.47)***	-7.03(-4.01)***	I(1)
CREDG	0.98(-2.58)	-0.65(-3.14)	-14.42(-3.47)***	-14.88(-4.01)***	I(1)
RL	-2.56(-2.58)	-1.89(-3.14)	-14.29(-3.47)***	-14.53(-4.01)***	I(1)
FXNGDP	-1.04(-2.58)	-0.67(-3.14)	-5.87(-3.47)***	-6.09(-4.01)	I(1)
BOND	-1.42(-2.58)	-0.30(-3.14)	-13.08(-3.47)***	-13.26(-4.01)***	I(1)
AID	0.16(-2.58)	-1.33(-3.14)	-3.80(-3.44)***	-3.75(-3.44)**	I(1)
*,**,*** Stationary at 10, 5 and 1 percent level of significance, respectively					

Heteroscedasticity and Autocorrelation Consistent (HAC) weighting matrix for GMM is applied in the estimation. In addition, Bartlett kernel with Newey-West bandwidth selection criteria of lags is used to weight the autocovariances in computing the weighting matrix. These procedures are executed easily using the functions of GMM in Eviews 9 software.

iii. Methodology

Since most explanatory variables specified in equations 6 and 7 are influenced largely by the Central Bank and the commercial banks, this could imply correlation between these variables and the error term. This is commonly known as the endogeneity bias. In addition, incorrect measurement of the explanatory variables may also induce this endogeneity problem. This could potentially lead to the generation of inconsistent results if simple estimators such as Ordinary Least Squares (OLS) are employed for estimation. This warrants for the application of modified estimators such as the Instrumental Variable (IV) estimators which are designed to correct for this estimation bias. These IV estimators such as the Two Stage Least Square (2SLS) and General Method of Moments (GMM) add instrumental variables which are correlated with endogenous variables but independent of error terms to correct for this biasness. Saxegaard (2006) employed the 2SLS estimator; however, Devi (2016) citing Hansen and Singleton (1982) later argued that the use of GMM is better and more efficient. She further emphasized that GMM does not involve strong underlying assumption on the underlying model; instead only requires identifying relevant instruments. Hence, the GMM framework assumes that error terms are uncorrelated to the vector of instruments, z_t.

Following Devi (2016), the GMM estimator is employed to estimate the model.
The orthogonality condition given the set of instruments takes the following form;

$$E\left[(Xliq_t - \beta X_t)\middle| z_t\right] = 0 \qquad (10)$$

Where; β is the matrix of coefficients; X_t is the matrix of determinant variables including the constant; z_t is the vector of instruments. The set of instruments, z_t includes four lags of all endogenous variables namely CRR, $REPO\_R$, DEP_{PS}, DEP_G, $PORT$, $CRED_{PS}$, $CRED_G$, $BOND$ and R_l, and the second to fourth lag of excess liquidity, $XLIQ$ and rest of the exogenous variables (VOL_Y, VOL_{CD}, VOL_{PS}, VOL_{GOV}, Y_hp, $FXNGDP$, AID and OIL).

iv. Results & Discussion

Table 2 provides the estimated results of equation (4) computed using the GMM estimation technique. A series of residual diagnostic tests are conducted on GMM estimation results to validate the statistical properties of the model. First, the Instrument Orthogonality C-Test applied on three subsets of instrumental variables finds that all the instruments certify orthogonality condition (Table 5-Appendix). Further, the Regressor Endogeneity test confirms that the variables that are treated endogenous in the estimation can be used as exogenous variables (Table 6-Appendix). Since the Stock-Yogo bias and size critical values are not available for models with more than 30 instruments, the test of weak instruments is discarded, even though the results indicated that most of the instruments are tested to be weak (See Table 7). Autocorrelation test shows that residuals do not possess serial autocorrelation up to lag 12. The Jarque-Bera test rejects the null hypothesis that residuals are normally distributed but loosely speaking it is of less concern due to large sample size.

Table 2: Estimated GMM Excess Reserves Model for PNG		
Method: Generalized Method of Moments Sample (adjusted): 2002M05 2016M12 Included observations: 176 after adjustments		
Variable	**Coefficient**	**Std. Error**
C	0.07	0.070
CRR	-0.47*	0.280
REPO_R	-0.21	0.154
Y_HP	0.001*	0.001
VOLY	-0.02*	0.010
VOLCD	1.51**	0.728
VOLPS	-0.33***	0.069
VOLGOV	0.03	0.030
PORT	0.03**	0.010
DEPPS	0.49***	0.252
DEPG	0.60***	0.197
CREDPS	-0.57*	0.303
CREDG	0.43**	0.215
RL	0.11	0.444
FXNGDP	0.43***	0.096
BOND	-0.45**	0.175
AID	-0.59	0.479
OIL	-0.26	0.194
EXLIQ(-1)	0.13	0.082
R-squared	0.67	
Adjusted R-squared	0.63	
Durbin-Watson stat	1.77	
J-statistic	21.07	
Prob(J-statistic)	0.86	
1.*,**,*** significance of coefficients at 10, 5 and 1 percent, respectively 2. Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 5.0000) 3.Standard errors & covariance computed using HAC weighting matrix (Bartlett kernel, Newey-West fixed bandwidth = 5.0000) 4.Instrument specification: CRR(-1 TO -4) REPO_R(-1 TO -4) PORT(-1 TO -4) DEPG(-1 TO -4) DEPPS(-1 TO -4) CREDPS(-1 TO -4) CREDG(-1 TO -4) BOND(-1 TO -4) RL(-1 TO -4) C EXLIQ(-2 TO -4) Y_HP VOLY VOLCD VOLPS VOLGOV FXNGDP AID OIL 5. Constant is added to the instrument list		

The coefficients of the estimated model are substituted into equation 4 and as shown in equation 11 below.

$$Xliq_t = -\underset{0.09}{0.47}RR + \underset{0.08}{0.0009}Y\_hp - \underset{0.09}{0.02}VOL_y + \underset{0.04}{1.51}VOL_{cd} - \underset{0.00}{0.33}VOL_{ps} + \underset{0.01}{0.03}PORT$$

$$+ \underset{0.05}{0.49}DEP_{ps} + \underset{0.00}{0.60}DEP_g - \underset{0.06}{0.57}CRED_{ps} + \underset{0.05}{0.43}CRED_g + \underset{0.00}{0.43}FXNGDP - \underset{0.01}{0.45}BOND$$

(11)

The signs of the coefficients are generally consistent with priori expectations. It is evident from equation 11 and Table 2 that the magnitudes of the coefficients of most of the involuntary factors are higher and statistically significant compared to the precautionary factors. This

suggests that in PNG, excess reserve is mainly driven by involuntary factors compared to the precautionary factors. The main determinants of involuntary excess reserves include deposits of and lending extended to the government and the private sector, domestic securities investment and the accumulation of foreign exchange reserves. Other involuntary factors including the weighted average lending rate, oil revenue and aid inflows are statistically insignificant in explaining movements in the excess reserves. For precautionary factors, significant factors estimated by the model include currency volatility, reserve requirement and the volatility in the private sector deposits. The relationship of excess reserves and the output gap and its volatility, and the ratio of short-term demand deposits to savings and term deposits are negligible while repo rate and volatility of government deposit were found to be insignificant.

The positive relationships between private sector and government deposits and excess reserves are expected as excess reserve held by commercial banks at the Central bank is composed basically of the excess of various deposits held at the commercial banks. As the model estimated, the coefficients of 0.49 and 0.60 means that a 10 percent increase in the private sector and government deposits results in an increase of 4.9 percent and 6.0 percent, respectively. This implies that higher the deposits at commercial banks over and above their reserve adequacy level spills over into excess reserve accumulation at the Central bank. A high accumulation of private sector deposits at commercial banks in PNG could be attributed to a decline in the private sector investments, which could potentially reflect a dampened aggregate domestic demand conditions or lack of alternative savings options owing to the oligopolistic market structure of PNG's banking system. The latter imply existence of only few banks, hence, limited available savings options, which leads to a structural increase in the private sector deposits in the existing banks. In addition, for small to medium-sized firms, difficulty in accessing credit could force firms to maintain large deposits at the commercial banks to meet their capital expenditures. On the other hand, the increase in government deposits at commercial banks is closely associated with the export revenue of the government which is mainly composed of mining and petroleum dividends and taxes. These export revenues are usually denominated in US dollars, are typically converted to kina and re-deposited into government trust accounts in the commercial banks composing one of the key sources of excess liquidity. During periods of high international commodity prices which results in an increase in PNG's export earnings, or development of mining resource projects which composes of high foreign direct investments, inflows of foreign exchange into the foreign exchange market usually increase dramatically. This induces the Bank to undertake increased foreign exchange interventions by diffusing the large build-up of US dollars which could otherwise exert upward pressure on the kina exchange rate. This additionally contributes to large deposits of kina in the commercial banks and leads directly to the build-up in the excess reserves if these kina deposits through the foreign exchange interventions are not effectively sterilized through the Bank's Open Market Operations (OMOs). This was a notable experience during the period, 2006 to 2012, when international commodity prices were high, coinciding with the large inflow of foreign capital during the construction of the multi-billion dollar LNG Project.

Commercial bank lending to both the private sector and government also influences the build-up of the involuntary component of excess reserves. Whilst a 10 percent increase in the credit to the private sector results in a 5.7 percent decline in the holding of involuntary excess reserves, an increase of the same magnitude of lending to government would increase the

level of involuntary excess reserves by 4.3 percent. The decline in private sector lending could be due to loan market conditions. In most cases, although commercial banks in PNG are often willing to extend credit to firms and individuals, a low demand for loans due to an overall decline in the investment climate emanating from a worsening aggregate demand condition tend to be a constraint to the private sector credit growth. Other demand factors could include an increase in the cost of borrowing, other structural and regulatory constraints such as stringent collateral requirements or foreign currency constraints, such as shortage of foreign currency or a decline in kina exchange rate, faced by importing firms which reduces their demand for loans. A decline in private sector lending implies an increase in bank deposits which could spill over into commercial banks holding higher excess reserves at the Central Bank. On the other hand, the positive relationship between government deposits and excess reserves is not anticipated. This could reflect factors including the expenditure absorption constraint faced by the government or through their State-Owned Enterprises (SOEs)[10] resulting in the parking of idle funds in the government trust accounts at the commercial banks. This corroborates the internal findings of the KFR Review (2014) by the Bank whereby the balances of government trust accounts at the Central bank were noted to decline over the recent period complemented by proportional increases in government trust accounts at the commercial banks. In some instances, lending to government through the SOE's may not be intended for projects, instead for other purposes such as borrowing for dividend payments to the State which could end up in the government trust accounts at the commercial banks. Investments in the domestic debt securities or bond markets and the accumulation of foreign exchange reserves were also found to be significant in explaining changes in the holdings of involuntary excess reserves. In particular, a 10 percent increase in domestic debt securities and foreign exchange reserves would result respectively in an increase of 4.3 percent and a decline of 4.5 in excess reserves. Both signs of the coefficients are as anticipated. For investments in domestic debt securities, the issuance of Central bank bills (CBBs) and government's Treasury bills and bonds (formerly Inscribed Stocks) have assisted in diffusing some excess liquidity in the system. However, this could be seen as temporary relieve as during maturity periods of these domestic securities and bonds, liquidity is again injected into the banking system with additional interests. In any particular period, the influence on the changes in the level of excess liquidity primarily depends on net issuance, that is, the residual of the new issuance of domestic debt and bonds and the maturity of the existing debt instruments. An increase in the accumulation of foreign exchange reserves has a positive and significant effect on the excess liquidity in the banking system. The increase inflows of foreign exchange by exporters to the foreign exchange market during favorable exporting periods or inception of large mineral projects have contributed to large deposits. Also when the BPNG intervenes in the foreign exchange market to buy USD during periods of surplus foreign reserves, kina equivalent is injected into the commercial banks and builds-up into excess reserves if not adequately sterilized,

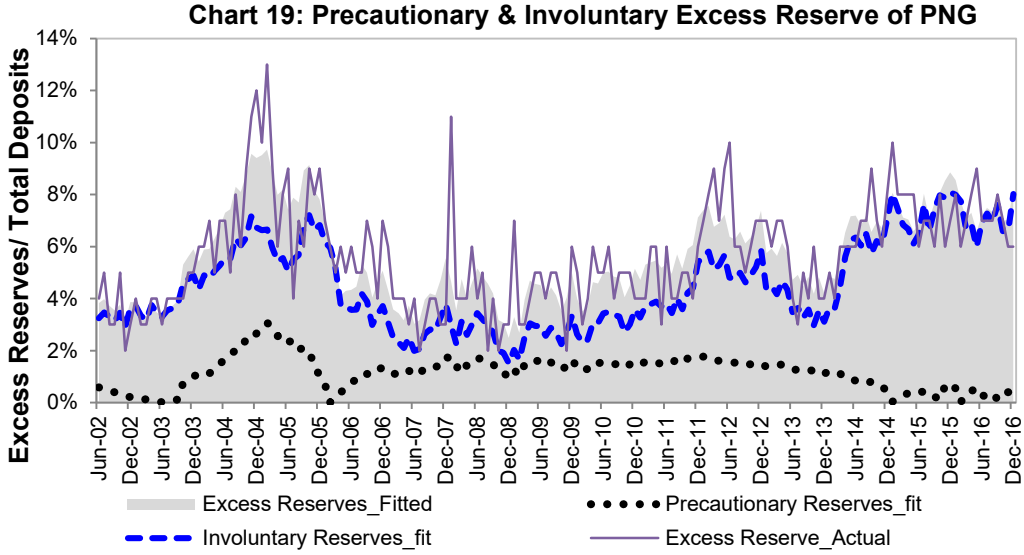
For the precautionary excess reserves, cash to deposit ratio, a proxy for currency or liquidity risks, is highly significant in explaining movements in the precautionary excess reserves. With a coefficient of 1.15 percent, this implies that a 10 percent increase in currency risks would induce the commercial banks to increase their precautionary excess reserves by 11.5 percent, on average. The negative relationship of the cash reserve requirement and the excess

[10] In the compilation of the lending to government, lending to the public non-financial corporations which mainly comprises of the State-Owned Enterprises (SOE's) is treated as loans received by the government in this study.

reserves is anticipated as the Bank uses the Cash Reserve Requirement (CRR) as a direct monetary policy tool to effectively manage liquidity in the banking system. A 10 percentage point increase in the CRR withdraws about 4.7 percent cash from the banking system. The negative relationship of risks associated with private sector deposits and excess reserves is not anticipated. In particular, a 10 percent increase in the volatility of the private sector deposits would result in a 3.3 percent decline in the accumulation of precautionary excess reserve. This unanticipated negative relationship could possibly illustrate the behavior of commercial banks in PNG as risk-takers, at least to some extent. This however, does not correlate with other proxies of risks including the demand volatility and liquidity risks, as proxied by the volatilities of output gap and cash to deposits ratio, which as expected, depicted positive correlation with the holding of precautionary excess reserves.

Using the estimated coefficients generated from the model and applying equations 8 and 9, dynamic forecasts of the precautionary and involuntary excess reserve series are generated. As explained in the methodology section, one of the limitations of this approach is that it would not directly produce the respective levels of precautionary and involuntary excess reserves; hence, ratios are shown in the Chart 19. In addition, note that absolute value is used for the precautionary component and was combined with the involuntary component in the construction of respected shares of components before applying them to construct the respective fitted series of both components as presented in Chart 19[11]. In this model, the residual of the estimated model, e_t is assumed to be zero, implying that the fitted series only reflect the precautionary and involuntary excess reserves component variables captured in the model. The result shown in Chart 19 confirms that commercial banks in PNG accumulate excess reserves involuntarily, that is, excess reserves are demand-induced. In the recent period, 2015 to 2016, the precautionary excess reserves are at historically lowest levels whilst the involuntary excess reserves almost composed the whole of the excess reserves.

Chart 19: Precautionary & Involuntary Excess Reserve of PNG

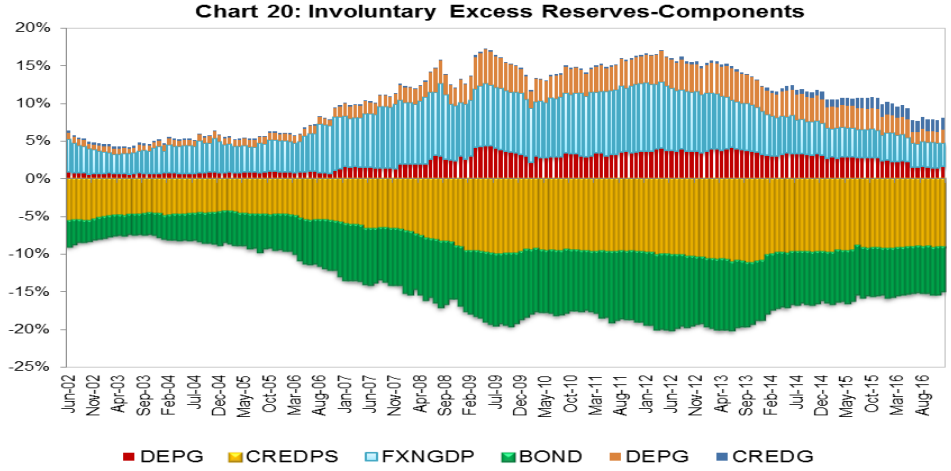


The contributions of the major factors influencing the build-up of the precautionary and involuntary excess reserves over the study are depicted in Charts 20 and 21, respectively. Chart 20 on the involuntary excess reserves illustrates that credit to the private sector,

[11] Saxeguaard (2006) identifies as one of the limitations of the method that there is no guarantee, mathematically, that components of the excess reserves would be positive. This implies that a negative deposit in the commercial banks would prove economically spurious. This is to some extent corrected through the application of absolute values to the negative series.

investment in domestic debt securities and the accumulation of foreign exchange reserves have been the main drivers of involuntary excess reserves over the study period. Whilst a decline in private sector credit and investment in domestic securities continues to be dominant contributing factors to accumulation of involuntary excess reserves, the impact of the accumulation of foreign exchange reserves as reduced in the recent years as reflected by the recent shortages in the foreign exchange market. Private sector and government deposits at commercial banks including credit to government also contributed to the build-up of involuntary excess reserves but their contribution are relatively smaller.

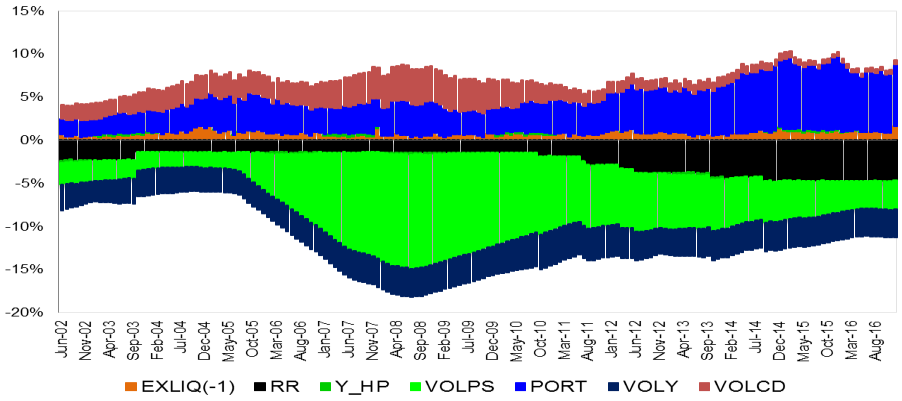
Chart 20: Involuntary Excess Reserves-Components



Source: Author's calculation

Chart 21 of the precautionary excess reserves show that volatility of private sector deposits largely contributed to the accumulation of the precautionary excess reserves prominent from 2005 to 2013. From 2013 up to present, the contributions from the demand deposit to savings and term deposit, reflecting the effect of higher proportion of short term deposits on the volatility of commercial banks' liabilities, increased and contributed to the build-up of excess reserves to present. Other precautionary factors such as the reserve requirement, output gap volatility and the currency volatility also contributed to holding of precautionary excess reserves by the commercial banks.

Chart 21: Precautionary Excess Reserves-Components



Source: Author's calculation

V. CONCLUSION

This study attempts to establish an excess reserves demand model for Papua New Guinea (PNG). Using the General Methods of Moments (GMM) estimation technique and following the empirical approach by Saxegaard (2006), the study found that excess reserves in PNG is mainly influenced by involuntary factors including private sector and government deposits, credit to private sector and government, investment in domestic securities market, and the accumulation of the foreign exchange reserves. On the other hand, precautionary component of excess reserves contribute less to the overall holding of excess reserves in the banking system. The main significant factors commercial banks consider for precautionary motive include volatility in private sector deposits, volatility of cash to deposit ratio and the cash reserve requirement. Other negligible precautionary factors include the ratio of demand deposits to term and savings deposits, and output gap which reflects the demand for cash, and its volatility. With this empirical finding, one can conclude that the build-up of excess liquidity in PNG is a demand-induced phenomenon, implying that the current build-up of excess reserves is driven largely by the reduction in demand for loans. This means that sudden increase in aggregate demand in the economy, could result in an increase in the demand for loans, hence, excess liquidity is likely to be translated to increased private sector credit growth, and in turn, exert upward pressure on the price level. This however, is subject to further empirical investigation especially for PNG, although it has been established for some other related countries.

Given the findings above, the Central Bank should focus its efforts on influencing the key determinants of excess liquidity identified in the model in order to influence the levels of excess liquidity in the banking system. First, since excess liquidity is found to be demand-induced, policy actions related to stimulating demand for loanable funds should be undertaken. Investable projects should be encouraged, although this largely depends on government expenditure or development of a new mining resource project large enough to stimulate demand in the domestic economy. The Bank should ensure that the supply of foreign exchange into the foreign exchange market is adequate with effective management of exchange rate policy to ensure that the exchange rate is not too depreciated which could otherwise make import payments costly, and could discourage demand for loans. In addition, cost of borrowing should also be reviewed so that the interest rates are not exorbitantly charged to discourage lending. Structural and regulatory constraints should also be addressed to ensure that the deposits at the commercial banks are not kept idle, instead are channelled out for productive use. For example, tight regulatory requirements relating to collaterals should be eased in order to stimulate demand for credit. The Bank should also promote alternative savings vehicles to attract private sector deposits from commercial banks, or encourage competition in banking industry in the long-run. One such approach already undertaken by the Bank is the development of domestic debt securities market for small to medium investors, the TAP facility. Further, trust accounts for the government in the commercial banks should be transferred back to BPNG. In addition, issuance of the government securities and Central Bank bill (CBBs) should continue as this would assist to diffuse excess liquidity directly from the banking system. Since credit to government, which is largely composed of loans extended to State-Owned Enterprises (SOE's), is positively correlated to the excess reserve accumulation, this channel should be a focal point to ensure that loans received purportedly for project related expenses are not parked in accounts in commercial banks, but instead used for their intended purposes. The Bank should also continue to use the cash reserve

requirement as a direct instrument to complement the OMO to absorb additional excess reserves conditioned that all banks have surplus of cash deposits.

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APPENDIX:

Chart 22: CRR(rhs) ,LAR,MLAR, Free Reserves -%

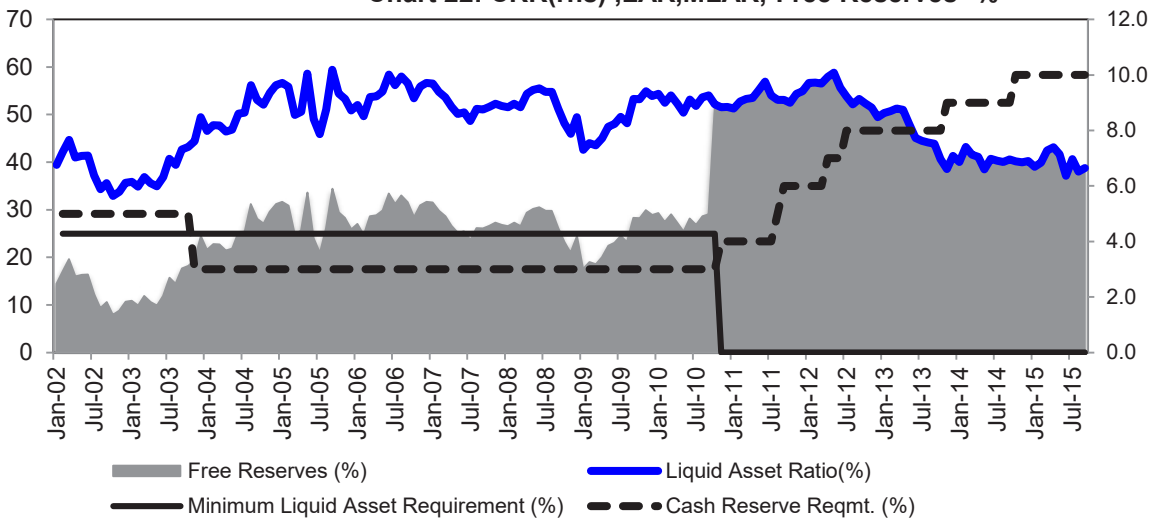

Table 3. Variables, definition and sources

Variable	Description	Source
EXLIQ	Ratio of Excess Reserves to Total Deposits	QEB,BPNG
CRR	Ratio of Required Cash Reserve to Total Deposit at Commercial Banks	QEB,BPNG
VOLY	5year Moving Averages of the Standard Deviations of the Output gap	QEB,NSO,BPNG, Construction
VOLCD	5year Moving Averages of the Standard Deviations of the Cash to Deposit Ratio	QEB,BPNG,Construction
VOLPS	5year Moving Averages of the Standard Deviations of Private Deposits divided by the 5 year Moving Average of Private Sector Deposits	QEB,BPNG,Construction
VOLGOV	5year Moving Averages of the Standard Deviations of Government Deposits divided by the 5 year Moving Average of Government Deposits	QEB,BPNG,Construction
PORT	Ratio of Demand to Savings & Term Deposits	QEB,BPNG
Y_hp	Output Gap-Percentage Deviation of Actual RGDP from T rend RGDP (Trend Calculated using HP Filter in Eviews Statistical program)	NSO, BPNG,Construct ion
Repo_R	Repurchase Agreement(Repo) Rate-Percentage	QEB,BPNG ,NSO
DEPps	Ratio of Private Sector Deposits to Nominal Gross Domestic Product	QEB,BPNG,NSO
DEPg	Ratio of Government Deposits to Nominal Gross Domestic Product	QEB,BPNG,NSO
CREDps	Ratio of Private Sector Credit to Nominal Gross Domestic Product	QEB,BPNG,NSO
CREDg	Ratio of Public Sector (Government) Credit to Nominal Gross Domestic Product	QEB,BPNG,NSO
BOND	Ratio of Securitized Domestic Debt to Nominal Gross Domestic Product	QEB,BPNG,NSO
AID	Ratio of Aid Inflows to Nominal Gross Domestic Product	QEB,BPNG,NSO
OIL	Ratio of Oil Exports to Nominal Gross Domestic Product	QEB,BPNG,NSO
RL	Commercial Bank Weighted Average Lending Rate(in percentage)	QEB,BPNG
FXNGDP	Ratio of Foreign Exchange Reserves to Nominal GDP	QEB, BPNG, NSO

Table 4: KWIATKOWSKI-PHILIPS-SCHMIDT-SHIN(KPSS) UNIT ROOT TEST					
	LEVELS		FIRST DIFFERENCE		Stationarity
VARIABLE	INTERCEPT	TREND+INTERCEPT	INTERCEPT	TREND+INTERCEPT	
EXLIQ	0.31(0.74)***	0.147(0.15)	0.08(0.74)***	0.03(0.22)***	I(0)
CRR	1.25(0.74)	0.39(0.22)	0.66(0.74)***	0.14(0.22)***	I(1)
REPO_R	1.02(0.74)	0.26(0.22)	0.11(0.74)***	0.07(0.22)***	I(1)
Y_HP	0.05(0.74)***	0.04(0.22)***	0.04(0.74)***	0.03(0.22)***	I(0)
VOLY	0.79(0.74)	0.25(0.22)	0.08(0.74)***	0.08(0.22)***	I(1)
VOLCD	0.86(0.74)	0.35(0.22)	0.43(0.74)***	0.14(0.22)***	I(1)
VOLPS	0.40(0.35)	0.37(0.22)	0.45(0.74)***	0.15(0.22)***	I(1)
VOLGOV	0.39(0.35)	0.38(0.22)	0.43(0.74)***	0.18(0.22)***	I(1)
PORT	1.36(0.74)	0.27(0.22)	0.08(0.74)***	0.07(0.22)***	I(1)
DEPPS	1.34(0.74)	0.32(0.22)	0.24(0.74)***	0.18(0.22)***	I(1)
DEPG	1.17(0.74)	0.30(0.22)	0.25(0.74)***	0.12(0.22)***	I(1)
CREDPS	1.43(0.74)	0.26(0.22)	0.28(0.74)***	0.22(0.22)***	I(1)
CREDG	1.90(0.74)	0.34(0.22)	0.69(0.74)***	0.08(0.22)***	I(1)
RL	1.24(0.74)	0.24(0.22)	0.52(0.74)***	0.16(0.22)***	I(1)
FXNGDP	0.47(0.35)	0.39(0.22)	0.50(0.74)***	0.13(0.22)***	I(1)
BOND	0.99(0.74)	0.39(0.22)	0.49(0.74)***	0.12(0.22)***	I(1)
AID	1.22(0.74)	0.16(0.15)	0.10(0.74)***	0.10(0.22)***	I(1)
*,**,*** Stationary at 10,5 and 1 percent level of significance , respectively					

Table 5: INSTRUMENT Orthogonality C Test				
Subset A:Null Hypothesis: CRR(-1 TO -4) REPO_R(-1 TO -4) PORT(-1 TO -4) DEPG(-1 TO -4) DEPPS(-1 TO -4) are valid instruments Subset B: Null Hypothesis: CREDPS(-1 TO -4) CREDG(-1 TO -4) BOND(-1 TO -4) RL(-1 TO -4) are valid instruments Subset C:Null Hypothesis: C EXLIQ(-2 TO -4) Y_HP VOLY VOLCD VOLPS VOLGOV FXNGDP AID OIL are valid instruments				
Difference in J-Statistics		Value	df	Probability
	Subset A	15.12505	20	0.7692
	Subset B	5.929183	16	0.9888
	Subset C	4.748704	12	0.9658

Table 6: Regressor Endogeneity Test			
Null hypothesis: CRR REPO_R PORT DEPPS DEPG CREDPS CREDG RL BOND EXLIQ(-1) are exogenous Endogenous variables to treat as exogenous: CRR REPO_R PORT DEPPS DEPG CREDPS CREDG RL BOND EXLIQ(-1)			
	Value	df	Probability
Difference in J-stats	3.341729	10	0.9722
J-statistic summary:			
	Value		
Restricted J-statistic	25.07283		
Unrestricted J-statistic	21.7311		

Table 7: Weak Instrument Diagnostics		
Equation: EQ01_GMM_SAAXEGUARD_BOND		
Cragg-Donald F-stat:	1.072884	
Stock-Yogo bias critical values not available for models with more than 30 instruments.		
Stock-Yogo size critical values not available for models with more than 30 instruments.		
Moment selection criteria:		
SIC-based:	-128.8736	
HQIC-based:	-74.69808	
Relevant MSC:	-24.77277	

Table 8: Residual Autocorrelation Test

Sample: 2002M01 2016M12
Included observations: 176
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|* |	.|* |	1	0.075	0.075	1.0016	0.317
.|. |	.|. |	2	0.019	0.014	1.0691	0.586
.|. |	.|. |	3	0.022	0.020	1.1573	0.763
.|. |	.|. |	4	0.056	0.053	1.7221	0.787
*|. |	**|. |	5	-0.198	-0.208	8.9038	0.113
.|. |	.|. |	6	0.004	0.036	8.9070	0.179
*|. |	*|. |	7	-0.137	-0.143	12.377	0.089
*|. |	.|. |	8	-0.070	-0.044	13.288	0.102
.|. |	.|. |	9	-0.040	-0.005	13.583	0.138
.|. |	.|. |	10	-0.017	-0.056	13.640	0.190
*|. |	*|. |	11	-0.133	-0.106	17.022	0.107
.|* |	.|. |	12	0.075	0.051	18.092	0.113

*Probabilities may not be valid for this equation specification.

Chart 23: Residual Normality Test-Residual Histogram