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Muhammad, Omer and de Haan, Jakob and Scholtens, Bert

State Bank of Pakistan, University of Groningen

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An Empirical Analysis of Excess Interbank Liquidity: A Case Study of Pakistan

Muhammad Omer[a,b], Jakob de Haan[a,c,d] and Bert Scholtens[a,e]

[a] University of Groningen, The Netherlands
[b] State Bank of Pakistan, Karachi, Pakistan
[c] De Nederlandsche Bank, Amsterdam, The Netherlands
[d] CESifo, Munich, Germany
[e] School of Management, University of Saint Andrews, Scotland, UK

Abstract

We investigate the drivers of excess interbank liquidity in Pakistan, using the Autoregressive Distributed Lag approach on weekly data for December 2005 to July 2011. We find that the financing of the government budget deficit by the central bank and non-banks leads to persistence in excess liquidity. Moreover, we identify a structural shift in the interbank market in June 2008. Before June 2008, low credit demand was driving the excess liquidity holdings by banks. After June 2008, banks' precautionary investments in risk-free securities drive excess liquidity holdings. Monetary policy is less effective if banks hold excess liquidity for precautionary reasons.

JEL Classification: E44, E61, E63

Key words: Excess liquidity, interbank money market, Pakistan, structural breaks, bound test, Autoregressive Distributed Lag approach

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Corresponding author: Muhammad Omer, Economic Policy Review Department, State bank of Pakistan, I.I. Chundrigar Road, Karachi, Pakistan. Tel. +92-21-32453826; Fax. +92-21-99212592; email muhammad.omer@sbp.org.pk

Non-Technical Summary

Government borrowing from the banking sector in Pakistan increased considerably between 2005 and 2011. At the same time, the interbank market of Pakistan has experienced an unprecedented accumulation of excess liquidity. Empirical literature suggests that presence of excess interbank liquidity in developing economies often limits the ability of their central bank to effectively conduct monetary policy. This paper investigates the persistent presence of excess interbank liquidity, its causes, and its behavior in the interbank market of Pakistan. We use data from December 2005 to July 2011. The time and demand liabilities reported before December 2005 is inconsistent with the currently available information on these variables.

This paper statistically tests whether excess liquidity is a short-term phenomenon or a long-term phenomenon. In case of the former, effectiveness of the monetary policy is not undermined while in case of the latter it is weakened. The paper also analyzes the determinants of excess interbank liquidity in Pakistan, which are then separated into voluntary and involuntary liquidity components to study the behavior of excess liquidity in the interbank market.

The findings of this paper suggest that the presence of excess liquidity in interbank market of Pakistan is persistent. Moreover, our empirical investigation identifies a number of variables contributing to excess interbank liquidity, such as deficit financing, foreign currency deposits, discount rate, volatility in the overnight rate, and industrial production. Also, our results point to the deficit financing by the central bank and non-banks for explaining persistence in interbank liquidity.

The determinants of excess liquidity were then separated into voluntary and involuntary liquidity components. The key finding suggests that the interbank market in Pakistan has experienced a structural shift in June 2008. Before June 2008, low credit demand was driving (involuntary) excess liquidity holdings by banks. After June 2008, banks' precautionary investments in risk free securities drive their (voluntary) liquidity holdings.

This permanent shift of the banking sector towards holding government securities is not healthy for economy. Though our work does not deliberate on implication of increased risk free security holdings by banks on economic growth, we benefit from Mohanty et al. (2006). These authors note that developing countries with large fiscal deficit often increase local currency debt financing as a strategy to reduce government's exposure to foreign currency risks. However, this

strategy could have adverse implication if there is a structural shift in banks' behavior towards holding more risk free assets. These authors further argue that a large stock of government or central bank securities pushes up the risk premium on sovereign debt, and it could also lead to a sharp increase in the interest rate charged to private sector borrowers. Thus in the long run, the economy's ability to generate higher savings as well as to borrow from external sources at lower cost may deteriorate, which also may limits its ability to invest in human capital. Consequently, the overall developmental goal of the economy may suffer.

1. Introduction

Excess interbank liquidity is defined as the pool of reserves held by the commercial bank with the central bank, over and above the regulatory liquidity requirements.[1] The findings of Nissanke and Aryeetey (1998) and Agénor and Aynaoui (2010) suggest that excess interbank liquidity in developing economies often limits the ability of the central bank to effectively conduct monetary policy.

Several studies (including Agénor *et al*., 2004 and Saxegaard, 2006) investigate excess interbank liquidity by distinguishing between supply and demand components. The demand component reflects low demand for credit in the economy, while the supply component constitutes the part of excess liquidity that banks hold for precautionary reasons. Banks may be holding liquidity for precautionary reasons if the risk of default is likely to increase and this perceived default risk cannot be internalized by raising the risk premium on lending (Agénor *et al*., 2004). In addition, structural or cyclical factors may lead to precautionary liquidity accumulation. As will be discussed in more detail in Section 2.1, structural determinants include the presence of a large informal sector, inaccessibility of remote areas of the country, and a weak or inefficient payment system. Cyclical factors, such as fluctuations in foreign capital inflows, a change in inflationary expectations or government borrowing, may also cause banks to hold liquidity for precautionary reasons (Agénor and Aynaoui, 2010).

Central banks can design monetary policy more effectively if the cause of excess liquidity is known. For example, if excess liquidity is largely due to low credit demand expansionary monetary policy may not be very effective. Any attempt by the central bank to stimulate aggregate demand by relaxing monetary policy will only add to excess liquidity. Likewise, if the central bank would tighten its policies in the presence of excess liquidity, a sudden improvement in credit demand may cause a rapid increase in credit thereby undermining the central bank's policies.

This study examines the interbank market of Pakistan as a case study. In response to the recent global financial crisis, the State Bank of Pakistan (*henceforth* SBP) eased its policies. As will be explained in more detail in Section 2.2, the regulatory liquidity requirements have been relaxed frequently since June 2008 while the pool of securities that are eligible as reserves has

[1] Mishkin (2012).

been widened. These measures led to an unprecedented liquidity accumulation in the interbank market of Pakistan. The presence of excess interbank liquidity may weaken the monetary transmission mechanism as acknowledged in the State Bank of Pakistan (2011). We investigate the nature and causes of excess liquidity in the interbank market of Pakistan.

This study is innovative for two reasons. First, the study investigates the persistence of excess liquidity.[2] To the best of our knowledge, persistence of excess interbank liquidity has not been evaluated before using high frequency data. Second, the study defines interbank liquidity by augmenting it with government securities that are eligible to meet liquidity requirements. Mohanty *et al.* (2006) argue that banks' deposits at the central bank may be misleading as indicator of liquidity if the banks hold substantial amounts of government securities that can be sold easily to the central bank.

Our findings suggest persistence of interbank excess liquidity. Our results also indicate that the financing of the government's budget deficit by the central bank is one of the causes of this persistence in interbank liquidity. Moreover, we identify a structural shift in the interbank market in June 2008. Before June 2008, low credit demand was driving excess liquidity holdings by banks. After June 2008, banks' precautionary investments in risk free securities drive their liquidity holdings.

The remainder of the paper is structured as follows. The next section discusses the implications of excess liquidity for monetary policy and outlines monetary policy in Pakistan. Section 3 discusses previous studies, while Section 4 describes our methodology. Section 5 describes the data used and Section 6 offers our main results. Finally, Section 7 concludes.

2. Excess liquidity and monetary policy in Pakistan

Following Mohanty *et al*. (2006), we include government securities that are eligible in meeting regulatory liquidity requirements in calculating excess liquidity.[3] Thus we define excess liquidity as the ratio of reserves deposited with the central bank by the banks, cash in their vault and eligible government securities, in excess of the statutory limit to the total time and demand

[2] Fuhrer (2009) defines 'persistence' as a tendency of an economic variable not to change, in the absence of economic forces that could have move it elsewhere.

[3] Agénor *et al*. (2004), Ruffer and Stracca (2006), , Saxegaard (2006), and Gigineishvili (2011)use similar measures for excess liquidity but do not include short-term government securities.

liabilities of the banks.[4] We include eligible securities as the banking sector in Pakistan holds a considerable amount of highly liquid short-term government securities, which banks can substitute for cash using the SBP's discount window at their own discretion (Mohanty *et al*., 2006).

4.2.1 Excess liquidity and monetary policy

The SBP actively uses all policy tools at its disposal to manage liquidity. These policy tools are direct tools, such as cash reserve requirements and statutory liquidity requirements, and indirect tools, such as the discount rate and open market operations.[5]

If the SBP raises reserve or liquidity requirements, excess interbank liquidity decreases immediately, which in turn causes the interbank lending rate to increase. Subsequently, the lending and the deposit rates respond. If the central bank raises the discount rate, risk-averse banks are likely to increase their liquidity holdings to mitigate liquidity risk. Likewise, open market operations of the central bank will affect interbank liquidity.

Banks hold excess liquidity either due to low demand for credit (involuntary excess liquidity) or for precautionary reasons (voluntary excess liquidity). If firms' demand for credit declines due to weak economic activity banks accumulate excess liquidity. Alternatively, banks may hold liquidity as a precaution if the risk of default on extended credit is expected to rise. Moreover, structural and/or cyclical factors may promote precautionary liquidity holdings by banks. Often structural impediments like a less developed financial sector or a large informal sector force banks to hold extra liquidity. For example, banks tend to have greater demand for liquidity due to the unreliability of the payment system. Also, the cost of processing information, evaluating projects, and monitoring borrowers is relatively high in these economies, which generally leads to accumulation of liquidity (Agénor and Aynaoui, 2010). Similarly, the presence of a large informal sector promotes cash transactions instead of transactions through bank instruments like checks or bills in order to avoid taxes. The banks are then forced to hold large liquid reserves to meet frequent large demands for cash.

Cyclical factors refer to fluctuations in inflationary expectations, foreign capital inflows,

[4] The eligible assets include short-term market treasury bills, Pakistan Investment Bonds (PIBs) up to a certain maximum, and other government enterprise bonds.

[5] The SBP also frequently uses 'moral suasion', i.e., the commercial banks' executives are briefed on objectives of a specific policy move and the central bank's expectation of the market response.

and government borrowing.[6] Elaborately, a higher volatility in prices increases uncertainty about the value of the collateral pledged by the borrower. The banks may react to inflation risk by charging a higher premium to the borrower or by increased rationing of credit. Agénor and Aynaoui (2010) argue that both an increase in the risk premium and credit rationing may result in the involuntary accumulation of excess liquidity.

Furthermore, in the past two decades, foreign capital inflows have contributed significantly to the accumulation of excess liquidity in developing economies (Ganley, 2004; and Agénor and Aynaoui, 2010). Irrespective of the presence of a pegged or a managed float (or a crawling peg) regime, capital inflows add to excess interbank liquidity. Under a pegged exchange rate regime, foreign capital inflows cause upward pressure on the nominal exchange rate which may lead to central bank foreign exchange interventions. If the central bank sterilizes these interventions by selling securities to the banks, excess liquidity holdings of the banks increases. The situation is not very different under a managed float regime, except that here the central bank always intervenes to maintain the exchange rate within the targeted range.

Finally, government borrowing from the central bank may act as a catalyst regarding excess interbank liquidity accumulation. In developing economies, often the government borrows directly from the central bank. This borrowed money enters in the monetary system very quickly in the form of deposits at banks and hence becomes part of the money supply (see Table A1 in Appendix for an overview of Pakistan's recent monetary developments)[7]. For this reason, the government borrowing from the central bank is generally known as monetization of the deficit.[8] The increase in deposits leads to excess liquidity holding of the banks. Ganley (2004) notes that the monetization of the deficit is one of the main sources of excess liquidity in some developing countries.

Persistent fiscal deficits may also increase the interest rate on the government debt. The higher return may attract the banks towards risk free government securities. Mohanty *et al*.

[6] See Agénor and Aynaoui (2010) for further details.

[7] When government borrows from the central bank, the central bank's assets increase in the form of government security. In exchange of those securities, the central bank increases government deposits held with the central bank. When government pays for goods and the services, the individual's deposits at the banks increases at the expense of the government's deposit at the central bank. Thus the central bank's liability with the banks increases as a result of government asset held by the central bank. The increased deposit base increases money supply. Table A1 in appendix briefly presents the overview of this mechanism.

[8] This monetization may have inflationary consequences (De Haan and Zelhorst, 1990; Fischer *et al*. 2002; and Catao and Terrones, 2005).

(2006) argue that inflationary expectations fuelled by government borrowing may further increase the interest rates. In such a high interest rate environment, the banking sector may structurally shift towards holding more risk-free assets, thereby crowding out private sector debt.

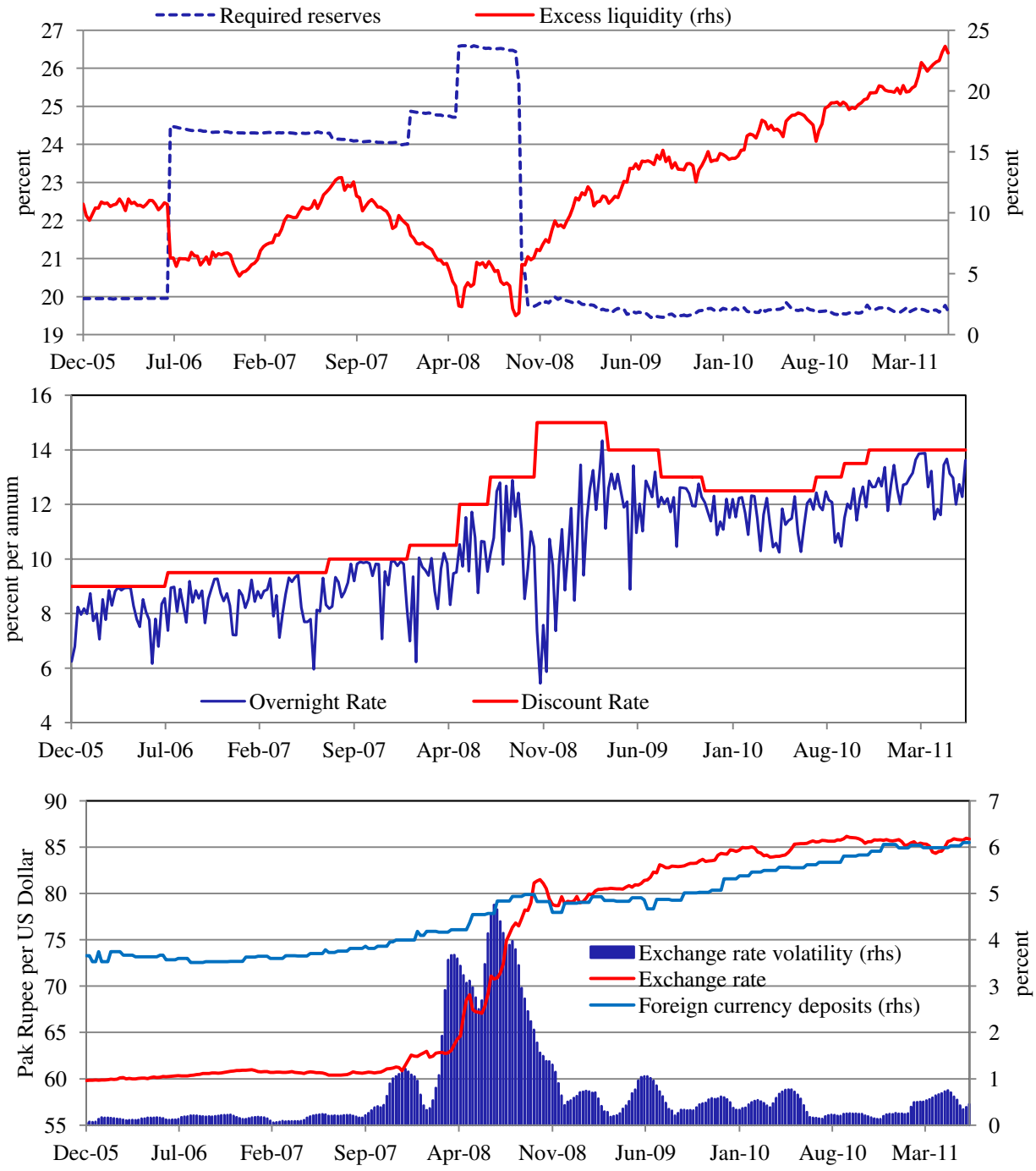
2.2 Recent developments in monetary policy in Pakistan

Two important features characterize the period under consideration in this study. First, the foreign currency deposits steadily increased over this period, specifically after May 24th 2008, when the exchange rate depreciated sharply (see the lower panel in Figure 1). Pak Rupee depreciated against US Dollar by almost 7- percent in May 2008 due to speculative attack. Resident foreign currency deposits[9] are deposits denominated in foreign currency held by individuals or firms with local banks, independent of the nationality or residential status of the holder.[10] As regulatory requirements limit the local banks' access to the international market, banks often substitute the foreign currency for domestic currency to invest in the local money market.

The SBP has a managed float strategy to mitigate exchange rate volatility and to alleviate perceived exchange rate risk. To stabilize the exchange rate, the SBP replaces the foreign exchange inflows with domestic currency, either through direct purchases, or through currency swaps.[11] The interventions in the exchange rate market thus increase interbank liquidity. The banks prefer placing this liquidity in the form of short-term risk-free securities as financial markets in Pakistan lack financial depth.

[9] Residence Foreign Currency Deposits generally known as RFCD.
[10] Vide F.E. Circular No. 25, 20th June 1998, State Bank of Pakistan.
[11] The substitution of foreign currency by domestic asset involves exchange rate risk. The SBP's managed float strategy does not mitigate the exchange rate risk completely. To mitigate the exchange rate risk, banks use currency swaps with the central bank and also with peer banks.

Figure 1. Excess Liquidity, Interest Rates and Exchange Rate



On May 24th 2008, the SBP further tightened its policies using both direct and indirect tools. As a result, the effective reserve requirements reached 26.5 percent of time and demand liabilities of the banks, the highest the banking sector of Pakistan has witnessed over the last decade.[12] The SBP relaxed this requirement at the start of the global financial crisis. In October 2008, the requirements were brought down twice with 100 bps. However, the SBP continued its tight monetary policy stance using the discount rate (see Table 1 for details).

Table 1. Chronology of Changes in Policy Instruments

Date	Cash reserve requirements				Liquidity requirements		Discount rate
	Demand liabilities		Time liabilities		Demand liabilities	Time liabilities	
	Weakly average	Daily minimum	Weakly average	Daily minimum			
31-Dec-05	5.0	4.0	5.0	4.0	15.0	15.0	9.0
22-Jul-06	7.0	4.0	3.0	1.0	18.0	18.0	
29-Jul-06							9.5
19-Jan-07	7.0	6.0	3.0	2.0			
1-Aug-07							10.0
4-Aug-07	7.0	6.0	0.0	0.0	18.0	18.0	
2-Feb-08	8.0	7.0					10.5
24-May-08	9.0	8.0			19.0	19.0	12.0
30-Jul-08							13.0
11-Oct-08	8.0	7.0					
18-Oct-08	6.0	5.0					
1-Nov-08	5.0	4.0					
13-Nov-08							15.0
21-Apr-09							14.0
15-Aug-09							13.0
25-Nov-09							12.5
2-Aug-10							13.0
30-Sep-10							13.5
30-Nov-10							14.0

Second, during this study period monetary policy was tightened as the discount rate mostly moved upward (see the panel in the middle of Figure 1). Table 1 details the various policy steps of the SBP. First, on 22nd July 2006 all savings deposits were classified as demand liabilities. Other notable changes include the re-classification of special notice deposits and time

[12] The effective reserve requirements for any given week is the weighted average of the cash and liquidity reserve requirements based on their respective time and demand liabilities.

deposits of less than 6 months from time liabilities to demand liabilities. The re-classification was extended to time deposits of up to 12-month maturity on 4th August 2007. In tandem, reserve requirements were increased on demand liabilities but relaxed on time liabilities (see Table 1). These measures increased the effective reserve requirements to more than four percent of time and demand liabilities, i.e. PKR 12.7 billion (see the upper panel in Figure 1). As will be explained in more detail below, the SBP aimed to push the sticky deposit rate upward. The SBP also wanted to reduce the maturity mismatch between the assets and the liabilities of the banking sector and therefore time liabilities are exempted from cash reserve requirements since August 4th 2007.[13]

On October 18th 2008, the SBP increased the eligibility of long-term government bonds from 5- to 10- percent of the statutory liquidity requirements.[14] The move increased the borrowing ability of banks from the SBP's discount window by roughly PKR135 billion thereby increasing excess liquidity holdings of the banks substantially. As the literature shows that the long-term presence of excess liquidity weakens the monetary policy, it is therefore important to investigate if these policy moves by the SBP have created persistence (long-term presence) in excess liquidity present in the interbank market of Pakistan. Moreover, investigation leading to the causes of liquidity accumulation in the interbank market of Pakistan could be an important contribution in understanding the dynamics banks' behavior in interbank market and effectiveness of monetary policy.

3. Related studies

The economic literature on interbank liquidity is mostly theoretical, striving to model the banks' behavior and/or the central bank's policy response when the interbank market suffers from adverse liquidity shocks, be it aggregate or idiosyncratic shocks. Bhattacharya and Gale (1987), Freixas and Holthausen (2005), Heider *et al*. (2010), and Allen *et al*. (2009) examine the banks' behavior in case of aggregate shocks, while Bolton *et al*. (2009), Acharya *et al*. (2012), Diamond and Rajan (2009), and Freixas *et al*. (2011) focus on scenarios in which banks suffer from idiosyncratic shocks. However, only a few studies examine interbank liquidity in normal times.

[13] The State Bank of Pakistan (2006) identifies the following objectives of these changes in the reserve requirements: (i) draining excess liquidity from the inter-bank market, in order to put upward pressure on the money market rates; and (ii) encouraging banks to mobilize long-term deposits.
[14] See Vide BSD Circular No. 24 of 2008, State Bank of Pakistan.

Wyplosz (2005) examines the accumulation of excess liquidity in the Eurozone before the crisis, arguing that this buildup was due to deficient borrowing resulting from weak growth prospects. Agénor *et al*. (2004) analyze the buildup of excess liquidity in the interbank market of Thailand during the East Asian crisis. Their results also suggest that the increased excess liquidity by banks reflected weak credit demand in the wake of the crisis. Likewise, based on a survey among central banks of developing and emerging economies, Mohanty *et al*. (2006) argue that the buildup of excess liquidity in the last decade was due to weak credit demand from the business sector.

Surprisingly, there is little work formalizing the channels through which excess liquidity impacts the monetary transmission mechanism. Saxegaard (2006) examines excess liquidity in sub-Saharan Africa and its consequences for the effectiveness of monetary policy. He quantifies the impact of excess liquidity using impulse responses from threshold VAR models. The study suggests a weakening of the monetary policy transmission mechanism in the presence of excess liquidity.

More recently, Agénor and Aynaoui (2010) provide a theoretical framework for modeling excess liquidity in a general equilibrium setup. They argue that excess liquidity may hamper the ability of monetary policy makers to lower inflation. Their model shows that excess liquidity induces easing of collateral requirements on borrowers, which in turn may translate into a lower risk premium and lower lending rates, thus resulting in asymmetric bank pricing behavior. To the best of our knowledge, excess liquidity in the interbank market of Pakistan has not been studied earlier.

4. Methodology

We first use unit root tests to examine the data generating processes of the variables used in the analysis. If excess liquidity is stationary in levels, we see interbank liquidity accumulation as a short-term phenomenon not hampering monetary policy. If excess liquidity has a difference stationary data generating process, we see liquidity accumulation as a long-term phenomenon which may have serious repercussions for the effectiveness of monetary policy as discussed in Section 1. Next, we investigate the long- term determinants of excess interbank liquidity, distinguishing between voluntary and involuntary liquidity holdings.

4.1 Persistence of interbank liquidity

In generalized form, an augmented unit root process can be described by

$$\Delta y_t = \mu_0 + \mu_1 \tau + \rho y_{t-1} + \sum_{p=1}^{k-1} \gamma \Delta y_{t-i} + \varepsilon_t \qquad (1)$$

where y_t is the series to be tested, τ is the deterministic trend, μ_0 and μ_1 are parameters, while ρ and γ are the coefficients of the unit root and the lagged dependent variable respectively, and ε_t is the error term (for details, see Enders, 2004; Hamilton, 1994). Empirical studies frequently use the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. However, the performance of these tests deteriorates significantly in the presence of structural changes (Perron, 1989). As policy variables, such as the discount rate and required reserves, are subject to policy shocks (see Figure 1), we therefore will want to use unit root tests also for structural breaks.

The literature proposes a number of unit root tests incorporating structural breaks (e.g., Perron 1989, 1990; Zivot and Andrews, 1992; Perron and Vogelsang 1991, 1992; and Ng and Perron, 2001).[15] Shresta and Chowdhury (2005) argue that the power of the Perron and Vogelsang (1992) test is superior in the presence of a structural break, while Enders (2004) argues that the Perron-Vogelsang test is more appropriate in case of an uncertain break date. Table 1 and Figure 1 suggest a number of policy shifts during the period under consideration in this study. If an economic series experiences more than one structural shift, Ben-David *et al*. (2003) argue that the power of the unit root test with one structural break reduces significantly. Figure 1 shows that the some variables may have suffered from more than one shift.

We employ the unit root test with two breaks as suggested by Clemente *et al*. (1998), which is an extension of the Perron and Vogelsang (1992) test with one structural break.[16] This class of unit root tests distinguishes two types of outliers: an additive outlier and an innovative outlier. The additive outlier test best suits to series exhibiting a sudden change in mean, while the innovative outlier test assumes that the change takes place gradually. As the power of these tests improves considerably if the break points are known *a priori,* often the tests employ grid search to locate the break points. For simplicity, assume that the breaks occur at an unknown date,

[15] For empirical studies of unit root tests with structural breaks, we refer to Banerjee *et al*. (1992), Christiano (1992), De Haan and Zelhorst (1994), Perron (2005), Glyn *et al*. (2007), and Carrion-Silvestre *et al*. (2009).

[16] If the test of Clemente *et al*. (1998) suggests both structural shifts are significant we keep this result. However, if this test finds only one significant structural shift we employ the Perron and Vogelsang (1992) test.

$1<T_{b1}<T_{b2}<T$ with T being the sample size. The additive outlier test follows a two-step procedure. First, the deterministic part of the series is filtered using

$$y_t = \mu + \delta_1 DU_{1t} + \delta_2 DU_{2t} + \tilde{y}_t, \tag{2}$$

where break dummies $DU_{mt}=1$ for $t>T_{bm}$, and 0 otherwise, for *m = 1, 2*, and the remaining noise $\tilde{y}_t$ is examined for a unit root

$$\Delta\tilde{y}_t = \sum_{i=1}^{k}\theta_{1i}D(T_{b1})_{t-i} + \sum_{i=1}^{k}\theta_{2i}D(T_{b2})_{t-i} + \rho\tilde{y}_{t-1} + \sum_{i=1}^{k}\gamma_i\Delta\tilde{y}_{t-i} + e_t, \tag{3}$$

The change in the break dummy $D(T_{bm})_{t-i}=1$ if $t=T_{bm}+1$ and zero otherwise, while *k* is the truncated lag parameter determined by a set of sequential F-tests.

The innovative outlier model assumes that an economics shock to a trend function of a variable affects the subsequent observations. Starting from its initial position the shocks propagates to the subsequent observations through the memory of the system. The estimation strategy is based on;

$$y_t = \mu_0 + \delta_1 DU_{1t} + \delta_2 DU_{2t} + \theta_1 D(T_{b1})_t + \theta_2 D(T_{b2})_t + \rho y_{t-1} + \sum_{i=1}^{k}\gamma_i\Delta y_{t-i} + e_t \quad . \tag{4}$$

$$y_t = \mu + \phi(L)(e_t + \delta_1 DU_{1t} + \delta_2 DU_{2t}), \tag{5}$$

In Equations (2) and (4), δ_i measures the immediate impact of the changes in mean. The innovative outlier test can identify the long-run impact of changes by the design of its alternative hypothesis. Here, L is the lag operator $Ly_t = y_{t-1}$. The first lag $\delta\phi(1) = (\delta_1 DU_{1t-1} + \delta_2 DU_{2t-1}) + e_{t-1}$ in Equation (5) picks up the long-run effect. Both models test the null hypothesis of a unit root, that is $\rho=1$. The limiting distribution of these test statistics does not follow the Dickey–Fuller distribution and Perron and Vogelsang (1992) and Clemente *et al*. (1998) provided the critical values respectively for one and two structural breaks. If $\rho<1$, the null hypothesis is rejected and series is stationary. Clemente *et al*. (1998) collapses to Perron and Vogelsang (1992) test when restriction *m=1* i.e. only one break is imposed on the former.

4.2 Long-term determinants of excess liquidity

To identify the long-term determinants of excess liquidity in Pakistan, we utilize the methodology proposed by Agénor *et al*. (2004), augmented by Saxegaard (2006). Equation (6) presents excess liquidity with its voluntary and involuntary determinants.

$$\alpha_1(L)EL_t = \alpha_2(L)X_t^1 + \alpha_3(L)X_t^2 + v_t \tag{6}$$

where, $\alpha_j(L)$ are lag polynomials, EL_t is the ratio of excess reserves to total deposits, X_t^1 and X_t^2 are vectors of variables that explain voluntary and involuntary excess liquidity holdings, respectively, and v_t is an error term. Any structural break can be included as a trend component in the model.

The vector X_t^1 includes variables such as required reserves, discount rate, output gap, volatility in the overnight rate, volatility in the government borrowing from the SBP, and foreign currency deposits. Any change in the policy tools (required reserves and the discount rate) has a direct impact on excess liquidity in the interbank market. The output gap captures demand for cash.[17] The volatility of the overnight rate is an indicator of interbank liquidity risk. The more the overnight rate is volatile, the more the bank will be cautious in managing its liquidity holdings. Volatility in government borrowing from the SBP also increases volatility of the current deposits with the banks and hence banks may become more vigilant in managing their precautionary liquidity holdings. Foreign currency deposits are included to capture exchange rate risk. As discussed earlier in Section 2, the banks in Pakistan substitute foreign currency assets for domestic government securities. Typically, such substitution involves exchange rate risk. The managed float strategy practiced by the SBP reduces the volatility in the exchange rate and hence partially mitigates the exchange rate risk. However, foreign currency deposits are denominated in foreign exchange and any sudden speculative withdrawal of foreign currency deposit may expose banks to exchange rate risk.

Agénor *et al*. (2004) propose to derive the determinants of involuntary excess liquidity X_t^2, as a residual from Equation (6), when this equation includes only voluntary liquidity

[17] Arguably, the output gap should be the part of the involuntary liquidity accumulation as it captures the fluctuation in credit demand. However, following Saxegaard (2006) we include it as a determinant of voluntary liquidity accumulation. Saxegaard (2006, p. 21) argues: "We also include the output gap Y (in voluntary liquidity) to proxy for demand for cash. In particular, in a cyclical downturn one would expect the demand for cash to fall and commercial banks to decrease their holdings of excess reserves.". We will deliberate further on this issue in Section 6.2.

accumulation factors, X_t^1. This approach, however, inherently minimizes involuntary excess liquidity X_t^2. To overcome this drawback, Saxegaard (2006) proposes augmenting the approach of Agénor *et al*. (2004) with variables that are important in the buildup of involuntary excess liquidity. Since involuntary accumulations are driven by a deficient private sector credit demand, Saxegaard (2006) proposes to include a large number of macroeconomic factors as explanatory variables for X_t^2. Following Saxegaard (2006), we include credit to the private sector, credit to the government (by the SBP, commercial banks and the non-banking sector), Index of Industrial Production (IIP) indicating the level of economic activity, and the exchange rate as explanatory variables in X_t^2.

Private sector credit is negatively related to excess liquidity. Any increase in private sector credit decreases excess liquidity holdings of the banks. The impact of government borrowings from the SBP, the commercial banks, and the non-banks on excess liquidity may differ. Government borrowing from the central bank leads to the creation of new deposits. When the government borrows from the central bank, the central bank increases the government's deposit with the central bank. As the government makes payments for the goods and services it has acquired, the increase of the deposit rapidly increases the monetary base. Table A1 in Appendix shows that impact of the government borrowing on assets and liabilities of the banking sector. Thus the government borrowing from the central bank increases the excess liquidity holding of the banks through increase in the banks' deposits. Ganley (2004) suggests that borrowing from the central bank is the main source of excess interbank liquidity in many countries. We therefore expect that government borrowing from the SBP will have a positive effect on excess liquidity. Borrowing from non-banks involves a transfer of funds from the banks to the non-bank institutions and hence it should affect excess interbank liquidity negatively.

When a government borrows from commercial banks, the excess reserves of the banks with the central bank are transferred to the government account. As the government makes payments for the goods and services it acquires, the borrowed amount gets transferred quickly from the government account to the accounts of individuals or private businesses thus replenishing the liquidity holdings of the banks. Therefore, government borrowing from the banks is not expected to have any impact on excess liquidity as the assets and liabilities of the banking sector remains unchanged (see Table A1 in Appendix).

An increase in the level of economic activity, as captured by the Index of Industrial Production, is likely to increase the money demand in the economy which in turn increases the liquidity holdings of banks. We expect a positive relation between increased industrial production and excess liquidity. Similarly, when the Pakistan Rupee depreciates the foreign currency liabilities of the banks will increase. Therefore, banks are likely to switch their excess liquidity with foreign currency assets. Hence, we expect exchange rate movements to have a negative effect on excess liquidity.

Separation of the voluntary and involuntary components of liquidity in the framework of Equation (6) requires identification of the intercept and the lagged dependent variable. This can be explained as follows. Rewriting Equation (6) gives:

$$EL_t = [a^s + (1-a^s)]\hat{c} + (\alpha_1^s + \alpha_1^d)EL_{t-p} + (L)X_t^1 + \alpha_3(L)X_t^2 + v_t \qquad (7)$$

where $\hat{c}$ the intercept and p is the number of lags associated with the dependent variable. In Equation (7), the intercept has a voluntary component a^s and an involuntary component $(1-a^s)$ which are indistinguishable. Similarly, the voluntary α_1^s and involuntary α_1^d parts of the lagged dependent variable are also inseparable. As we are interested in the long-run relationship and the long-run coefficients estimation uses the lagged dependent variable EL_{t-p} Therefore, separate values of α_1^s and α_1^d is not necessary. However, identification of the intercept is required. Ideally, we would like to have information on the banks' precautionary reserves on a weekly basis. As this information is not available, we use the minimum average cash reserves held by the banks above statutory requirements, in any given week, as a proxy for the precautionary liquidity holdings intercept a^s. We assume that the minimum amount of cash reserves held by the banks is the 'mean' of precautionary liquidity holding. Since the intercepts refer to levels, they will not impact estimates of the variation in voluntary or involuntary components of liquidity.

As will be discussed in Section 6, some explanatory variables are difference stationary. Therefore, we will use the Bound Testing Approach proposed by Pesaran *et al*. (2001) for identification and the Autoregressive Distributed Lag (ARDL) approach for estimation of the long-run relationship between the levels of the variables.

Compared to other procedures for detecting long-run relationships, such as Johansen's rank test, the Bound Testing procedure has two distinct advantages. First, it does not require

testing the data generating processes of the underlying series and remains applicable even if regressors are a mixture of I(0) and I(1) variables. Second, it allows a large number of explanatory variables, as in Equation (6), which involves in our application thirteen regressors and their lags. The Bound Testing procedure employs a generalized Dickey–Fuller type regression and tests the significance of the lagged level of the variables in a conditionally unrestricted error correction model (ECM)

$$\Delta EL_t = \mu_0 + \mu_1 \tau + \pi_{EL} EL_{t-1} + \pi_x^{'} x_{t-1}^{j} + \sum_{k=0}^{n} \gamma_k^{'} \Delta x_{t-1}^{j} + \sum_{k=1}^{n} \delta_k^{'} \Delta EL_{t-1} + u_t \,, \tag{8}$$

where x_t^j indicates j^{th} regressor, μ_0 and μ_1 are trend parameters, $\gamma_k^{'}$ and $\delta_k^{'}$ are short run regressor parameters, u_t is the error term, and π_{EL}, and π_x are long-run parameters, the joint significance of which is tested using an F-test. The asymptotic distribution of the F-statistic is non-standard. Pesaran *et al*. (2001) provide two sets of asymptotic critical values for the upper and lower bounds for the F-statistic. The upper bound assumes that all regressors are I(1), while the lower bound assumes all are I(0). The F-test has the null hypothesis that there exists no long-run relationship between the variables, i.e. $\pi_{EL} = \pi_x = 0$. If the F-statistic falls outside the upper bound, the null hypothesis of no long-run relationship is rejected indicating that the regressors are forcing a long-run relationship on the dependent variable.[18] However, if the F-statistic falls within the bounds information on the order of integration of the underlying variables is essential to draw conclusions.

The long-run relationship.is estimated from the ARDL equation,

$$EL_t = \mu + \sum_{j=1}^{m} \sum_{k=0}^{n} \psi_k^j x_{t-k}^j + \sum_{k=1}^{n} \alpha_k EL_{t-k} + \varsigma_t \qquad . \tag{9}$$

Here x_t is the set of regressors, $\psi^j{}_k$ are coefficients for any j^{th} regressor at lag *k*, α_k reflects the stickiness in the dependent variable at lag '*k*'. Starting with a maximum number of lags, a general to specific approach is used to adopt a parsimonious model with white noise residuals. We employ a battery of diagnostic tests to check the robustness of the specified model.[19]

[18] Bound tests assume only one cointegrating relationship exist where weakly exogenous dependent variable forces a long-run relationship on the dependent variable. This method of detecting a long-run relationship remains valid even in presence of more than one long-run relationship. Next paragraph further discusses this issue.

[19] For example, we test for serial correlation with the Breusch-Godfrey test and/or Portmanteau (Q) test. The Breusch-Godfrey test is useful in testing low order autocorrelation, whereas the Portmanteau (Q) tests works better for higher order autocorrelation (Lütkepohl and Kratzig, 2004, p -129). Both tests take no serial correlation as the

Like other single equation cointegration procedure, ARDL also presumes only one long-run relationship; from regressors to the dependent variable. When development in the explanatory variable drives the changes in the dependent variable in presence of only one cointegrating vector, then explanatory variables may be termed as weakly exogenous to the system (Kirchgässner and Wolters, 2007 p-207).[20]However, if the dependent variable also forces a long-run relationship on one or more of the regressors, then assumptions that there exists only one cointegrating vector and the regressors are weakly exogenous are violated. In that case, the coefficient estimates obtained from the ARDL model are not efficient.[21] However, they remain asymptotically consistent and can be used for making inferences (Harris, 1995).

We use the Bound Test for establishing the weak exogeneity of regressors. Each regressor is used as a dependent variable to test for the existence of a long-run relationship with excess liquidity. If the F-statistic does not reject the null hypothesis of no long run relationship between the variables, the regressor can be considered weakly exogenous for the relationship specified in Equation (9).

The long-run relationship is obtained from the ARDL estimates of Equation (9). For this purpose, the lagged dependent variable is used as shown in Equation (10). Hence, lag dependent variable is not required to be identified with the voluntary or involuntary components, as discussed earlier.

$$\hat{\beta}_i = \frac{\sum_{k=0}^{n} \hat{\psi}^{j}{}_{k}}{1 - \sum_{k=1}^{n} \hat{\alpha}_k} \quad . \tag{10}$$

Using information on 'excess cash reserves' holdings (a^s) and the long-run estimates using Equation (10), the 'voluntary' (EL^s) and the 'involuntary' (EL^d) component of excess

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null hypothesis. Normality of the residuals is tested using the Shapiro-Wilk test with normally distributed residuals as the null hypothesis. For checking the stability of the specified model, CUSUM and CUSUMSQ tests, proposed by Brown *et al*. (1975) are used. The CUSUM test uses cumulative sums of recursive residuals based on the first *n* observations, which are updated recursively and plotted against the break points. If the plot of the CUSUM statistics stays within the 5 percent significance level, the coefficient estimates are said to be stable. CUSUMSQ applies a similar procedure, but is based on the squared recursive residuals.

[20] Also, Kirchgässner and Wolters (2007, p-225) defines weak exogeneity as;

A variable is weakly exogenous with respect to the cointegration parameters if and only if no (other) cointegrating relation is included in the equation of this variable. (Text in parenthesis added for clarity).

[21] Harris (1995) notes that;

Assuming that there is only one cointegrating vector, when in fact there are more, leads to inefficiency in the sense that we can only obtain a linear combination of these vectors when estimating a single equation model.

liquidity can be calculated, as shown by Equation (11).

$$EL_t^s = a^s \hat{c} + \hat{\alpha}_2(L) X_t^1 \tag{11}$$

$$EL_t^d = (1 - a^s)\hat{c} + \hat{\alpha}_3(L) X_t^2 + v_t.$$

5. Data

We use weekly data from the last week of December 2005 to the first week of July 2011. The SBP reports net time and demand liabilities in a new format since the last week of December 2005, excluding Islamic banks and foreign currency liabilities from net time and demand liabilities. Previously, Islamic banks and foreign currency liabilities were not clearly identified. Hence, excess liquidity calculated using recent information is not consistent with excess liquidity based on figures before December 2005. Unfortunately, net time and demand liabilities do not include foreign currency deposits held by banks. Foreign currency asset and liability holdings of the banks are accounted separately and are subjected to different prudential requirements. However, compared to the total demand and time liabilities the magnitude of foreign currency deposits is small.

We employ weekly data as it helps in maintaining sufficient degrees of freedom which is important as our specification involves a large number of explanatory variables and their lags. Using weekly data has a serious drawback too. Some explanatory variables are reported on a monthly basis. Fortunately, the specification used in this study involves only two variables with a monthly frequency, namely the index of industrial production, and government borrowing from non-banks. We disaggregate them into weekly data using forward moving averages over 6-weeks as the series obtained using as this procedure yields least mean error.[22] Table A2 in the appendix provides further details of the variables used in this study.

For estimating the output gap, we employ the Hodrick-Prescott (HP)-filter to the index of industrial production since GDP is only available on a yearly basis.[23] The output gap is measured as the gap between the HP trend and the actual level of output at any given time. Further details are provided in Office for Budget Responsibility (2011). The volatilities of the overnight rate and

[22] Forward moving average is based on, $n_t = \frac{1}{6}\sum_{i=1}^{6} n_{t+i}$, where n_t indicates any specific week at time t.

[23] We have used (λ=*270,400*) but following Ravn and Uhlig (2002)'s recommendation to use (λ= *45,697,600*) gave similar de-trended series. See Figure A1 in Appendix for the comparison of the two series obtained using the above values of λ.

of government borrowing from the SBP are calculated as ratios of standard deviation to the average over a moving 13- week period. The effective reserve requirements for any given week is the weighted average of the cash and liquidity reserve requirements based on their respective time and demand liabilities.

6. Results

6.1 Unit root tests

The results for the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) unit root tests are reported in Table A3 (in the Appendix). Except for the output gap and the volatility of the government borrowing from the SBP, all variables appear difference stationary at the five percent level of significance. Figure 1 shows sharp shifts in the policy variables, which may have caused loss in power of PP or ADF unit root tests, as discussed in Section 1. Therefore, the difference stationary variables are subjected to the unit root test proposed by Clemente *et al*. (1998), which allows for two structural breaks. This test also helps in identifying whether there are one or two structural breaks. If the test of Clemente *et al*. (1998) suggests two significant structural shifts we retain the test results, but if this test suggests only one significant structural shift we employ the Perron and Vogelsang (1992) test with one structural break.

The results for the unit root test with structural breaks are reported in Table 2. Except for excess liquidity and some GDP normalized macroeconomic variables (such as private credit, foreign currency deposits, government borrowing from banks and non-banks) all variables are level stationary with significant breaks. The identified break dates are in the vicinity of the various policy moves of the SBP as described in Table 1. For example, unit root test with discount rate shows that the series suffered a structural break on May 10 2008, while the SBP increased the discount rate by 150 bps on May 23rd 2008.[24]

[24] Only those break dates should be taken into account for which the null hypothesis of unit root is rejected. In other words, even if AO and IO tests shows different no of breaks, the difference in the number of break dates is not important if only one test rejects the null hypothesis of unit root.

Table 2. Results for Unit Root Tests with Structural Breaks

	Additive Outlier Test			Innovative Outlier Test		
	Test stats.	No. of breaks	Break dates	Test stats.	No. of breaks	Break dates
Excess liquidity	-2.841	2	28-03-09, 08-05-10	-2.585	2	19-01-08, 4-10-08
Required reserves	-4.187	2	17-05-08, 25-10-08	-9.530*	2	10-05-08, 04-10-08
Discount rate	-1.842	2	12-07-08, 01-08-09	-5.447*	1	10-05-08
Private credit	-3.068	2	24-11-07, 13-06-09	-3.504	2	19-09-07, 14-03-09
Foreign currency deposits	-1.909	2	03-05-08, 02-01-10	-3.329	2	12-01-08, 12-12-09
Exchange rate	-2.222	2	19-07-08, 08-08-09	-6.292*	2	05-04-08, 14-06-08
Government borrowing from:						
Commercial banks	-1.428	2	24-03-07, 22-08-09	-0.539	-	
SBP	-3.076	2	12-01-08, 14-06-08	-4.579*	1	11-10-07
Non-banks	-0.796	2	05-05-07, 06-03-10	0.217	1	12-12-09
			**5% Critical Values*			
2-breaks	*-5.49*			*-5.49*		
1-break	*-3.56*			*-4.27*		
			***10% Critical Values*			
2-breaks	*-5.24*			*-5.24*		
1-break	*-3.22*			*-3.86*		

Notes: Only difference stationary variables in ADF or PP test are subjected to unit root tests with structural breaks. No. of breaks shows the significant breaks at the five percent significance level, suggested by the unit root tests. 2 breaks the statistics refer to the test proposed by Clemente *et al*. (1998), while 1 break indicates that the test statistics refer to the test proposed by Perron and Vogelsang (1992). The null hypothesis assumes that series has a unit root. Break dates are identified by the unit root tests. Break dates should be read as week ending on day-month -year (*dd-mm-yy*).

As the difference stationary behavior of excess liquidity is directly related to the effectiveness of monetary policy, it is investigated thoroughly. In a competitive market, banks are expected to respond to policy shocks by changing their liquidity holdings; they increase liquidity holdings when monetary policy is lax and decrease them when it is tight. The estimates reported in Table 2 shows that the null hypothesis of unit root excess liquidity cannot be rejected at 5- percent level of significance. It is possible that excess liquidity has more than two structural shifts. Though, the power of the test proposed by Clemente *et al*. (1998) in the presence of more than two structural shifts may be low, leading to non-rejection of the unit root null hypothesis even if this series is stationary. To be certain about the integrated behavior of excess liquidity, we utilized rigorous tests as proposed by Carrion-i-Silvestre *et al*. (2009) incorporating up to five

structural breaks. These authors have adopted a variety of tests, including a DF type test with structural breaks proposed by Harris *et al.* (2009) for designing unit root tests that can accommodate up to 5- structural breaks. The null hypothesis of a unit root of these tests cannot be rejected confirming integrated behavior of excess liquidity. For example, the calculated the DF test statistics (-4.32) provided by Carrion-i-Silvestre *et al*. (2009) is lower than that of its 5-percent critical value (-4.56).

The unit root characterization of the data generating process of excess liquidity suggests that the variable has infinite memory and any shock to the series persists forever. This result confirms the long-term presence of excess liquidity in the interbank market of Pakistan which may be detrimental to the conduct of the monetary policy. The persistence of interbank liquidity may have resulted from policy surprises (as shown by Figure 1) during the period under consideration. Findings of Rubina and Shahzad (2011) suggest that monetary policy of the SBP is often inconsistent and non-transparent so that markets only slowly learn the true intentions of the monetary authorities. Westelius (2005) argues that such a learning process creates persistence.

6.2 Analysis of long-run relationship

As discussed in Section 2, we use the Bound Test Approach for testing the existence of a long-run relationship as the specification involves variables that are I(0) and I(1). Although the unit root tests have identified structural shifts in most explanatory variables, we did include the shift dummies but they turned out to be insignificant. A maximum of five lags is imposed for all estimation purposes to obtain reasonable degrees of freedom as the model has a large number of regressors.

Table 3 shows the F-statistics for the joint significance of the error correction term of the Bound test.[25] The F-statistic (3.45) for excess liquidity is greater than the five percent critical value indicating that the regressors are forcing a long-run relationship on excess liquidity. To determine whether the regressors are weakly exogenous, separate Bound tests have been conducted, using each regressor in Equation (6) as a dependent variable. The significant F-

[25] Pesaran *et al.* (2001) have provided critical values only up to ten variables whereas our model includes 12 explanatory variables. The table with critical values provided by Pesaran *et al.* (2001) shows that the critical value generally decreases with the increased number of regressors. Hence, our inference is probably not affected.

statistics for required reserves, the exchange rate, and the volatility in government borrowing from the SBP suggest that these regressors are not weakly exogenous.

Table 3. Testing for, and Estimation of Long-run Relationship for Interbank Liquidity

	F-Statistics	**Long-run relationship**	
		Coefficient	***p*-values**
Excess liquidity	3.45**		
Required reserves	4.39***	-1.357	0.000
Output gap	2.15	-0.366	0.000
Discount rate	2.36	0.863	0.021
Exchange rate	3.14*	-0.885	0.000
Volatility of overnight rate	2.61	0.055	0.426
Private credit	2.07	-0.799	0.000
Index of Industrial Production	2.04	0.392	0.000
Foreign currency deposits	1.48	5.796	0.003
Volatility in government borrowing from SBP	3.34**	-0.119	0.073
Government borrowing from			
SBP	2.88	0.657	0.002
Commercial banks	2.53	1.147	0.000
Non-banks	1.28	-0.374	0.005
Intercept		16.269	0.133
Critical values for I(1) Boundary[1]	*F-Statistics*		
1%	3.86		
5%	3.24		
10%	2.94		

Notes: The second column shows the results of the bound test, as well as, the weak exogeneity test for the regressors. Pesaran *et al.* (2001) only provide critical values for 10 variables; the data period includes 289 observations. ***, ** and * indicate significance at the 1, 5 and 10% level. The last two columns show the estimates of the long-run relationship between excess liquidity and the regressors and the relevant *p*-values. The long-run variance is estimated using Newey- West (1987). Dynamic estimates are obtained using Equation (9) and the long-run coefficients are calculated using Equation (10).

The single equation estimation strategy yields asymptotically consistent, though inefficient, estimates in the absence of weakly exogenous regressors. Hence the estimates are reliable for making inferences. We use the Autoregressive Distributed Lag (ARDL) procedure to estimate the long-run relationship. The estimated parsimonious ARDL model is shown in the upper panel of Table A4 (in the Appendix). The specified model is subjected to a battery of diagnostic tests. The results from these tests, reported in the lower panel of Table A4, suggest that the specification is robust to the diagnostic tests and hence can be used for making

inferences.[26]

Table A4 shows that some of the regressors explain the variation in excess liquidity with their long lags. These variables, such as government borrowing from the central bank and non-bank institutions, are responsible for structural persistence in the interbank excess liquidity. Fuhrer (2009) argues that the persistence in an economic variable is structural if the factors explaining this variable also have persistence. This evidence suggests that government borrowing from the SBP and the non-banks reduce the effectiveness of the monetary policy in Pakistan.

The long-run coefficients together with their *p*-values are shown in the last two columns of Table 3. These long-run coefficients are calculated using Equation (10) and the ARDL estimates reported in Table A4. Except for the volatility of the overnight rate and the volatility of government borrowing from the SBP, all long-run coefficients are significant at the five percent level. Volatility of government borrowing from the SBP is significant at the ten percent level. The insignificance of the volatility of the overnight rate is not surprising. Since 17th August 2009, the SBP has introduced an interest rate corridor to reduce the volatility in the overnight money market repo rate.[27] This policy move has reduced the variation in the overnight rate.

The signs of the long-run coefficients are in line with our expectations. The negative coefficient of required reserves indicates that increasing required reserves directly drain liquidity from the interbank market. The positive coefficient of the discount rate shows that the banks respond to the positive discount rate changes by increasing their excess liquidity holdings. However, the SBP frequently resorts to open market operations to mop up liquidity from the interbank market. The banks willingly substitute their cash liquidity for short-term government securities as the latter yield a lucrative risk-free return besides enhancing their ability to borrow from the SBP discount window, and thus reducing their liquidity risk.

The coefficient of the exchange rate is negative suggesting that a depreciation of the

[26] The serial correlation is tested using the Breusch-Godfrey test with 12 lags and the Portmanteau (Q) test with 40 lags. Both tests indicate that residuals are white noise. Normality of the residuals is tested using the Shapiro-Wilk test. The null hypothesis of normal residuals is rejected at the five percent level of significance. To check the severity of the problem, a non-parametric Kernel density estimation procedure is employed. Kernel density estimators, similar to histograms, approximate the density *f(x)* from observations on *x*. The data are divided into non-overlapping intervals, and counts are made of the number of data points within each interval. Figure A2, in the Appendix, shows that the deviation of Kernel density estimate from normal density estimate is minor and can be ignored without significant implication for inference. The stability of the specified model is tested using the CUSUM and CUSUMSQ tests, proposed by Brown *et al*. (1975). The graph shown in Figure A3, in the Appendix, indicates that the null hypothesis of stable specification cannot be rejected at the 95 percent level of confidence.

[27] Vide DMMD Circular No.1 of 2009, State Bank of Pakistan.

Pakistan Rupee leads banks to decrease their liquidity holdings. Moreover, the coefficient of foreign currency deposits is positive and large in magnitude, which coefficient suggests that an increase in foreign currency deposits leads to an increase in excess liquidity holdings of banks. The large magnitude reflects the exchange rate of the Pakistan Rupee against the US Dollar.[28] Finally, a one percent increase in the foreign currency deposits causes a 5.8 percent increase in the excess liquidity in the interbank market.

The estimates reported in Table 3 also show that government deficit financing by commercial banks and the SBP has positive long run effects on excess liquidity. The positive coefficient of the SBP credit to the government supports Ganley's (2004) argument that the monetization of the government's budget deficit is a main cause of excess liquidity in some countries. The negative coefficient with the non-bank institution borrowing shows that this source of financing has a negative long-run effect on excess liquidity, but its magnitude is small.[29]

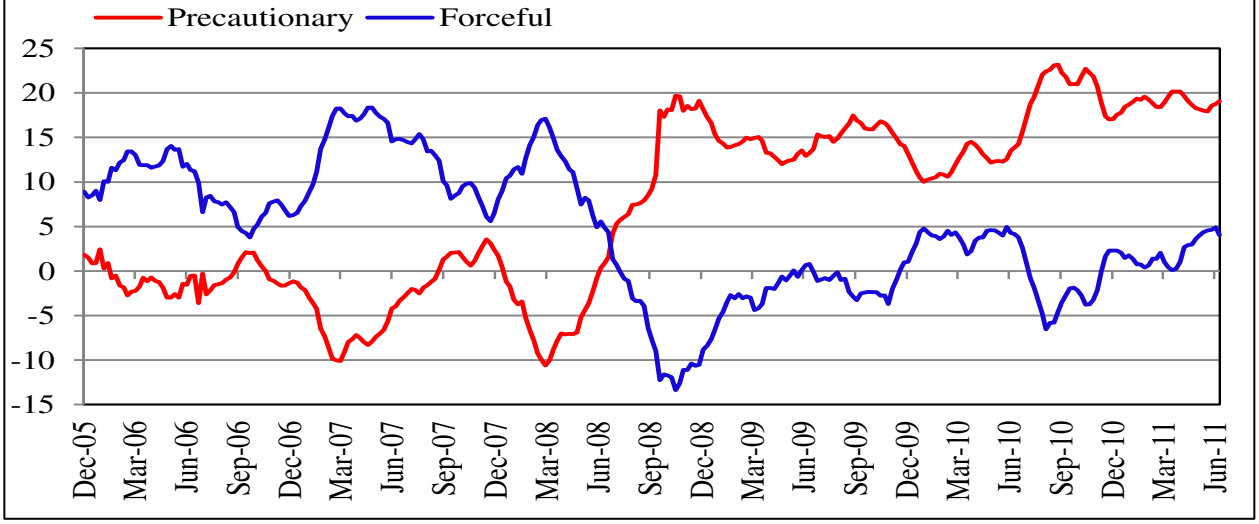
Next, we decompose excess liquidity into its voluntary and involuntary components, as indicated in Equation (11), using the long-run coefficients of Table 3. The outcome is shown in Figure 2. This figure indicates that the interbank market of Pakistan has experienced a structural shift since June 2008. Before June 2008, banks' holdings of excess liquidity were largely 'involuntary' representing lack of credit demand in the economy. Wyplosz (2005) argues that the central bank's monetary tightening remains at risk if excess liquidity accumulation is demand driven. Any improvement in credit demand may cause a rapid increase in credit. Not surprisingly, the SBP consistently missed the inflation projections between 2005 and 2008.[30]

After June 2008, excess liquidity holdings by banks become voluntary. The persistent foreign currency inflows and government deficit financing by the banking sector increased excess interbank liquidity. As Pakistan's financial markets lack depth, banks preferred parking their liquidity in short-term government securities. Also, the SBP's liquidity management after the fall of Lehmann Brothers contributed to the banking sector's shift towards precautionary behavior. On 18th October 2008, the SBP expanded the eligibility of long-term government bonds from five to ten percent. This move was meant to provide liquidity support to the

[28] Over the period of this study, the average of the Pakistan Rupee - US Dollar exchange rate was 72.97.
[29] When government borrows from non-banks, excess liquidity with banks decreases as the deposits from banks get transferred to the non-bank institutions.
[30] Inflation projections are inflation figures underlying the government budget plans. For a discussion on the deviation of actual from 'projected' inflation, see Omer and Saqib (2009).

interbank market and caused an increase in the borrowing ability of banks from the SBP discount window by roughly PKR135 billion, hence increasing 4- percent excess liquidity holdings of the banks in terms of their total time and demand liabilities.

Figure 2: Components of Interbank Excess Liquidity



As discussed in Section 2, our involuntary liquidity estimates includes the output gap following Saxegaard (2006). We re-estimated the model with the output gap as a determinant of the involuntary liquidity accumulation, dropping the index of industrial production (IIP). Figure A4 in the Appendix shows that the overall conclusion of this paper remains unchanged. We prefer keeping IIP in our model mainly for statistical reason, as it helps in identifying the long-run relationship between the regressors.

7. Conclusions

We investigate excess liquidity in the interbank market of Pakistan using the bound test and Autoregressive Distributed Lag approach on weekly data for December 2005 to July 2011. Our findings suggest persistence of interbank excess liquidity. Our results also indicate that the financing of the government's budget deficit by the central bank and non-banks contributes to persistence in interbank liquidity. This persistence may have weakening effect on the monetary transmission mechanism.

Moreover, we identify a structural shift in the interbank market in June 2008. Before June 2008, low credit demand was driving excess liquidity holdings by banks. After June 2008,

precautionary investments in risk free securities drive the liquidity holdings by banks. Perhaps, the change in the political regime in 2008 is related to this structural change. On June 11 2008, the government formed after the general election in February 2008, presented its first budget. Importantly, we did not have employed any break dummy in our model although the unit root tests have suggested structural breaks in the number of variables. As mentioned in Section 6.2, the shift dummy employed to incorporate the structural break turned out to be insignificant.

Mohanty (2006) argues that such a structural shift in the banking sector's behavior towards holding government securities may have repercussions on the economy, such as persistently higher interest rates, higher sovereign risk premium, and crowding out of private sector investments. Mishra *et al*. (2011) argue that the objective of deficit financing may become so important that it turns into a source of macroeconomic instability instead of stabilization. The independence of the central bank and its ability to conduct monetary policy effectively is then compromised.

Given our findings, we suggest reducing the government budget deficit and to limit borrowing, especially from the central bank, in order to reduce liquidity inflow in the interbank market. We consider the recent legislative move aimed at limiting the government's borrowing as a step in the right direction. On March 2012, State Bank of Pakistan Act (1956) has been amended restricting the government from borrowing from the SBP for more than one quarter (Clause 9C, p.13). However, further steps seem to be necessary, such as capping the government's debt. Also, further liberalization of the foreign exchange market aimed at increasing the access of domestic banks to international financial markets could be helpful in enhancing banks' foreign exchange management. A better ability of banks to manage their foreign exchange inflows may help the SBP to move from a managed float to a free floating exchange rate regime. All this could help in reducing the liquidity glut in the interbank market of Pakistan which is essential for increasing the efficacy of monetary policy.

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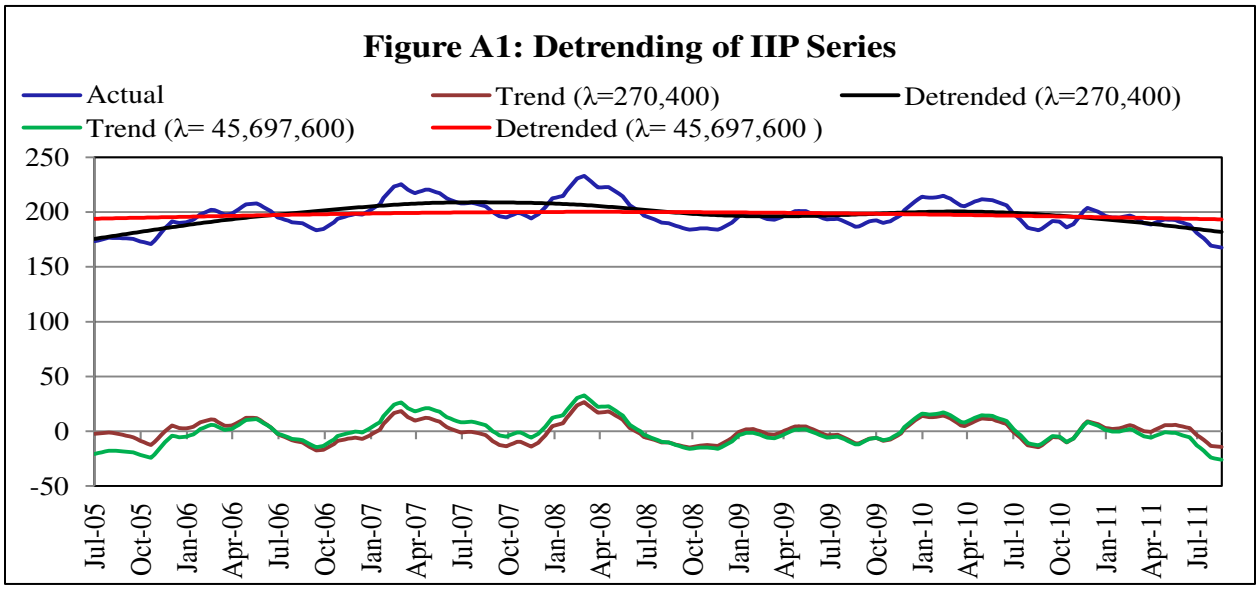
Appendix

Figures



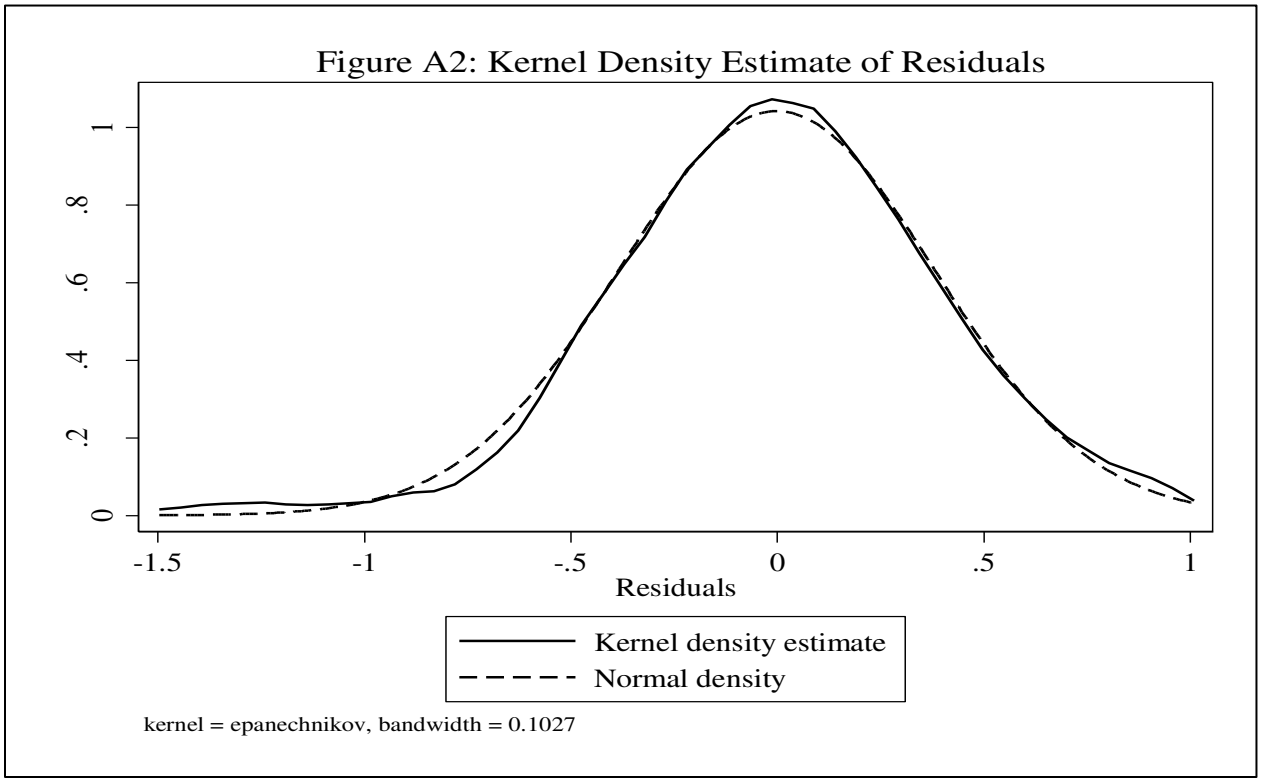
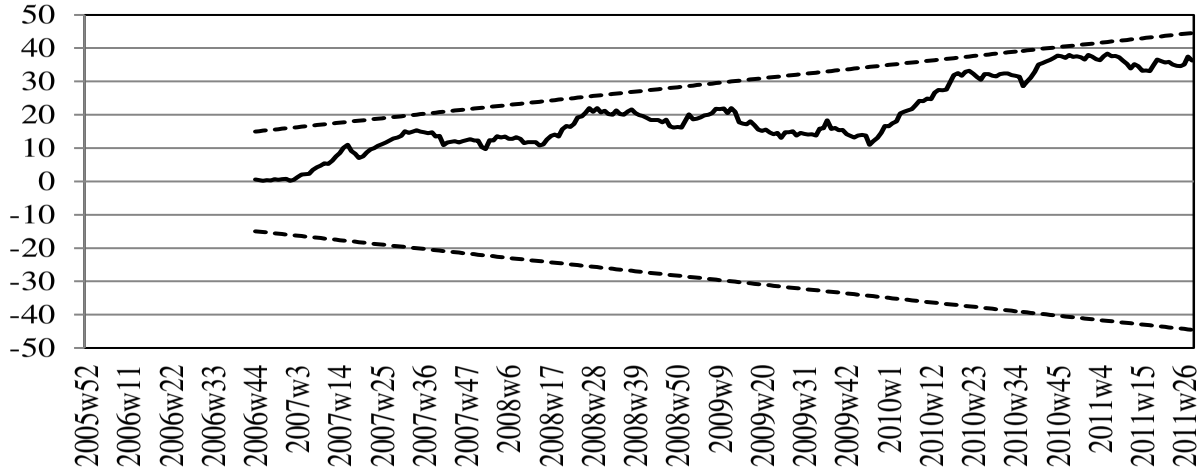


Figure A3: Stability Test

CUSUM Test Statistics with 95 % Confidence Interval



CUSUM SQUARE Test Statistics with 95 % Confidence Interval

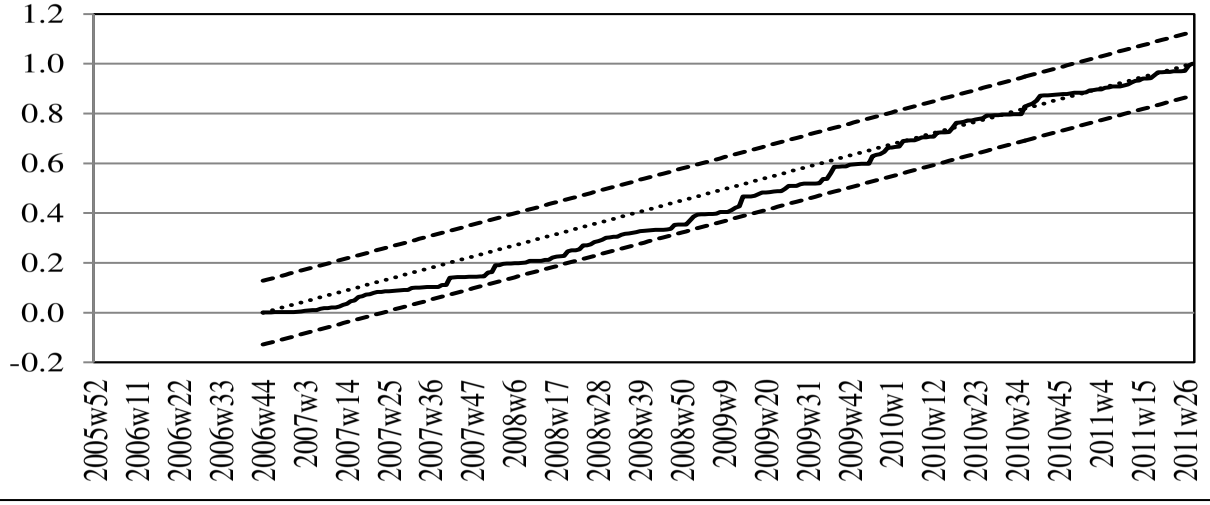
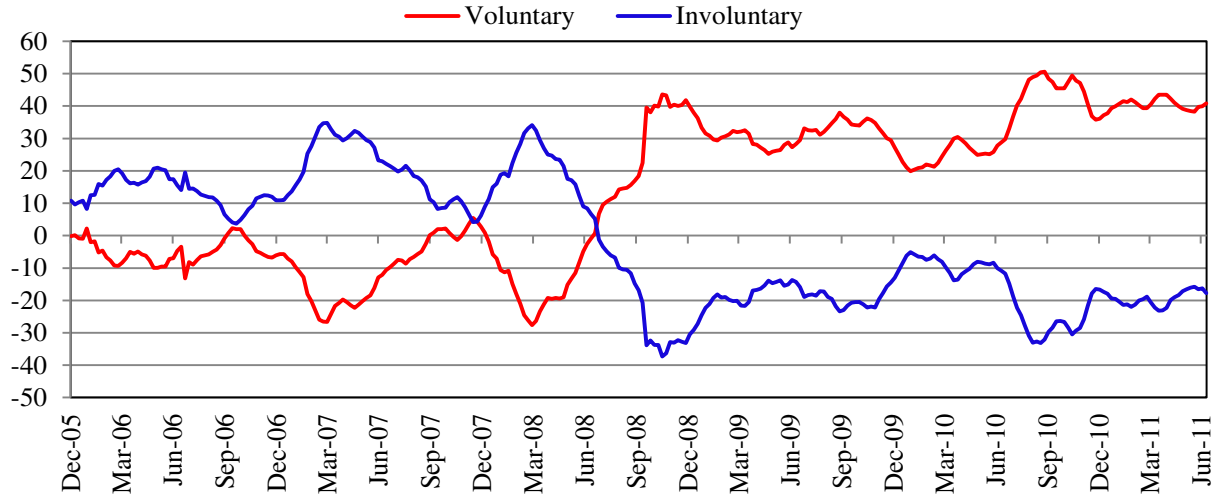


Figure A4: Components of Interbank Excess Liquidity (Involuntary Output Gap)



Tables

Table A1 Overview of Monetary Developments in Pakistan between 2005-2011 (End of the year stock in billion Rupees)

	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011
Assets							
Government Sector Borrowing (net)	**753**	**834**	**927**	**1509**	**2034**	**2441**	**3021**
Net Budgetary Borrowing (i+ii)	**647**	**708**	**810**	**1365**	**1681**	**2011**	**2602**
(i) From the State Bank of Pakistan	*268*	*404*	*345*	*1034*	*1165*	*1209*	*1201*
(ii) From scheduled banks	*378*	*304*	*465*	*331*	*516*	*803*	*1401*
Credit to Non-Government Sector	**1782**	**2191**	**2576**	**3020**	**3190**	**3389**	**3547**
A. Net domestic assets of the banking system	**2329**	**2718**	**3080**	**4022**	**4641**	**5232**	**5915**
(i) State Bank of Pakistan	195	218	151	773	902	988	1037
(ii) Scheduled banks	2134	2501	2930	3248	3740	4244	4878
B. Foreign assets of the banking system	**637**	**688**	**985**	**668**	**496**	**545**	**780**
(i) State Bank of Pakistan	195	565	788	480	303	379	614
(ii) Scheduled banks	133	123	197	187	193	167	166
Monetary Assets (M2) (A+B)	**2966**	**3407**	**4065**	**4689**	**5137**	**5777**	**6695**
Liabilities							
Currency in Circulation	**666**	**740**	**840**	**982**	**1152**	**1295**	**1501**
Bank Deposits with SBP (Reserves)	**196**	**208**	**305**	**425**	**274**	**290**	**349**
Time and Demand Deposits	**2117**	**2466**	**3011**	**3439**	**3700**	**4130**	**4809**
Foreign Currency Deposits	180	196	207	263	280	345	375
Money Supply (M2)	**2966**	**3407**	**4065**	**4689**	**5137**	**5777**	**6695**

Table A2. Description of Variables

Name	Description
Excess liquidity	Reserves excess of statutory requirements (quantity of reserves deposited with the central banks + cash in their vaults +statutory liquidity requirement eligible securities) to the total time and demand liabilities.
Required reserves	Required reserves is combined effect of cash reserve requirement and statutory liquidity requirements over the period as shown in Table 1.
Output Gap	Output gap calculated using the Index of Industrial Production and the HP Filter, using $\lambda=270400$ as smoothening parameter. The output gap is measured as the gap between the trend and the actual level of output.
Discount Rate	SBP 3-day reverse repo rate
Exchange Rate	Average weekly exchange rate of Pakistan Rupee per US Dollar
Volatility in overnight rate	Volatility of interbank overnight rate measured as ratio of 13 week moving average standard deviation and mean.
Private Credit	Private sector credit (as percentage of GDP) extended by the Banks
Govt. borrowing- SBP	Government borrowing (as percentage of GDP) from the central bank
Govt. borrowing-banks	Government borrowing (as percentage of GDP) from the commercial banks
Government borrowing from Non-Banks	Government borrowing (as percentage of GDP) from non-banking sector
Index of Industrial Production	Monthly Index of industrial production is disaggregated using 6-week forward moving average.
Foreign currency deposits	Residents' foreign currency deposits (as percentage of GDP) deposited with the banks in Pakistan Rupee.
Volatility in Govt. borrowing from SBP	Volatility of government borrowing from the central bank measured as ratio of 13 week moving average standard deviation and mean.
MTBs	6-months Treasury Bills rate used as a proxy for the Discount Rate

Table A3. Unit Root Test Results

	Dickey-Fuller Test		Philips-Perron Test	
	drift only	**drift with trend**	**drift only**	**drift with trend**
Excess liquidity	0.003	-1.924	0.174	-1.708
Required reserves	-1.635	-2.835	-1.58	-2.412
Output gap	-5.833*	-5.822*	-2.968*	-2.962
Volatility in overnight rate	-2.236	-2.46	-2.391	-2.481
Volatility in SBP financing	-3.272*	-3.309	-3.185*	-3.718*
Credit to private sector	-1.729	-1.909	-1.718	-1.522
Foreign currency deposits	0.279	-3.153	0.526	-2.901
Government borrowings from:				
Banks	1.622	-0.729	2.428	-0.042
SBP	-1.586	-1.665	-1.12	-1.304
Non-banks	2.867	0.944	1.578	-0.924
Exchange rate	-0.846	-1.855	-0.442	-1.145
95% Critical Values	*-2.879*	*-3.429*	*-2.878*	*-3.428*

Notes: The null hypothesis of ADF and PP tests assumes that the series has unit root. * indicates that the null hypothesis is rejected at 5% level of significance.

Table A4. Estimates of Short-run Determinants of Excess Interbank Liquidity

	Level	lag (1)	lag (2)	lag (3)	lag (4)	lag (4)
Excess liquidity	-	0.814***				
		(0.000)				
Required reserves	-0.927***	0.674				
	(0.000)	(0.000)				
Output gap	-0.019	-0.0003	-0.049*			
	(0.627)	(0.995)	(0.064)			
Discount rate	0.271*	-0.130	0.184	-0.164		
	(0.060)	(0.480)	(0.315)	(0.222)		
Exchange rate	-0.278***	0.113				
	(0.001)	(0.162)				
Volatility in overnight rate	0.033	0.009	0.050	-0.08***		
	(0.168)	(0.797)	(0.139)	(0.001)		
Credit to private sector	-0.451***	0.161	0.141*			
	(0.000)	(0.108)	(0.072)			
Government borrowing from:						
SBP	0.235***	-0.066	-0.062	0.008	-0.080	0.087*
	(0.000)	(0.354)	(0.301)	(0.896)	(0.208)	(0.089)
Banks	0.407***	-0.193**				
	(0.000)	(0.030)				
Non-banks	0.037	0.063	-0.081*	-0.038	0.052	-0.103***
	(0.367)	(0.182)	(0.053)	(0.353)	(0.238)	(0.005)
Index of Industrial Production	-0.003	0.077*				
	(0.934)	(0.066)				
Foreign currency deposits	1.080***					
	(0.003)					
Volatility in SBP financing	-0.022*					
	(0.073)					
Intercept	3.030					
	(0.133)					
Diagnostic Test	*Statistics*	*p-values*				
Adj. R-square	0.994					
F-Statistics	1182.59	(0.000)				
Normality	2.261	(0.012)				
Ramsey Reset Test	0.390	(0.760)				

Notes: ***, **, and * indicates significance at1 -, 5-, and 10- percent level of significance. *p*-values are reported in parenthesis. Normality test is based on Shapiro and Wilk (1965). The null hypothesis assumes that the variable is normally distributed. Ramsey Reset Tests is related to specification error. Ramsey test amounts to fitting higher power of residuals from regression of *x* on *y*. Terming the higher power of the residuals with *t*, the Ramsey Reset testing procedure tests $t = 0$ in specification $y = xb + zt + u$. The non-rejection of the null hypothesis $t = 0$ indicates the model specification do not have omitted variable.