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Non-Technical Summary

Literature on monetary transmission mechanism often argues that regulating money supply become difficult in presence of excess bank liquidity. Any attempt by the central bank to stimulate aggregate demand by relaxing monetary policy will only increase the prevalent interbank market liquidity. Likewise, if the central bank adopts monetary tightening, any sudden improvement in credit demand may cause rapid increase in credit which may subvert the central bank's tightening initiative.

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. This paper explores the impact of excess interbank liquidity on the monetary transmission in Pakistan. For this purpose, the short- and long-run pass-through of changes in policy instruments to lending and deposit rates and the exchange rate is estimated with and without excess interbank liquidity in the model.

Specifically, the paper asks the questions: 1) what is the impact of the main policy tools of the SBP on retail rates and the exchange rate? 2) does excess interbank liquidity affect the monetary transmission mechanism, i.e., the pass-through of the policy tools to the retail rates and the exchange rate? A significant impact of excess liquidity on the monetary policy pass-through will undermine monetary policy.

We have examined not only the transmission of changes in the discount rate, but also the transmission of changes in reserve requirements. Previous empirical studies have largely ignored the pass-through of required reserves as a monetary policy tool, as they are not changed very frequently. Currently, reserve requirements on banks in Pakistan are based on time and demand liabilities separately, which produced sufficient variability in this policy tool to be used for a meaningful economic analysis.

In addition to the transmission of shocks from policy tools to retail interest rates, we also have examined the transmission of these shocks to the exchange rate. The impact of the changes in the policy tools on the exchange rate was completely ignored in previous studies on Pakistan. The SBP, like other central banks, does not pay attention to the exchange rate specifically. However, central banks' interest in the exchange rate developments is well documented by McKinnon (1995), Clarida and Gertler (1997), and Clarida (2001). The use of monetary policy

tools in tandem with the speculative pressure on the Pakistan Rupee-US Dollar exchange rate often creates the impression that the SBP uses a *de facto* fixed exchange rate policy. This paper shows that only required reserves has an impact on the exchange rate which is likely to bring clarity in understanding the exchange rate channel of monetary policy pass-through in Pakistan.

The main findings of this paper suggest that excess liquidity significantly affect the pass-through of the policy tools to the lending rate. Excess liquidity has no long-run effect on the pass-through of the policy tools to deposit rate and (growth of) exchange rate. Moreover, the pass-through of the discount rate to the lending rate is complete but it is incomplete for required reserves. Furthermore, only changes to required reserves have an effect on the deposit rate and the exchange rate in the long run. Moreover, our results suggest the presence of a structural shift in the interbank money market in Pakistan in June 2008. Studies ignoring this shift may produce misleading conclusions.

Impact of Interbank Liquidity on Monetary Transmission Mechanism: A Case Study of Pakistan

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Abstract

We investigate the transmission mechanism of policy-induced changes in the discount rate and required reserves in Pakistan. Our results suggest that the pass through to the lending rate is complete for the discount rate but incomplete for required reserves. However, only shocks to required reserves have an effect on the deposit rate and the exchange rate in the long run. The observation that the discount rate is not a very effective monetary policy tool is attributed to excess liquidity present in the interbank market of Pakistan. Finally, our findings suggest a structural shift in the interbank money market in Pakistan.

JEL Classification: E51, E52, E58, E61

Key Words: Monetary transmission mechanism, Pakistan, excess liquidity, VAR, ARDL

The views expressed do not necessarily reflect the views of De Nederlandsche Bank or the State Bank of Pakistan.

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1. Introduction

Usually, it is assumed that a change in central bank interest rates is transmitted through interbank liquidity to lending and deposit rates, thereby influencing spending decisions of firms and households (Mohanty and Turner, 2008). The role of interbank liquidity in monetary transmission has mostly been examined theoretically.[1] The empirical literature has mainly assessed the transmission mechanism following Bernanke and Gertler's (1995) 'black box' approach ignoring the role of interbank liquidity. The role played by interbank liquidity is still not well understood, even though there is some evidence that notably the presence of excess liquidity may limit the ability of central banks in developing economies to conduct monetary policy effectively.[2]

The experience of Pakistan provides a good illustration of the issue at hand as the interbank market of Pakistan has witnessed an unprecedented growth in excess liquidity in the recent period. Since 2006, repeated attempts by the State Bank of Pakistan (*henceforth* SBP) to increase deposit rates using monetary policy tools proved largely ineffective. In its Monetary Policy Statement of July 2011 (SBP, 2011), the SBP acknowledges weaknesses in the monetary policy transmission mechanism.[3] Several studies point to excess interbank liquidity as an important cause for ailing monetary transmission. For instance, Agénor and Aynaoui (2010) argue that excess liquidity leads to stickiness of the deposit rate during monetary contractions in middle-income economies, undermining the effectiveness of deflationary monetary policy.

We investigate the impact of interbank liquidity on monetary transmission mechanism in Pakistan. Specifically, this study assesses the interest rate pass-through using monthly data from July 2004 to December 2011. The pass-through of the discount rate and required reserves is used to describe how changes in the central bank's policy tools have a short-run and a long-run impact

[1] See, for example, Ganley (2004), Ulrich *et al.* (2004), Allen *et al.* (2009), Agénor and Aynaoui (2010), Freixas *et al.* (2011), and Acharya *et al.* (2012).
[2] See, for example, Nissanke and Aryeetey (1998), Agénor et al. (2004), Saxegaard (2006), and Agénor and Aynaoui (2010).
[3] SBP (2011, pp. 11), states that;
"… unlike the lending rates, the (Weighted Average) Deposit Rate (WADR) has not changed much during fiscal year 2011. It increased from 6.8 % in June 2010 to 7.2 percent in June 2011. This represents a weakness in the monetary transmission mechanism as is evident from a stagnant and high currency to deposit ratio of 29% on 30th June 2011."

on the retail lending and deposit rates. We also investigate the policy instruments' pass-through to the exchange rate. We address the following research questions: What is the impact of the main policy tools of the SBP on retail lending and deposit rates, and the exchange rate? Does excess interbank liquidity affect the monetary transmission mechanism, i.e., the pass-through of the policy tools to the retail rates and the exchange rate?

Our study is unique in a number of ways. To the best of our knowledge, the role of interbank liquidity has never been assessed directly in research on monetary transmission in developing economies. Previous studies on non-industrial countries, such as Egert and MacDonald (2009) and Gigineishvili (2011), evaluate the impact of interbank liquidity only indirectly (see Section 2 for more details).

Moreover, we examine not only the transmission of changes in the discount rate, but also of changes in the reserve requirements. Previous empirical studies have ignored the pass-through of the required reserves, as they are not changed very frequently. However, from July 22 2006 onwards, the SBP has imposed reserve requirements on banks for time and demand liabilities separately, so that there is sufficient variability in required reserves for a meaningful economic analysis.

Finally, in addition to the transmission of policy tools to retail interest rates, we also examine their transmission to the exchange rate. As central banks in several emerging economies aim to stabilize exchange rates, a better understanding of monetary transmission mechanisms requires an analysis of the response of the exchange rate to a monetary policy shock (Disyatat and Vongsinsirikul, 2003; and Aleem, 2010). In a small open economy, the exchange rate channel may often affect the economy through the bond market and the banking system (Adolfson, 2001).[4]

Our results suggest that the pass-through of the discount rate to the lending rate is complete but it is incomplete for required reserves. However, only shocks to required reserves have an effect on the deposit rate and the exchange rate in the long run. Finally, our findings suggest a structural shift in June 2008 in the interbank money market in Pakistan.

The study is structured as follows. Section 2 reviews the relevant literature, while Section

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[4] Bhattacharya *et al.* (2011), Smets and Wouters (2002); Zorzi *et al.* (2007) and Ito and Sato (2008) analyze the inter-linkages between the interest and exchange rate channels.

3 discusses monetary policy in Pakistan. Section 4 outlines the methodology and Section 5 describes the data employed. Section 6 analyzes the results obtained and Section 7 concludes.

2. Literature review

The literature suggests that the transmission of monetary policy changes to lending and deposit rates may be impaired due to several structural rigidities. Previous studies investigating this issue have referred to market concentration and lack of competition (Hannan and Berger, 1991; and Neumark and Sharp, 1992), menu costs (Cottarelli and Kourelis, 1994; and Mester and Saunders, 1995), asymmetric information (Stiglitz and Weiss, 1981), high volatility and uncertainty (Borio and Fitz, 1995) and excess market liquidity (Sørensen and Warner, 2006; Lucchetta, 2007; Egert and MacDonald, 2009; and Gigineishvili, 2011).

So far, empirical studies have paid limited attention to the effect of excess interbank liquidity on monetary policy transmission in developing countries (Agénor and Aynaoui, 2010), even though several theoretical studies referred to earlier suggest that excess liquidity impairs monetary transmission mechanism in these economies. Previous empirical assessments of the impact of excess liquidity on monetary transmission include Ruffer and Stracca (2006); Sørensen and Warner (2006); Lucchetta (2007); Egert and MacDonald (2009); Gigineishvili (2011) and Rocha (2012). Only the studies of Egert and MacDonald (2009) and Gigineishvili (2011) relate to non-industrial economies. Egert and MacDonald (2009) show that the reaction of banks to the monetary policy changes in Central and East European countries depends on certain characteristics, including their liquidity position. Gigineishvili (2011) estimates the interest rate pass-through in some 70 developing countries. The estimated pass-through coefficient is then explained by a host of macroeconomic variables, including liquidity holdings of banks. His findings suggest that excess bank liquidity impedes interest rate pass-through.

In contrast to these studies, we assess the impact of excess liquidity by comparing the pass-through coefficient of the policy tools in a nested setting, by excluding and including excess liquidity in our models for pass-through. By doing so, this study makes a direct assessment of the effect of interbank liquidity on monetary policy transmission.

The remainder of this section reviews studies on the pass-through of the policy rate to retail interest rates and the exchange rate, for developing economies only. For detailed surveys of monetary transmission in industrial countries we refer to Boivin *et al.* (2010), Bhattacharya *et al.* (2011), Mishra *et al.* (2011) and Mohanty (2012).

The survey of Mohanty and Turner (2008) among central banks of developing and emerging economies reveals that most central banks consider interest rates as the most important channel for the transmission of a policy shock. However, recent empirical studies on the interest rate pass-through yield diverse results. For example, using data for Turkey from April 2001 to June 2007, Ozdemir (2009) reports complete pass-through to the lending rate and the deposit rate in the long run. In a complete pass-through the changes in the policy tool are transmitted completely to the retail rates. Similarly, Durán-Víquez and Esquivel-Monge (2008) report complete pass-through of the policy interest rate in the long run, using data for the 1996-2007 period for Costa Rica. In addition, Poddar *et al.* (2006) find that in Jordan the central bank's target rate affects the banks' retail rates. Ganev *et al.* (2002) and Dabla-Norris and Floerkemeier (2006) report complete pass-through only to the lending rates in some Eastern European countries (Bulgaria, Estonia, Latvia, Lithuania, Romania, and Slovakia) and Armenia, respectively. Al-Mashat and Billmeier (2007) find that both lending and deposit rates move in the direction of policy changes in Egypt but only the change in the deposit rate is statistically significant.

Similar to the findings for other developing economies, Table 1 summarizes related research on Pakistan. Except for Mohsin (2011), this literature suggests that the discount rate pass-through in the long run is almost complete for the lending rate, but sticky and often incomplete for the deposit rate. In their empirical investigations, the SBP (2005) and Hanif and Khan (2012) used the Auto Regressive Distributed Lag Approach, while Qayyum *et al.* (2006), and Khawaja and Khan (2008) apply the transfer function approach. The transfer function approach is frequently used to characterize the input-output relationships for a system that can be described by linear time-invariant differential equations. Using the panel cointegration methodology Mohsin (2011) reports a long-run relationship only between the discount rate and the lending rate.

Table 1 Literature on Interest Rate Pass-through to Retail Rates in Pakistan

Study	Period	Instrument	Method	Pass-through estimates: Short run: Lending rate	Short run: Deposit Rate	Long run: Lending rate	Long run: Deposit Rate
SBP (2005)	1999:07-2006:06	TB cut-off rate	ARDL	0.198	0.044	0.987	0.444
Qayyum *et al.* (2006)	1991:03 - 2004:12	TB rate	TFA	Nil	0.180	0.410[2]	0.223[1]
Khawaja and Khan (2008)	1991:06 - 2008:06	TB rate	TFA	Nil	Nil	0.430[3]	0.160[4]
Mohsin (2011)	2001:11 - 2011:03	DR	PC	0.100	0.160	0.200	Nil
Hanif and Khan (2012)	2001:07 - 2011:08	1-wk KIBOR	ARDL	0.300	0.130	0.910	0.640

Notes: TB: Treasury Bill, DR: Discount Rate, KIBOR: Karachi Interbank Offered Rate, ARDL: Auto Regressive Distributed Lags, TFA: Transfer Function Approach, PC: Panel Cointegration. Nil indicates no pass-through detected.

[1] Pass-through to the saving deposit rate (deposit with less than 6-month maturity), while long-run pass-through takes around 3 years to complete. [2] No short-run pass-through and long-run pass-through requires one and half to two years to complete. [3] Long-run pass-through requires one to one and half years. [4] Long-run pass-through requires one year.

The exchange rate is one of the policy variables through which monetary policy is transmitted to the larger economy by its impact on domestic inflation, the external sector, capital flows, and financial stability. The relationship between policy rates and the exchange rate can be described by the uncovered interest rate parity (UIP) hypothesis according to which the differential between domestic and foreign economies interest rates is determined by the differential between the future expected and the current exchange rate, and the time varying risk premium. The risk premium is the compensation required by the investors not only for an expected depreciation, but also for holding domestic assets.

For developing economies and emerging market economies, the literature in general provides support for UIP (see for example, Bansal and Dahlquist, 2000; Flood and Rose, 2001; Frankel and Poonawala, 2006; and Ferreira and Leon-Ledesma, 2007).[5] However, empirical literature on interest rate pass-through to the exchange rate in developing economies is scarce. This is also true for Pakistan. To the best of our knowledge, only Agha *et al.* (2005) study the impact of monetary policy changes on the real effective exchange rate in Pakistan. Using Vector

[5] Smets and Wouters (2002), Zorzi *et al.* (2007), Ito and Sato (2008), Boivin *et al.* (2010), and Bhattacharya *et al.* (2011) provide evidence about the linkages between the interest and the exchange rate channels for industrial economies.

Auto Regressions (VAR) they report that a 0.8 percentage point rise in the 6-month Treasury bill rate leads to a marginal appreciation of 0.2 percent of the real exchange rate during the first two months.

3. Excess liquidity and monetary policy in Pakistan

Saxegaard (2006) and Agénor *et al.* (2004) define excess liquidity as the ratio of the quantity of reserves deposited with the central bank by banks (and cash in their vaults) in excess of the statutory liquidity requirements, to the total time and demand liabilities of the banks. Mohanty *et al.* (2006) argue that if banks hold substantial government securities, bank reserves with the central bank only capture a part of the total holdings of liquid asset and therefore are less reliable as a measure of liquidity holdings. We therefore augment excess liquidity, as defined by Saxegaard (2006) and Agénor *et al.* (2004), with high-powered securities owned by banks that are eligible for statutory liquidity requirements. These securities include mostly short-term Treasury Bills and long-term government bonds (known as Pakistan Investment Bonds or PIBs) up to a maximum determined by the SBP. Thus the description of excess liquidity used in this study is the ratio of the quantity of bank reserves deposited with the central bank, cash held by banks, and securities that are eligible as reserves in excess of the statutory liquidity requirements, to the total time and demand deposits of banks.

The SBP has a monetary targeting strategy with the objective of maintaining price stability and promoting economic growth. Its main policy tool is the discount rate. Theoretically, any change in the discount rate alters the marginal cost of maintaining excess reserves, which through changes in the marginal cost of interbank lending, is transmitted to retail rates. In addition, the SBP frequently uses direct policy tools, such as cash reserve requirements and statutory liquidity requirements. Cash reserve requirements consist of non-remunerated deposits that bank have to keep at the central bank to back up their deposit holdings. Statutory liquidity requirements refer to liquidity that banks are required to maintain in the form of government securities or securities of government-owned enterprises. Changes in both types of required reserves influence banks' excess reserves, thereby changing the interbank market rates. The lending and the deposit rates, in turn, are influenced by the changes in the interbank market rates.

Table 2. Changes in policy instruments, 2005-2010

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

The table provides the chronological order of changes in policy instruments.

Between 2004 and 2011, the SBP tightened its policy frequently (see the upper panel in Figure 1 and Table 2) as the central bank was struggling to curtail inflation, which frequently was in the double-digit range.[6] Real lending and deposit rates were mostly negative due to the high inflation during this period (see the panel in the middle in Figure 1). The banks' nominal lending rates generally responded to the central bank's tightening measures, but deposit rates were stickier.

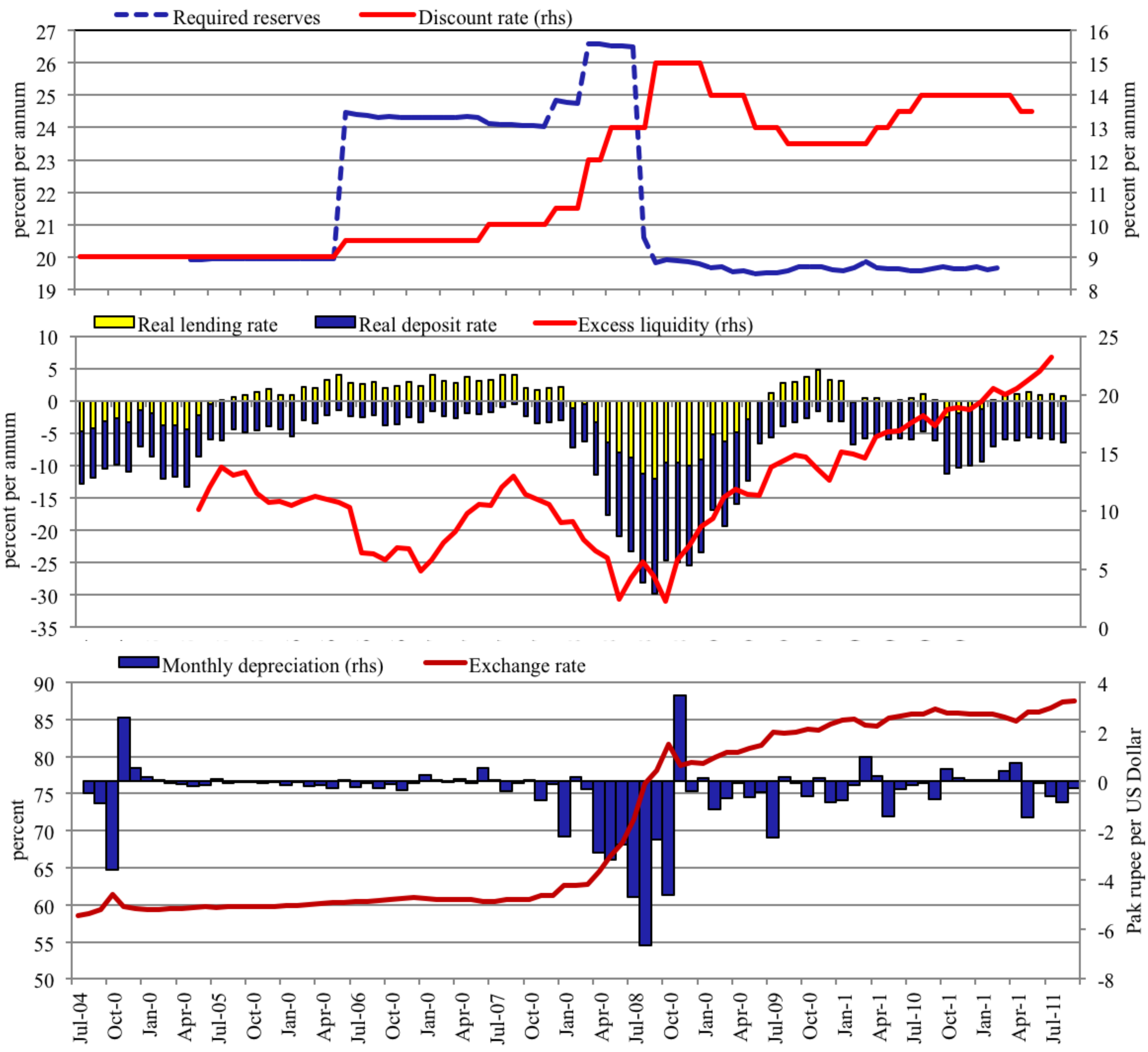
Until June 2008, the SBP had little success in increasing deposit rates. As a consequence, the SBP asked the banks to pay a minimum return of five percent on all savings products from 1 June 2008.[7] A floor for deposit rates implies that the nominal interest rate cannot fall beyond this level, reducing both the flexibility of monetary policy to address deflationary pressures and the

[6] For more details see Omer and Saqib (2008) and GoP (2007- 2009).
[7] The regulatory deposit rate has been increased to 6 percent on May 01, 2012 (see BPRD Circular No. 01of 2012, SBP).

transmission of policy shocks through interest rates.

Financial developments in this period and the relevant policy measures have amassed excess liquidity in the interbank market of Pakistan. For example, due to the global financial crisis the cash reserve requirements were relaxed. In the week that Lehmann Brothers fell, these requirements were brought down twice by 100 bps (see Table 2). Additionally, on 18 October 2008 the SBP increased the eligibility of long-term government bonds for the statutory liquidity requirements from 5 to 10 percent. The move increased the borrowing ability of the banks from the SBP's discount window roughly by PKR135 billion. Also, unprecedented foreign exchange inflows in the form of the remittances also allowed the banks to park funds in short-term government securities. Accordingly, the banking sector witnessed a steep growth in liquidity, specifically since June 2008.

Figure 1. Interbank liquidity, policy instruments and retail rates



Top panel: shows required reserves and the discount rate.
Middle panel: shows excess liquidity, the real lending and the real deposit rates.
Bottom panel: shows the exchange rate and its monthly depreciation. Monthly depreciation is calculated using monthly growth in exchange rate.

4. Model and methodology

We first use unit root tests to examine the data generating processes of the variables used in the analysis. In a generalized form, an augmented unit root process can be described by

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

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_i are the coefficients of the unit root and the lagged difference of the series, respectively, and ε_t is the error term (for details, see Enders, 2004 Chapter 4; and Hamilton, 1994 Chapter 15). Conventionally, the unit root tests test the null hypothesis that the series has a unit root, i.e. $\rho = 1$. As the Figure 1 suggest a structural shift in the banks' behavior, this study also utilizes unit root tests with structural shifts when conventional unit root tests fails to reject the null hypothesis.

The tests suggested by Clemente *et al*. (1998) allow for unit root testing with two breaks. This test is an extension of the Perron and Vogelsang (1992) test with one structural break.[8] This class of unit root tests distinguishes two types of outliers: an additive outlier and an innovative outlier. The additive outlier test suits best to series exhibiting a sudden change in the 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 dates. For simplicity, assume that the breaks occur at an unknown date, $1 < T_{b1} < T_{b2} < T$, 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 the break dummies $DU_{mt} = 1$ for $t > T_{bm}$, and 0 otherwise, for m = *1, 2*, and the remaining part noise $\tilde{y}_t$ is examined for a unit root

[8] If the test of Clemente *et al*. (1998) suggests that 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.

$$\Delta\tilde{y}_t = \sum_{i=1}^{m1}\theta_{1i}D(T_{b1})_{t-i} + \sum_{i=1}^{m2}\theta_{2i}D(T_{b2})_{t-i} + \rho\tilde{y}_{t-1} + \sum_{i=1}^{k-1}\gamma_i\Delta\tilde{y}_{t-i} + e_t\,. \quad (3)$$

The change in the break dummy $D(T_{bm})_{t-i} = 1$ if $t = T_{bm} + 1$ and zero otherwise; $m1$ and $m2$ are the maximum lags of the breaks; $\Delta\tilde{y}_t$ are included to control for serial correlation and heteroskedasticity in the errors, while k-1 is the truncated lag parameter. Often specification of lag length in a unit root tests involves practical issues. If k-1 is too small then the remaining serial correlation in the errors will bias the test. If k is too large then the power of the test will suffer. Here the lag length k is determined by a set of sequential F-tests.[9]

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

$$y_t = \mu_1 + \delta_1 DU_{1t} + \delta_2 DU_{2t} + \theta_1 D(T_{b1})_t + \theta_2 D(T_{b2})_t + \alpha y_{t-1} + \sum_{i=1}^{k-1} c_i \Delta y_{t-i} + e_t\,, \quad (4)$$

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

In Equations (2) and (4), δ_i measures the immediate impact of the changes in the mean. The innovative outlier test can identify the long-run impact of changes in trends by the design of its alternative hypothesis. Here, L is the lag operator defined as $Ly_t \equiv y_{t-1}$, while $\phi(L)$ defines the moving average representation of a stationary and invertible noise function e_t. The immediate impact of a change in the mean is equal to δ_m, m=1,2, and the long-run impact is $\delta_m\phi(1)$ in Equation (5), where $\phi(1)$ is equal to the sum of all coefficients of the lag polynomial $\phi(L)$. 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; Perron and Vogelsang (1992) and Clemente *et al*. (1998) provide the critical values for one and two structural breaks,

[9] This procedure works as follows: First, for a given value of T_{bm}, a maximum value of k (k_{max}) the auto regressions (AR) are estimated with (k_{max}), and (k_{max} - 1) lags. If the F-test suggests that the coefficient of $k_{\max}^{th}$ lag is significant, the value of k is chosen. If not, the model is estimated with (k_{max} - 1) versus (k_{max} – 2) lags. The procedure is repeated by lowering k until a rejection of the null hypothesis that additional lags are insignificant occurs or the lower bound $k = 0$ is attained.

respectively. The null hypothesis is rejected if $\rho < 1$; in that case the series is level stationary. The Clemente *et al*. (1998) tests collapse to the Perron and Vogelsang (1992) tests when the restriction *m=1*, is imposed, i.e. there is only one break.

To estimate the policy tools' pass-through, we follow the procedure of De Bondt (2002) and Chong *et al*. (2006). We employ the vector auto regressions (VAR) methodology for estimating the relationships between the policy tools and the impact variables (lending rate, deposit rate, and exchange rate). We employ levels of all variables in the VAR except for the variables which are difference stationary, as indicated by the unit root tests. For the difference-stationary series, we use first differences. The VAR methodology presumes that all regressors are endogenous, where variables are explained by their lags. A VAR for *N* variables of order *p* is written as

$$Z_t = \mu + \Psi(L) Z_{t-p} + \xi_t , \tag{6}$$

where $Z_t = (z_{1t}, z_{2t}, ..., z_{Nt})'$ represents a vector of (*Nx1*) variables with their *p* lags, $\Psi\ (L)$ is a lag polynomial of order *p*, while ξ_t is (*Nx1*) unobservable zero mean white noise vector process. The optimal lag length *k* is selected using the HQ criterion (as suggested by Lütkepohl and Kratzig, 2004).

The coefficients of the first lag of the policy tools of the VAR estimates shows the immediate impact of changes in the policy tool, generally termed as the short-run pass-through of policy tools. The long-run pass-through coefficient $\hat{\beta}$ for the first variable is found by aggregating and normalizing the short-run coefficients. To illustrate this for a bivariate VAR system with two lags, such as:

$$\begin{pmatrix} Z_{1t} \\ Z_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \Psi_{11}^1 \Psi_{12}^1 \\ \Psi_{21}^1 \Psi_{22}^1 \end{pmatrix} \begin{pmatrix} Z_{1t-1} \\ Z_{2t-1} \end{pmatrix} + \begin{pmatrix} \Psi_{11}^2 \Psi_{12}^2 \\ \Psi_{21}^2 \Psi_{22}^2 \end{pmatrix} \begin{pmatrix} Z_{1t-2} \\ Z_{2t-2} \end{pmatrix} + \begin{pmatrix} \xi_{1t} \\ \xi_{2t} \end{pmatrix}$$

we compute

$$\hat{\beta}_1 = \frac{\sum_{p=1}^{2} \Psi_{12}^{p}(L)}{1 - \sum_{p=1}^{2} \Psi_{11}^{p}(L)} \quad , \tag{7}$$

where $\Psi_{11}(L)$ are coefficients of the lag dependent variable and $\Psi_{12}(L)$ are coefficients of the explanatory variable of interest.

5. Data

The monetary policy instruments in Pakistan change infrequently (for details, see Table 2). Therefore, following Agha *et al.* (2005), Qayyum *et al.* (2006), and Khawaja and Khan (2008), we use the 6-month market Treasury bill rate as a proxy for the discount rate.[10] Reserve requirements often suffer from a similar non-variability problem. Finding a proxy for the reserve requirements is not easy which may explain why previous studies have not considered the pass-through of this instrument. Since 22nd July 2006 the SBP imposed separate reserve requirements for time and demand liabilities (also shown in Table 2).[11] We will therefore use the effective reserve requirements as weighted average of the cash reserve requirements and the statutory liquidity requirements. This creates sufficient variability in reserve requirements to be used for estimation purposes.

We use monthly data from July 2004 to December 2011.[12] Table 3 provides the descriptive statistics of the variables employed. The lending and the deposit rates used are weighted averages of rates offered by banks on new loans and deposits using amounts as weights, in any given month.[13] These rates are consistently available since July 2004. Prior to July 2004, the lending rate reported referred to new lending, while the deposit rate reported referred to outstanding deposits. Monthly data on excess liquidity is based on information for the last weekend of the month.

Table 3 Descriptive Statistics

Variables	No. of Observation	Mean	Standard Deviation	Minimum	Maximum
Lending rate	88	11.50	2.74	4.63	15.54
Deposit rate	88	5.83	2.06	1.20	9.53

[10] The correlation between the discount rate and the 6-month Treasury bill rate in our sample is 0.966.

[11] The SBP defines special notice deposits and time deposits with maturity of 12 months or less as demand liabilities. Time deposits with maturities above 12 months are categorized as time liabilities.

[12] The sample size reduces to June 2005 - June 2011 when the investigation involves excess liquidity. We also estimated all models reported for this shorter sample period but this gave fairly similar results.

[13] Weighted averages are calculated by weighting interest rates by the corresponding amounts of loans/deposits across all banks. The formula used by the SBP is: $\text{Weighted Average Rate} = \sum(\text{rate} \times \text{amount}) \div \sum(\text{amount})$.

Discount rate	90	11.32	2.13	9.00	15.00
6-month market Treasury bill rate	88	9.99	2.74	2.58	13.44
Excess liquidity	74	11.75	4.94	2.13	23.19
Required reserve	74	21.58	2.47	19.48	26.59
Exchange rate	87	70.79	11.60	58.45	87.50

Currently, the SBP reports net time and demand liabilities excluding the foreign currency and Islamic banks' deposits. The foreign currency and Islamic banks' deposits are reported separately, with different statutory requirements. Before December 2005, reported data included both foreign exchange and Islamic banks' deposits and hence are not comparable to the current data. We have successfully extended the time series for deposits six month backward using reported information of the SBP so that our sample starts in June 2005. We use the growth rate of the exchange rate, as the pass-through estimation requires that variables used have the same unit of measurement. All data have been kindly provided by the SBP.

6. Results

Table 4 provides the results of the conventional unit root tests, as well as unit root tests allowing for structural breaks. The results suggest that except for excess liquidity all variables included in the investigation are level stationary. For instance, the null hypothesis of unit root is rejected at 10 percent significance level for the lending rate (Phillips-Perron test) and for the deposit rate (innovative outlier test). Moreover, the test results for the deposit rate suggest that this variable has two significant structural shifts. Similarly, the results for the required reserves also suggest two structural shifts in this variable. The identified break dates are in the vicinity of the policy moves of the SBP as described in Table 2. For example, the results for required reserves show that the series had a structural break in May 2005 and August 2008. Table 2 shows that the SBP increased the cash reserve requirements on demand liability by 200 bps in July 2006, and by 100 bps in May 2008.

Only excess liquidity follows a difference stationary or I(1) process as a unit root null hypothesis cannot be rejected at the 5 percent significance level both for the conventional unit root tests and for the unit root tests incorporating structural breaks. We therefore employ first differences of the excess liquidity in the VAR system.

Table 4 Unit Root Test Results

	Without Structural Break				With Structural Break					
	Dickey-Fuller test		Philips-Perron test		Additive outlier test			Innovative Outlier test		
	No trend	Trend	No trend	Trend	Stats	# Breaks	Dates	Stats	# Breaks	Dates
Lending rate	-1.439	-1.268	-2.742**	-2.159						
Deposit rate	-1.973	-1.935	-2.122	-2.098	-4.683	2	11-05, 02-08	-3.915**	2	12-05, 01-08
Discount rate	-0.931	-1.800	-3.005*	-2.978						
Required reserves	-1.486	-2.98	-1.666	-1.876	-5.718*	2	08-06, 11-08	-14.722*	2	05-06, 08-08
Excess liquidity	0.771	-1.447	-0.17	-1.088	-0.655	2	03-08, 03-09	-3.061	2	12-07, 08-08
Exchange rate	-2.143	-2.109	-7.205	-7.173*						
				**5% C. V*						
No Break	-2.911	-3.476	-2.9	-3.463						
1-break					-3.560			-4.270		
2-breaks					-5.490			-5.490		
				***10% C.V.*						
No Break	-2.590	-3.166	-2.585	-3.158						
1-break					-3.22			-3.86		
2-breaks					-5.24			-5.24		

Notes: The additive outlier test assumes a sudden break while the innovative outlier test assumes a break in trend. The null hypothesis of ADF or PP test is that the series has a unit root, while for Clemente et at. (1998) test is that the series has unit root with structural breaks. For details see Clemente et at. (1998). Dates indicates break dates and should be read as month and year (*mm-yy*).

The break dates identified by the unit root tests are different for each variable indicating that different policy moves by the central bank may have had different impacts on these variables. We incorporate only one shift, the break in June 2008. Several important developments suggest that a structural shift has occurred in the financial system of Pakistan in June 2008. On 1 June 2008, the SBP imposed a minimum regulatory deposit rate of five percent, to be paid to the depositors, on all savings products as discussed in Section 3. Moreover, excess liquidity of banks witnessed an unprecedented growth since June 2008 (see the panel in the middle in Figure 1). Finally, the SBP changed its use of policy tools. After May 2008, reserve requirements were relaxed but the central bank continued to raise the discount rate (see Table 2). Earlier, the SBP used both the required reserves and the discount rate for monetary tightening. In view of the structural shift in June 2008 and following Glynn *et al.* (2007), we include both shift and pulse dummies (change in the shift dummy) in our VAR models.

Tables A1, A2, and A3 in the Appendix to this study present the detailed estimates of the VAR models showing the short-run (upper panel) and long-run (the lower panel) impact of the changes in policy rates on the lending rate, the deposit rate, and the exchange rate, respectively. Various diagnostic tests are applied to each model, the results of which are provided in Table A4, also in the Appendix.[14] Although the assumption that the residuals are normally distributed is often rejected, we analyze deviations from normality using a non-parametric Kernel density estimation procedure. 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. The kernel density estimates presented in Figures A1 to A12 in Appendix show the density estimates of residuals and a normally distributed data with similar features. These graphs suggest that the residuals deviation from normality is generally marginal and can be ignored without significant implication for inference.

Table 5 provides the long-run pass-through estimates. The upper panel shows the estimates for the discount rate while the lower panel shows the estimates for required reserves. Before discussing the long-run pass-through results in more details, we want to point out that the dummies for the structural breaks are significant in most of the cases supporting that a structural shift in the interbank market of Pakistan occurred in June 2008. Therefore, previous studies on monetary transmission in Pakistan may have produced misleading inferences by ignoring this shift if the data span covers 2008.

[14] Details of the applied diagnostic tests can be found at the bottom of Table A5.

Table 5 Long-run Interest Rate and Exchange Rate Pass-through Estimates

Dependent variable	**Lending rate**		**Deposit rate**		**Exchange rate**	
Include excess liquidity	No	Yes	No	Yes	No	Yes
	Policy tool: discount rate					
Model No.	(1)	(2)	(3)	(4)	(5)	(6)
Discount rate	0.928*	0.489	0.586	-0.325	-0.0784	0.196
	[0.002]	[0.196]	[0.200]	[0.613]	[0.746]	[0.713]
D(Excess liquidity)		-0.448*		-0.342		0.195
		[0.018]		[0.174]		[0.567]
Intercept	2.224*	6.156*	0.198	8.294**	0.406	-2.061
	[0.037]	[0.001]	[0.933]	[0.074]	[0.845]	[0.663]
Break Dummy	0.156	1.861*	0.186	3.532**	0.072	-0.862
	[0.750]	[0.008]	[0.877]	[0.076]	[0.948]	[0.677]
D(Break)	4.360*	2.246*	5.095**	0.690	-0.959	-0.160
	[0.000]	[0.018]	[0.054]	[0.823]	[0.675]	[0.957]
	Policy tool: required reserves					
Model No.	(7)	(8)	(9)	(10)	(11)	(12)
Required reserves	0.232*	0.210*	0.322*	0.301*	-0.362*	-0.361*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
D(Excess liquidity)		-0.244*		-0.112		0.133
		[0.010]		[0.327]		[0.262]
Intercept	5.367*	5.839*	-2.095	1.600	7.887*	7.890*
	[0.004]	[0.003]	[0.154]	0.270	[0.001]	[0.000]
Break Dummy	3.965*	4.072*	3.126*	3.127*	-1.118*	-1.226*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]
D(Break)	0.912	-0.059	1.058	-1.449	0.348	0.884
	[0.448]	[0.961]	[0.429]	[0.283]	[0.780]	[0.503]

Notes: *, **, indicates significance at respectively the 5 and 10 percent levels. The coefficients are the long-run pass-through estimates of shocks to the regressors (policy variable and excess liquidity) on the impact variables (lending rate, deposit rate, and exchange rate) as calculated by Equation 7.

6.1 Pass-through to the lending rate

The coefficient of the discount rate in model (1) of Table 5 is significant at the five percent level and suggests that 0.93 percentage-points of a unit shock to the discount rate is passed on to the lending rate in the long run. Thus, the long-run pass-through to the lending rate is almost complete. However, when excess liquidity is introduced in the model, the pass-through becomes insignificant (model (2)). In other words, a change in discount rate has no significant effect on the lending rate when one controls for excess liquidity.

The coefficient of excess liquidity in model (2) is negative and significant at the 5 percent level indicating that any unit positive change to the (difference of) excess liquidity leads to a decrease in the lending rate by 0.45 percentage point in the long-run. This result suggests that an increase in excess liquidity has a deterring effect on the lending rate in the long-run. Our findings of lending rate pass-through with model (1) are in line with the literature on monetary transmission in Pakistan (see Table 1) suggesting high pass-through to the lending rate in the long-run (SBP, 2005; Khawaja and Khan, 2008; and Hanif and Khan, 2012). Also our finding that inclusion of excess liquidity has a decreasing effect on the pass-through to lending rates is in line with some previous research for other countries (Ruffer and Stracca, 2006; Sørensen and Warner, 2006; Lucchetta, 2007; and Gigineishvili, 2011).[15]

Models (7) and (8) in Table 4 show the estimates for the long-run pass-through from required reserves to the lending rate. The coefficients indicate that the long-run pass-through to the lending rate is only 0.23- percentage point and significant at the 5- percent level. Inclusion of excess reserves has negligible effect on lending rate and reduces the long-run pass-through to 0.21 percentage point. The results suggest that the long-run pass-through of required reserves to the lending rate is low and incomplete.

6.2 Pass-through to the deposit rate

Models (3) and (4) in Table 5 show that the pass-through of the discount rate to the deposit rate is insignificant independent of the presence of excess liquidity in the model. Our findings of no pass-through of the discount rate to the deposit rate stands in contrast to the findings of the SBP (2005) and Khawaja and Khan (2008) who report low pass-through of the discount rate to the deposit rate. The introduction of the regulatory deposit rate in June 2008 may have destroyed the weak pass-through to the deposit rate, reported by earlier studies. Significant break dummies weakly supports our argument that the transmission mechanism to the deposit rate has changed.[16]

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[15] The lower panel of Table A1 (model (1) and (3) in grey) shows the results for the model in which the causality runs in the opposite direction. The results suggest that the lending rate has no effect on the discount rate independent of the inclusion of excess liquidity in the model.

[16] The lower panel of Table A2 (models (3) and (4) in grey) shows the results for the models in which the causality runs in the opposite direction. The results suggest that the deposit rate has significant long-run effect at the 5 percent level on the discount rate only when excess liquidity is controlled for (model (4)). A 100 bps increase in the deposit rate leads to 46 bps increase in the discount rate. The reverse causation from the deposit rate to the discount rate indicates the ineffectiveness of this policy tool. Perhaps, the regulatory deposit rate imposed by the SBP may have strengthened this reverse causation from the deposit rate to the discount rate, while weakening the desired

Models (9) and (10) in Table 5 show the long-run pass-through of required reserves to the deposit rate. Typically, this long-run pass-through is low, independent of whether excess liquidity is included or not. Almost 0.32 percentage point of a unit shock to required reserves is passed through to the deposit rate in the long run. If excess liquidity is controlled for, this pass-through reduces marginally to 0.30 percentage points. Still, compared to the discount rate, reserve requirements appear to be a more effective policy tool for influencing the deposit rate.

6.3 Pass-through to the exchange rate

Models (5) and (6) in Table 5 show the long-run pass-through estimates of the discount rate to the exchange rate. The coefficients of the discount rate are insignificant independent of the inclusion of excess liquidity in the model. This suggests that the discount rate does not influence the (growth of the) exchange rate in the long run.[17]

Models (11) and (12) in Table 5 display the pass-through of required reserves to the (growth in) exchange rate. The coefficient is significant at the five percent, independent of the inclusion of excess liquidity in the model. A one percent increase in required reserves leads to a 0.38 percentage point appreciation in Pakistan Rupee against the US Dollar. However, when excess liquidity is controlled for, the appreciation of the Pakistan Rupee slightly reduces to 0.36 percentage points.

7. Conclusions

We have investigated the effect of excess liquidity on the pass-through from the discount rate and required reserves to retail interest rates and the exchange rate in Pakistan. For this purpose, data from July 2004 to December 2011 has been used. Our findings suggest that excess liquidity significantly affects the pass-through of the discount rate to the lending rate. Moreover, the pass-through to the lending rate is complete for the discount rate but incomplete for required reserves. However, only changes in required reserves affect the deposit rate and the exchange rate in the

transmission mechanism from the discount rate to the deposit rate. Moreover, this result also suggests that excess liquidity has a distortionary effect on the interest rate pass-through to the deposit rate.

[17] The estimates for the models in which the causality runs in the opposite direction (shown in the lower panel of Table A3, model (5) in grey) suggest that exchange rate movements significantly influence the discount rate. A one percent depreciation of the exchange rate leads to a 0.73 percentage point decrease of the discount rate. As discussed in Section 2, this relationship is not in line with the UIP hypothesis. We suspect that this result is related to the borrowing cost on external debt and may be period specific.

long run, even though pass-through is incomplete. Additionally, our results suggest the presence of a structural shift in the interbank money market in Pakistan in June 2008. Studies ignoring this shift may produce misleading conclusions.

Our finding is important as the global increase in liquidity has resulted in foreign capital inflows to the developing and emerging economies thereby flooding their interbank markets with excess liquidity (for a detailed discussion, see Chinn, 2013). Also Ahmed and Zlate (2013), while discussing the impact of foreign capital inflows to emerging economies, point out that the monetary policies of the emerging economies are likely to suffer from this increase in excess interbank liquidity. Therefore, our study provides first-hand information on the impact of excess liquidity on the monetary policy transmission mechanism in developing economies. The conclusion of our study is likely to help policy makers in developing economies, in general, and Pakistan, in particular.

Finally, some caveats are in order. First, we have considered only positive changes to the policy tools assuming that the negative changes will have similar effect on our symmetric models. The literature on monetary policy pass-through suggests that pass-through is often different for positive and negative changes in the policy tools. As our data primarily refer to a period with monetary tightening, we leave this issue of asymmetric pass-through for future research. Second, the interbank market involves other players, like Islamic banks, microfinance banks, and non-bank financial institutions in addition to commercial banks. However, in view of their low shares in the interbank market, their excess liquidity position is unlikely to affect our conclusions.

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Appendix

Table A1 Estimates of Policy Impact on Lending Rate

Model #	(1)	(1)	(2)	(2)	(7)	(7)	(8)	(8)
Dependent Variable	**Lending rate**	**Discount rate**	**Lending rate**	**Discount rate**	**Lending rate**	**Required reserves**	**Lending rate**	**Required reserves**
Policy Tool	Discount rate	Discount rate	Discount rate	Discount rate	Required reserves	Lending rate	Required reserves	Lending rate
Liquidity Included	No	No	Yes	Yes	No	No	Yes	Yes
Lag Selection criteria	HQ	HQ	HQ	AIC	HQ	HQ	SBC	SBC
No of Lags	(5,5)	(5,5)	(5,5,5)	(5,5,5)	(1,1)	(1,1)	(1,1,1)	(1,1,1)
Lending rate (-1)	0.725*	0.122	0.725*	0.183*	0.720*	0.007	0.714*	-0.044
	[0.000]	[0.189]	[0.000]	[0.080]	[0.000]	[0.962]	[0.000]	[0.784]
Lending rate (-2)	-0.073	0.043	-0.191	0.057				
	[0.572]	[0.712]	[0.175]	[0.655]				
Lending rate (-3)	0.233**	-0.127	0.369*	-0.136				
	[0.064]	[0.263]	[0.005]	[0.261]				
Lending rate (-4)	0.0964	0.313*	-0.158	0.2100*				
	[0.458]	[0.008]	[0.238]	[0.085]				
Lending rate (-5)	-0.294*	-0.435*	-0.0477	-0.437*				
	[0.002]	[0.000]	[0.613]	[0.000]				
Discount rate (-1)	0.343*	0.878*	0.370*	0.907*				
	[0.002]	[0.000]	[0.001]	[0.000]				
Discount rate (-2)	-0.098	-0.432*	-0.236	-0.414*				
	[0.490]	[0.001]	[0.113]	[0.002]				
Discount rate (-3)	-0.004	0.224**	0.128	0.065				
	[0.980]	[0.088]	[0.409]	[0.645]				
Discount rate (-4)	0.0832	0.0783	0.0482	0.404*				
	[0.553]	[0.536]	[0.739]	[0.002]				
Discount rate (-5)	-0.034	0.1704**	-0.163	0.048				
	[0.744]	[0.072]	[0.149]	[0.641]				
Required reserves (-1)					0.065*	0.867*	0.060*	0.872*
					[0.000]	[0.000]	[0.000]	[0.000]
D(Excess liquidity (-1))			-0.064	-0.014			-0.070*	0.088
			[0.011]	[0.547]			[0.010]	[0.299]
D(Excess liquidity (-2))			-0.008	0.031				
			[0.735]	[0.171]				
D(Excess liquidity (-3))			0.0138	-0.0060				
			[0.589]	[0.783]				
D(Excess liquidity (-4))			-0.0224	-0.0310				
			[0.368]	[0.177]				
D(Excess liquidity (-5))			-0.054*	-0.008				
			[0.027]	[0.711]				
Intercept	0.696*	1.621*	1.855*	1.212*	1.503*	3.127*	1.669*	3.559*
	[0.037]	[0.000]	[0.001]	[0.020]	[0.004]	[0.047]	[0.003]	[0.040]
Break	0.0488	0.626*	0.677*	0.417*	1.110*	-0.692	1.164*	-0.569
	[0.750]	[0.000]	[0.018]	[0.031]	[0.000]	[0.258]	[0.000]	[0.379]
D(Break)	1.364*	0.473**	0.561	0.489**	0.255	1.026*	2.146	1.222
	[0.000]	[0.087]	[0.008]	[0.060]	[0.448]	[0.047]	[0.961]	[0.251]
Long run Pass-Through Coefficients								
Discount rate	0.928*		0.489					
	[0.002]		[0.196]					
Required reserves					0.232*		0.210*	
					[0.000]		[0.000]	
Lending rate		-1.042		11.322		0.0524		-0.344
		[0.282]		[0.190]		[0.962]		[0.784]
D(Excess liquidity)			-0.448	2.577			-0.244	0.686
			[0.018]	[0.593]			[0.010]	[0.299]

Notes: Gray columns indicate the auxiliary regression showing the reverse direction of presumed relationship. No. of lags read as (dependent variables, policy/impact variable, excess liquidity). * and ** respectively indicates significance at 5 and 10 percent level. HQ and AIC indicates Hannan-Quinn and Akaike Information Criteria respectively. Long-run pass-through estimates are based on Equation 7.

Table A2 Estimates of Policy Impact on Deposit Rate

Model #	(3)	(3)	(4)	(4)	(9)	(9)	(10)	(10)
Dependent Variable	**Deposit rate**	**Discount rate**	**Deposit rate**	**Deposit rate**	**Deposit rate**	**Required reserves**	**Deposit rate**	**Required reserves**
Policy Tool	Discount rate	Discount rate	Discount rate	Discount rate	Required reserves	Required reserves	Required reserves	Required reserves
Liquidity Included	No	No	Yes	Yes	No	No	Yes	Yes
Lag Selection criteria	HQ	HQ	HQ	HQ	HQ	HQ	SBC	SBC
No of Lags	(4,4)	(4,4)	(1,1,1)	(1,1,1)	(1,1)	(1,1)	(1,1,1)	(1,1,1)
Deposit rate (-1)	0.633*	0.119	0.841*	0.150*	0.691*	0.034	0.806*	-0.284*
	[0.000]	[0.137]	[0.000]	[0.006]	[0.000]	[0.823]	[0.000]	[0.030]
Deposit rate (-2)	0.298*	0.220*						
	[0.021]	[0.021]						
Deposit rate (-3)	-0.036	-0.114						
	[0.784]	[0.249]						
Deposit rate (-4)	-0.050	-0.188*						
	[0.672]	[0.031]						
Discount rate (-1)	0.267**	0.866*	-0.052	0.676*				
	[0.069]	[0.000]	[0.613]	[0.000]				
Discount rate (-2)	-0.456*	-0.459*						
	[0.015]	[0.001]						
Discount rate (-3)	0.603*	0.300*						
	[0.001]	[0.033]						
Discount rate (-4)	-0.323*	0.097						
	[0.012]	[0.311]						
Required reserves (-1)					0.099*	0.861*	0.052*	0.927*
					[0.000]	[0.000]	[0.015]	[0.000]
D(Excess liquidity (-1))			-0.054	-0.044			-0.019	0.087
			[0.174]	[0.112]			[0.640]	[0.331]
Intercept	0.0307*	1.570*	1.320	2.137*	-0.648	3.152*	-0.158	3.148*
	[0.933]	[0.000]	[0.074]	[0.000]	[0.154]	[0.003]	[0.760]	[0.006]
Break Dummy	0.0289	0.647*	0.562	0.814*	0.967*	-0.769	0.533*	0.331
	[0.877]	[0.000]	[0.076]	[0.000]	[0.000]	[0.136]	[0.004]	[0.418]
D(Break)	0.790**	0.360*	0.110	0.086	-0.327	1.083	0.070	0.569
	[0.054]	[0.000]	[0.823]	[0.799]	[0.429]	[0.261]	[0.875]	[0.564]
Long run Pass-Through Coefficients								
Discount rate	0.586		-0.325					
	[0.200]		[0.613]					
Required reserves					0.322*		0.301*	
					[0.000]		[0.000]	
Deposit rate		0.196		0.464*		0.246		0.072
		[0.501]		[0.006]		[0.823]		[0.950]
D(Excess liquidity)			-.342	-0.135			-0.112	0.654
			[0.174]	[0.112]			[0.327]	[0.304]

Notes: Gray columns indicate the auxiliary regression showing the reverse direction of presumed relationship. No. of lags read as (dependent variables, policy/impact variable, excess liquidity). * and ** respectively indicates significance at 5 and 10 percent level. HQ and AIC indicates Hannan-Quinn and Akaike Information Criteria respectively. Long-run pass-through estimates are based on Equation 7.

Table A3 Estimates of Policy Impact on Exchange Rate Growth

Model #	(5)	(5)	(6)	(6)	(11)	(11)	(12)	(12)
Dep. Var.	**Exchange rate**	**Discount rate**	**Exchange rate**	**Discount rate**	**Exchange rate**	**Required reserves**	**Exchange rate**	**Required reserves**
Policy Tool	Discount rate	Discount rate	Discount rate	Discount rate	Required reserves	Required reserves	Required reserves	Required reserves
Liquidity Included	No	No	Yes	yes	No	No	Yes	Yes
Lag Selection	HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ
No. of Lags	(4,4)	(4,4)	(2,2,2)	(2,2,2)	(1,1)	(1,1)	(1,1,1)	(1,1,1)
Exchange rate (-1)	0.281*	0.029	0.201**	0.065*	0.079	-0.066	0.081	-0.066
	[0.008]	[0.296]	[0.079]	[0.013]	[0.485]	[0.450]	[0.473]	[0.456]
Exchange rate (-2)	0.338*	-0.055*	0.319*	-0.070*				
	[0.001]	[0.039]	[0.007]	[0.010]				
Exchange rate (-3)	-0.043	-0.012						
	[0.683]	[0.679]						
Exchange rate (-4)	-0.100	-0.074*						
	[0.327]	[0.005]						
Discount rate (-1)	-0.479	0.972*	-0.796**	1.070*				
	[0.238]	[0.000]	[0.096]	[0.000]				
Discount rate (-2)	-0.069	-0.501*	0.890*	-0.275*				
	[0.899]	[0.000]	[0.037]	[0.005]				
Discount rate (-3)	0.8964**	0.328*						
	[0.098]	[0.019]						
Discount rate (-4)	-0.389	0.047						
	[0.268]	[0.608]						
Required reserves (-1)					-0.334*	0.847*	-0.332*	0.847*
					[0.000]	[0.000]	[0.000]	[0.000]
D(Excess liquidity(-1))			0.123	-0.025			0.122	0.083
			[0.307]	[0.367]			[0.262]	[0.328]
D(Excess liquidity (-1))			-0.029	-0.002				
			[0.794]	[0.933]				
Intercept	0.213	1.422*	-0.988	1.836*	7.263*	3.637*	7.249	3.653*
	[0.845]	[0.000]	[0.663]	[0.001]	[0.000]	[0.003]	[0.000]	[0.003]
Break	0.038	0.485*	-0.413	0.737*	-1.030*	-0.743*	-1.126	-0.813*
	[0.948]	[0.001]	[0.677]	[0.001]	[0.001]	[0.002]	[0.001]	[0.002]
D(Break)	-0.503	0.565**	-0.077	0.312	0.320	0.969	0.812	1.307
	[0.675]	[0.068]	[0.957]	[0.336]	[0.780]	[0.278]	[0.503]	[0.167]
Long run Pass-Through Coefficients								
Discount rate	-0.078		0.196					
	[0.746]		[0.713]					
Required reserves					-0.363*		-0.362	
					[0.002]		[0.000]	
Exchange rate		-0.725*		-0.024		-0.434		-0.431
		[0.003]		[0.874]		[0.450]		[0.456]
D(Excess liquidity)			0.195	-0.132			0.133	0.541
			[0.567]	[0.471]			[0.262]	[0.328]

Notes: Gray columns indicate the auxiliary regression showing the reverse direction of presumed relationship. No. of lags read as (dependent variables, policy/impact variable, excess liquidity). * and ** respectively indicates significance at 5 and 10 percent level. HQ and AIC indicates Hannan-Quinn and Akaike Information Criteria respectively. Long-run pass-through estimates are based on Equation 7.

Table A4 Diagnostic Checks of the Estimated Relationship

Model #	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent Variable	**Lending rate**		**Deposit rate**		**Exchange rate**		**Lending rate**		**Deposit rate**		**Exchange rate**	
D(Excess Liquidity) included	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Policy Instrument	Discount rate						Required reserves					
Serial Correlation	1.912	10.871	1.042	5.296	6.346	11.728	0.401	6.628	0.326	7.061	0.813	13.137
	[0.752]	[0.285]	[0.904]	[0.808]	[0.175]	[0.230]	[0.983]	[0.676]	[0.989]	[0.631]	[0.937]	[0.156]
Normality	1.644	0.339	18.198	16.060	200.357	135.919	40.221	76.551	28.066	24.231	48.892	32.721
	[0.440]	[0.844]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
EV Stability Condition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The serial correlation is tested using the LM test. For checking stability of VAR models, Eigen value stability conditions requires these calculated Eigen values to be should be strictly less than one (Lütkepohl, 2005). The normality of residuals is tested using the Jargue-Bera test. Table presents only the normality test for the main model where policy tool (and excess liquidity) affects the impact variables (lending rate, deposit rate, and exchange rate). Both test statistics are Chi-square test statistics.

Figures

Figures for the kernel density estimates show the density estimates of residuals and a normally distributed data with similar features. 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.

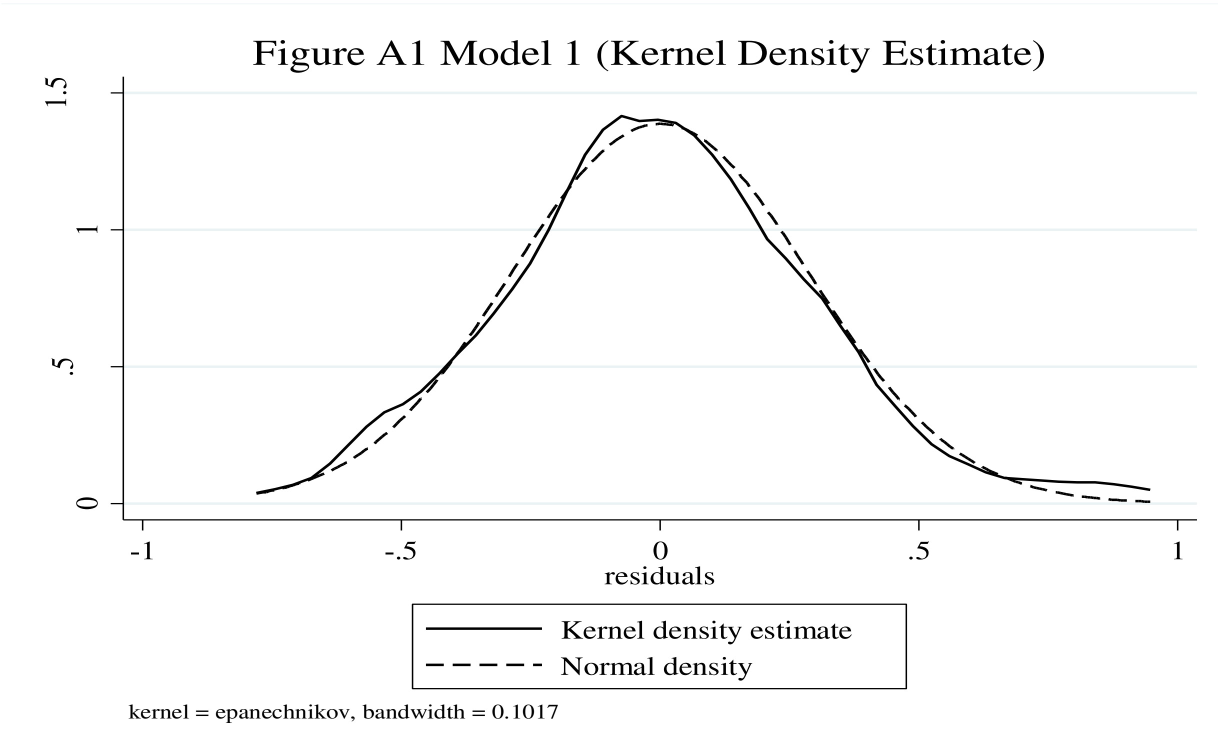


Figure A2 Model 2 (Kernel Density Estimate)

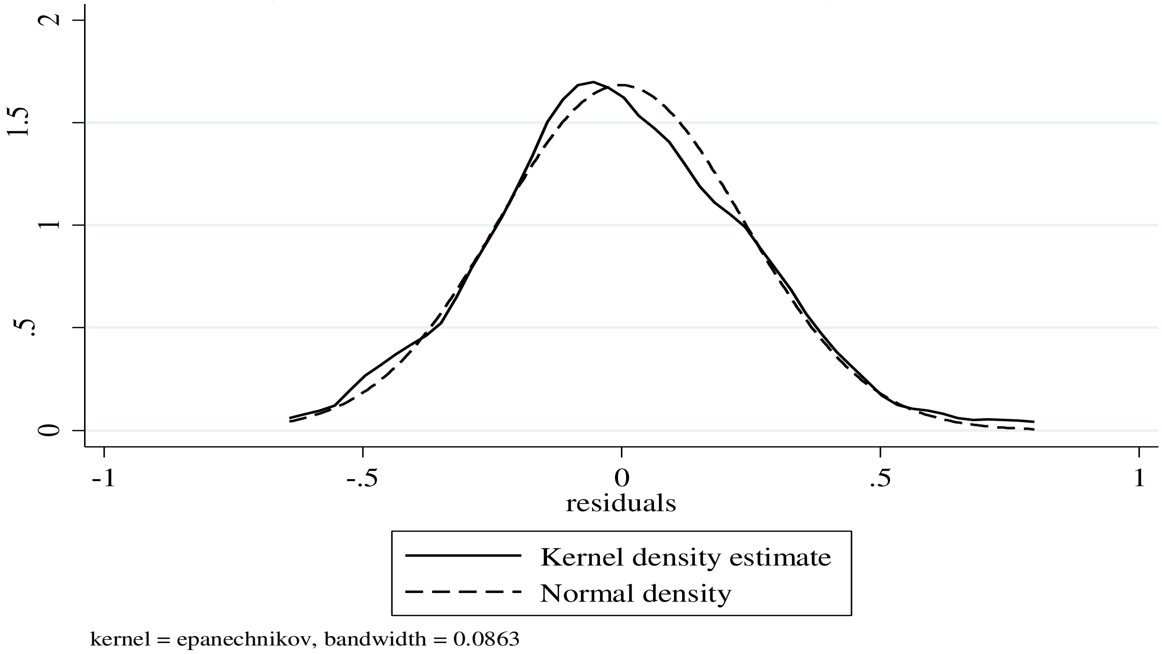


Figure A3 Model 3 (Kernel Density Estimate)

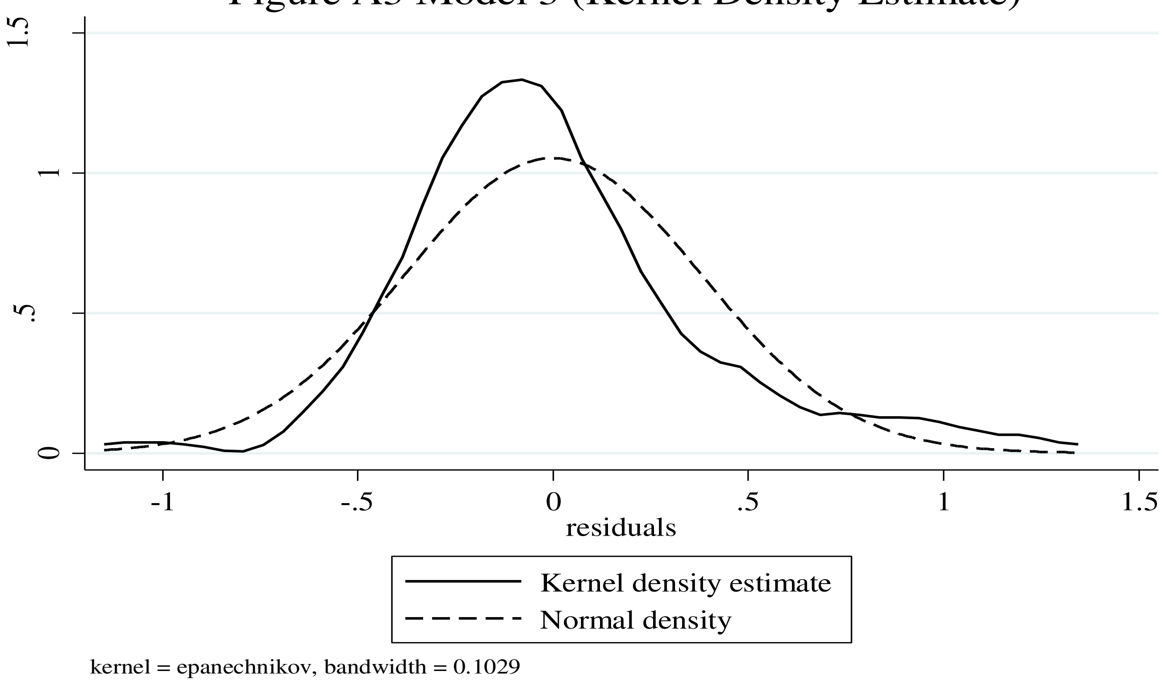


Figure A4: Model 4 (Kernel Density Estimate)

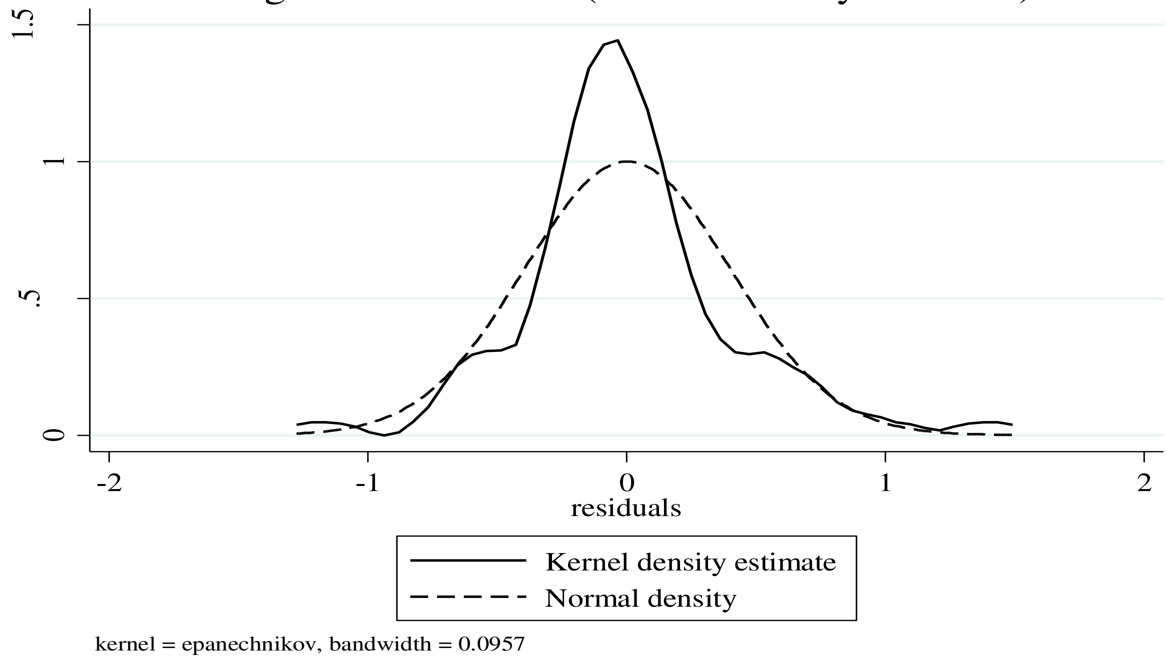
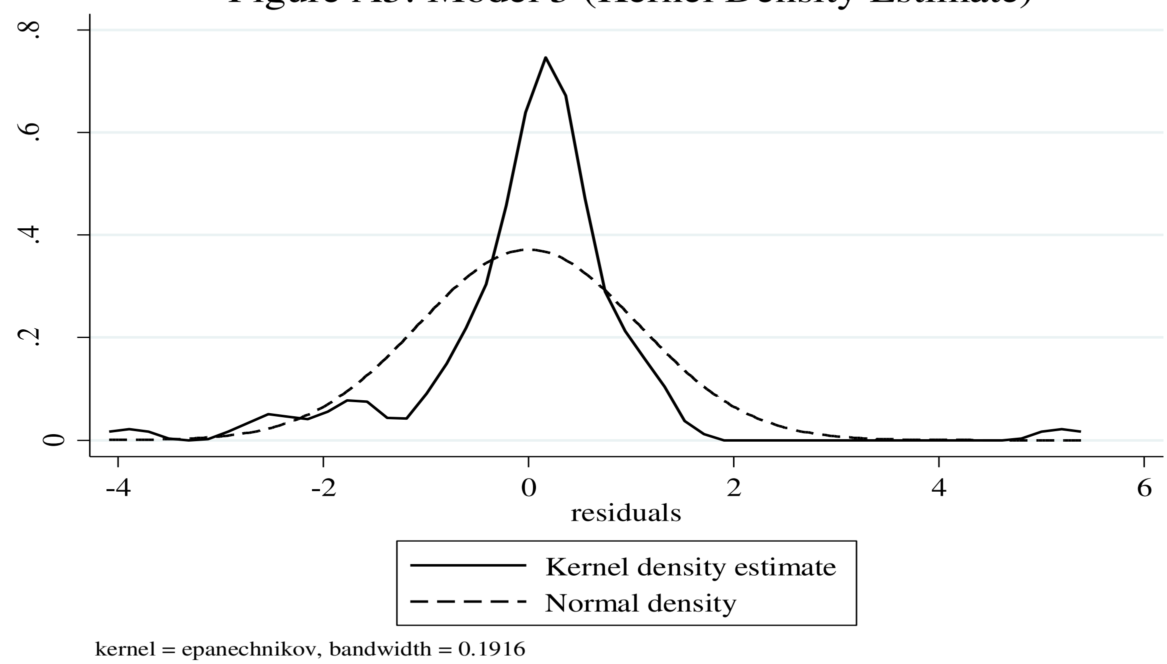


Figure A5: Model 5 (Kernel Density Estimate)



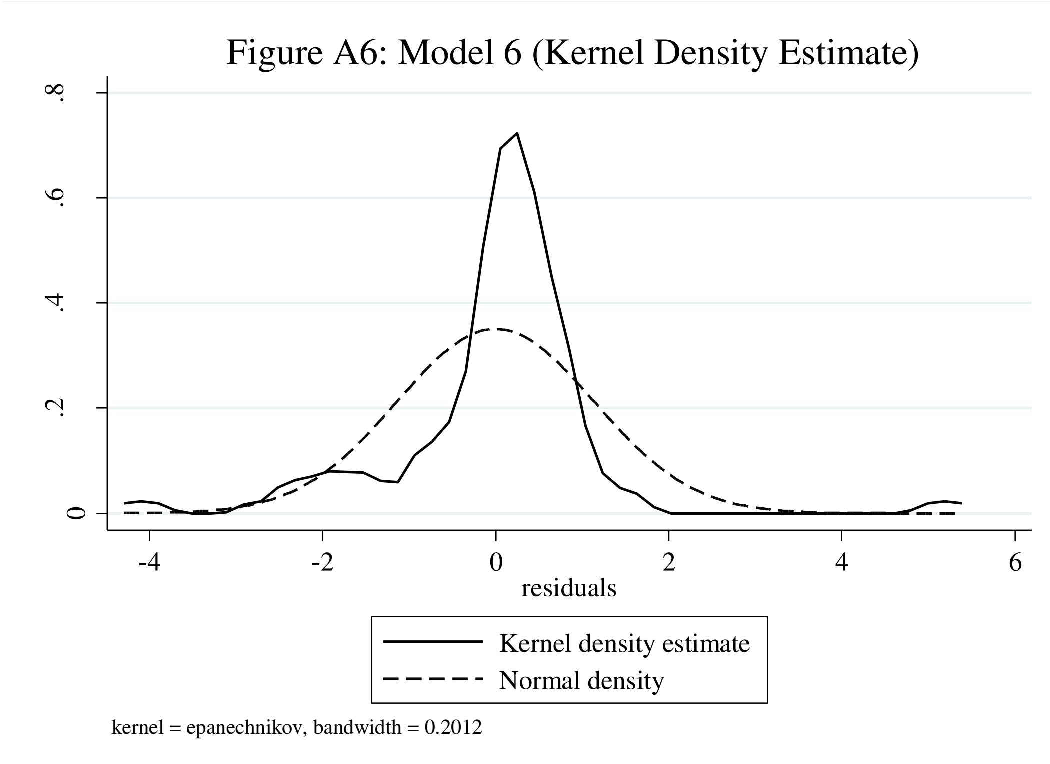


Figure A6: Model 6 (Kernel Density Estimate)
0
.2
.4
.6
.8
-4
-2
0
2
4
6
residuals
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.2012

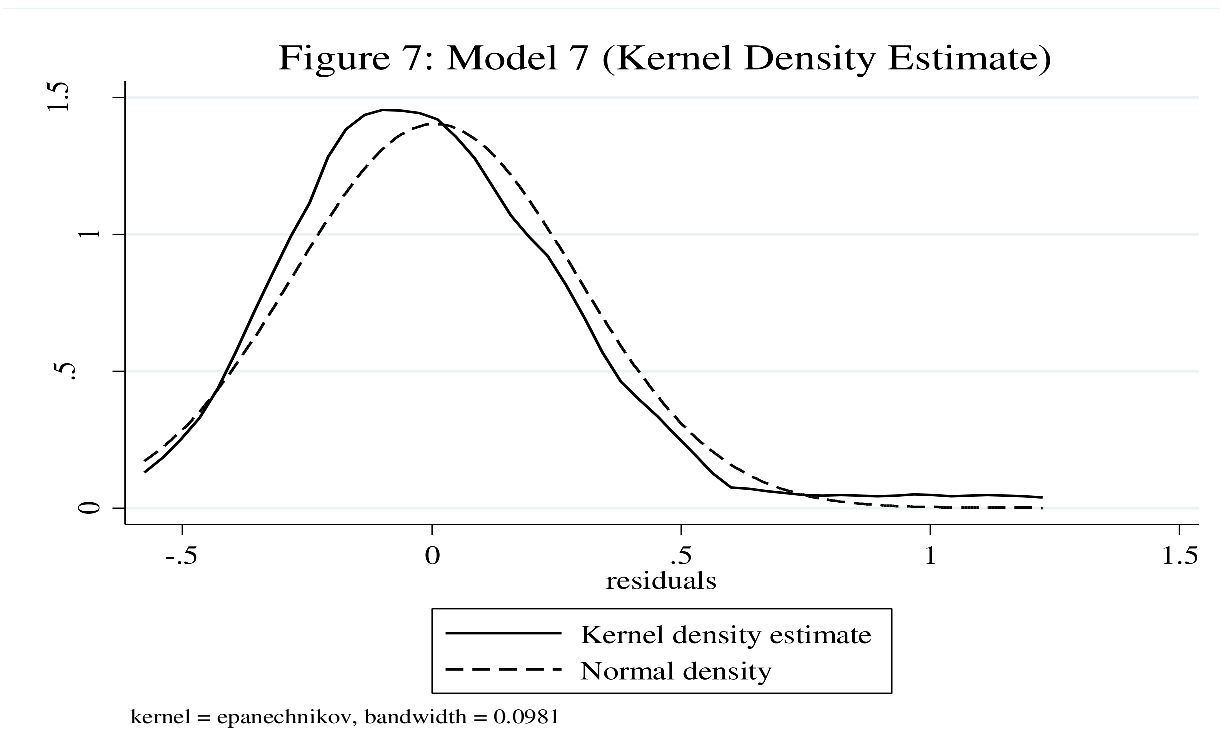


Figure 7: Model 7 (Kernel Density Estimate)
0
.5
1
1.5
-.5
0
.5
1
1.5
residuals
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.0981

Figure A8: Model 8 (Kernel Density Estimate)

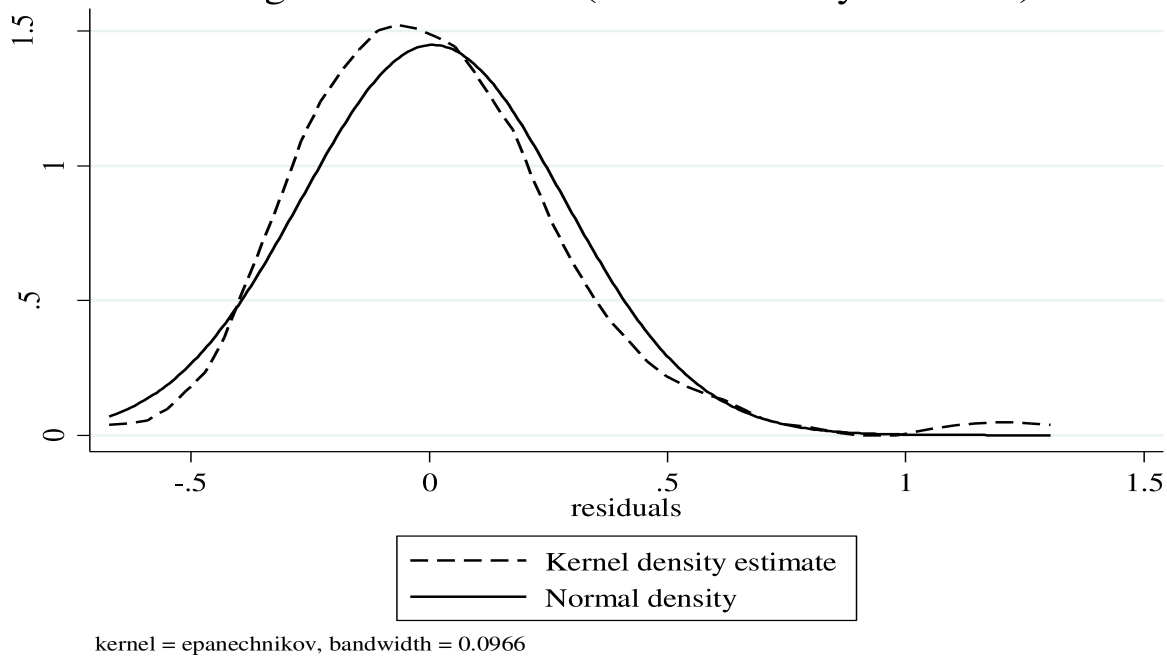
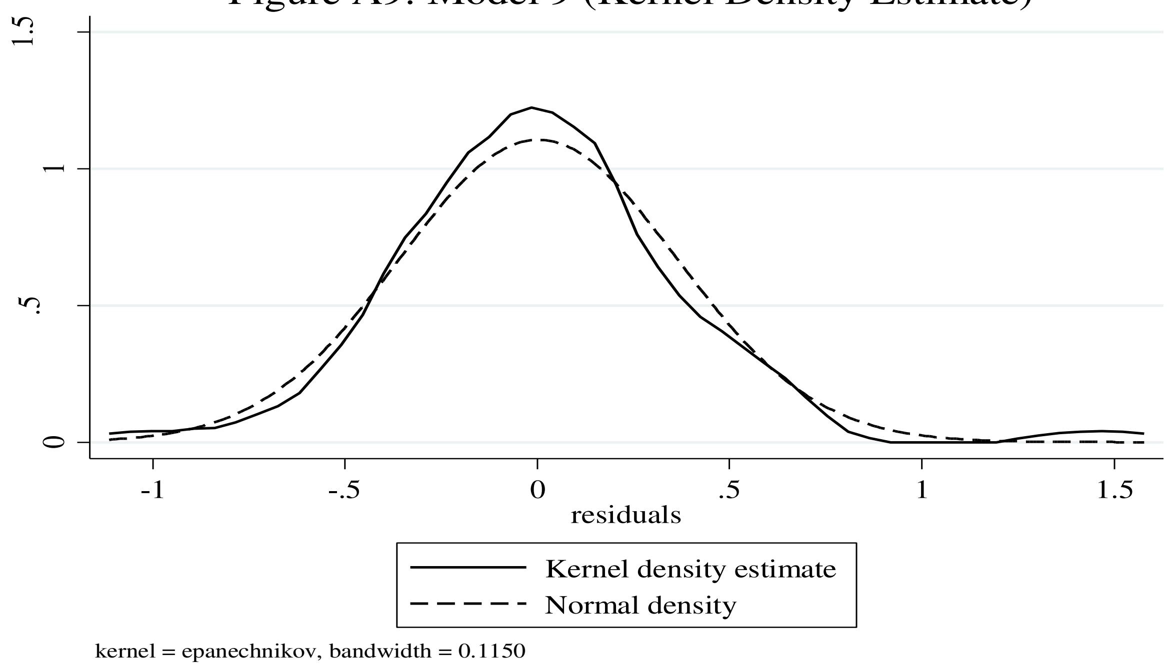


Figure A9: Model 9 (Kernel Density Estimate)



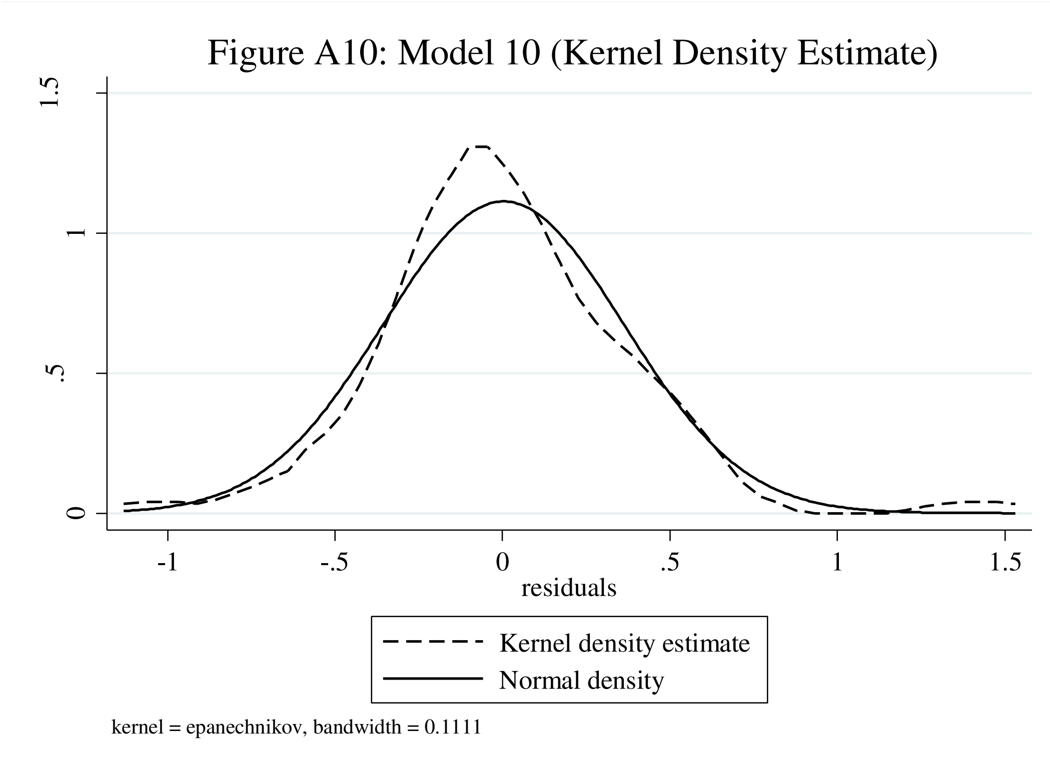


Figure A10: Model 10 (Kernel Density Estimate)
0
.5
1
1.5
-1
-.5
0
.5
1
1.5
residuals
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.1111

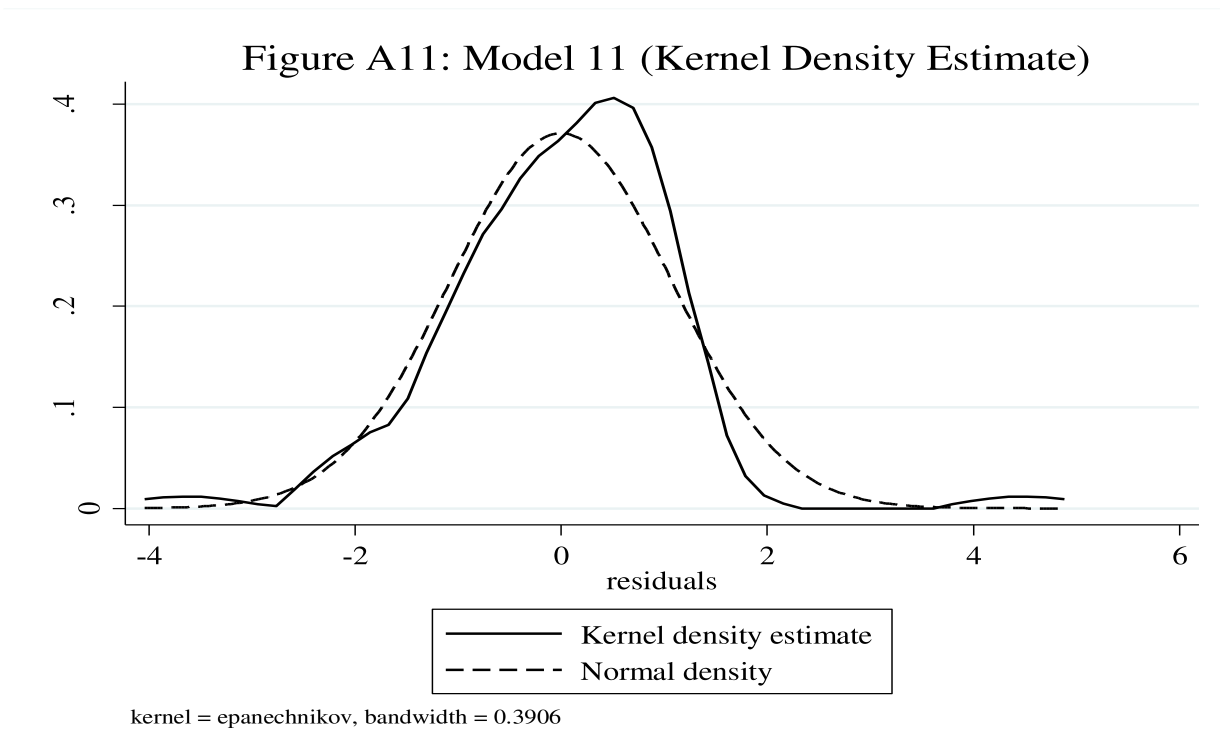


Figure A11: Model 11 (Kernel Density Estimate)
0
.1
.2
.3
.4
-4
-2
0
2
4
6
residuals
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.3906

Figure A12: Model 12 (Kernel Density Estimate)