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Empirical Evidence for the Bank Lending Channel in Bosnia and Herzegovina: Does Lending Differ Between Large and Small Banks?

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Abstract

The paper investigates transmission of different foreign and domestic shocks to bank lending activity in Bosnia and Herzegovina through the bank lending channel. The bank lending channel is analyzed in a time series cross sectional data framework for the period 2006q1-2014q1, investigating reactions of small vs. large banks to those shocks. First, the evidence has been found that both groups of banks decreased their lending activity in the aftermath of the crisis. There is some evidence that liquidity shock after the onset of the crisis is mainly transmitted through large banks that are affiliates of the large Western European banking groups. Second, strong evidence is found that loosening of domestic monetary conditions through required reserves rate change had a positive effect on lending supply, especially for small banks operating in the country.

1. Introduction

The cross-border banking literature argues that large foreign banks presence helps maintaining lending activity in the host country in the case of domestic economy turbulence, but has a drawback of transmitting the home country shocks to the host country economy. On the other hand, according to the bank lending channel literature, domestic monetary policy shocks that influence banks deposits and through them their lending activity should have a greater effect on small banks in comparison to the large foreign owned banks. The large foreign banks can potentially finance themselves through internal liquidity funds that exist within the banking group they belong to.

We assess in the case of Bosnia and Herzegovina the relevance of the bank lending channel for the transmission of different foreign and domestic monetary shocks on domestic loan supply. Bosnia and Herzegovina has a bank-centric financial system, with dominant position of foreign banks in the market that are affiliates of the large Western-European banking groups. Additionally, there are small foreign banks and standalone domestic banks that generally operate in their local market niches. During the observed period, banking system has been exposed to the influence of various foreign and domestic monetary shocks that are expected to be mainly transmitted through the bank lending channel due to the central role the banking system plays in the process of financial intermediation. Those shocks potentially have a differential effect on lending activity of the large and the small banks in the system.

Graphical analysis and difference-in-difference analysis helps us to determine whether the reaction in terms of lending to the private sector to those shocks of the large banks was different in comparison to the small banks. We use formal regression analysis on the time series cross sectional data for the period 2006q1-2014q1 to determine the reaction of the banks' loan supply to those shocks, explicitly controlling for the loan demand. The two main shocks are analyzed: the liquidity shock in international financial markets round the onset of the large financial crisis in 2008q3 and the domestic monetary policy shock in the form of required reserves rate change in 2011q1.

The formal regression analysis in the paper gives a strong evidence of a negative substantial lending supply shock to Bosnia and Herzegovina's banking system after the onset of the crisis. The transmission of this liquidity shock was strong for both the large and the small banks operating in the country. There is some evidence that liquidity shock after the onset of the crisis is primarily transmitted through the large banks that belong to Western European banking groups. The reaction of banks after the crisis shock in terms of the overall lending to the private sector was mainly the result of similar developments in the long term loans category. It appears that large foreign banking groups deleveraging process that started after the onset of the crisis was mainly reflected in the development of the loans to enterprises, since domestic private firms are probably recognized as potentially the largest credit risks and more stringent credit standards were applied.

On the other hand, strong evidence is found that loosening of domestic monetary conditions through required reserves (RR) instrument had a positive effect on the loan supply,

especially for small banks operating in the country. In accord with the earlier empirical findings in the literature on the bank lending channel, the positive domestic monetary policy impulse was primarily transmitted through the small banks that used additional liquidity funds acquired by the lower RR rate to increase the pace of their lending activity. This confirms that monetary policy can have significant effects in the economy even in the context of a currency board.

The rest of the paper is structured as follows. The next section presents main findings in the literature on the bank lending channel, with a special emphasis on the cross-border banking literature. Section 3 explains the main characteristics of Bosnia and Herzegovina's monetary and financial system and discusses key developments in the banking sector and especially in the credit market. Section 4 describes dataset used for the empirical analysis, while section 5 outlines econometric methodology adopted in the empirical analysis. Section 6 discusses the results of the analysis of the transmission of different shocks through the bank lending channel. The last section concludes.

2. Literature Review

Bank lending channel accounts for the significant part of the literature on the monetary transmission mechanism (Gertler and Gilchrist, 1993; 1994; Kashyap and Stein, 1995; 2000; Peek and Rosengren, 1995; 1997; 2003; Kishan and Opiela, 2000; 2006; Gambacorta, 2005 and many others). It emphasizes the role banking sector plays in amplification of the monetary policy signals, primarily through the impact of monetary policy on the supply of loans to bank dependent borrowers. The theoretical background was developed by Bernanke and Blinder (1988), where the IS curve is replaced by the credit-commodity (CC) curve to produce CC-LM model.

The bank lending channel is based on the idea that banks' cost of funds increases in response to restrictive monetary policy. Traditional depictions of the mechanism differ in the way in which the rise in the marginal cost of funding is modeled and are premised either on the concept of the money multiplier or a portfolio-rebalancing view of households' assets. The first conceptualizations are based on the ability of central banks to directly manipulate the level of deposits through the money multiplier mechanism (Bernanke and Blinder, 1988; Kashyap and Stein, 1995; Stein, 1998; Walsh, 2003). The second, more recent interpretations rely on portfolio substitution arguments whereby the policy tightening reduces the relative yields on deposits, inducing households to economize on them (Ehrman et al, 2001). Both are premised on the assumption that the central bank can closely influence the amount of deposits in the banking system that then forces banks to alter the composition of their financing away from relatively cheap deposits to more expensive managed liabilities. In essence, changes in the quantity of deposits generated by monetary policy measures bring about changes in the loan supply of banks which, in turn, affect investment and consumption of bank dependent borrowers, mainly small and medium sized enterprises and households. The imperfect substitutability between loans and other financial assets in the bank's balance sheet on one hand, and that between bank loans and other forms of financing on firm's balance sheets on the other hand are central to the existence of the bank lending channel.

The alternative interpretation of the bank lending channel in modern financial systems in which banks heavily rely on market-based funding has been offered in Disyatat (2010). In this framework, the bank lending channel works mainly through the impact of monetary policy on the bank balance sheet strength. The underlying premise is that variations in the health of financial intermediaries, in terms of leverage and asset quality, as well as in perceptions of risk constitute the more relevant mechanism through which the effect of monetary policy shocks may be propagated through the economy. The focus in this framework is on financial frictions at the level of financial intermediaries and how policy-induced variations in their external finance premium are reflected in the cost of funds to borrowers that are dependent on these institutions. This conceptualization of bank lending channel can help explain how real economy can be affected by shocks that originate from the financial sector, especially in the context of the current global financial crisis. Banks can act, depending on the state of their balance sheets, either as absorbers or amplifiers of such shocks.

A contraction in banks' reservable deposits has distinct effects across different types of banks, such as small stand-alone banks, small banks affiliated to larger bank holding companies and large banks (Kashyap and Stein, 2000). A monetary policy tightening that leads to reduced amount of reservable deposits can translate into a reduction in bank lending activity when banks are unable to replace lost deposits with other liabilities. The reduced liabilities generally lead to a combination of reduced liquid assets and reduced lending supply of those banks. The process is inverted in the case of an expansionary monetary policy.

Large banks or bank holding companies generally apply two business strategies: they can either be domestically oriented or spread their operations across foreign markets. Balance sheet effects of banks with international operations incorporate transmission of shocks through internal capital markets that are statistically and economically important (Cetorelli and Goldberg, 2008).

Throughout the transition process during the 90s large Western-European banks largely entered into the region of Central and Eastern Europe. Those banks were attracted to the region due to profit opportunities because of its scope for financial deepening and its ample growth potential, especially in comparison to their saturated home markets. Financial integration was welcomed by domestic policy makers and international institutions because of its presumed positive impact on the efficiency and stability of local banking systems. The empirical evidence suggests that foreign banks stimulated competition and transferred know-how (Fries and Taci, 2005; Havrylchyk and Jurzyk, 2011) and were relatively stable sources of credit during turbulent periods in local economies (De Haas and Van Lelyveld, 2006).

When the global crisis started, most of large banks with cross-border operations were affected by the sharp reduction in the interbank liquidity towards the end of 2007. The banks started deleveraging both home and especially abroad and the process accelerated after the collapse of Lehman Brothers in September 2008 (Cetorelli and Goldber, 2011; De Haas and Van Horen, 2012). This process had negative effects on the economies of the Eastern-European countries that cumulated imbalances and vulnerabilities through the process of credit and domestic demand booms in the pre-crisis period.

The cross-border banking literature, investigating the effects of liquidity shocks in bank funding markets on the bank lending channel during the global financial crisis, can roughly be divided into two generations, with the *first generation of papers* analyzing the impact of US subprime crisis-related liquidity shocks on bank lending (Allen, Hryckiewicz, Kowalewski and Tümer-Alkan, 2010; Iyer, Lopes, Pezdro and Schoar, 2010; Ivashina and Scharfstein, 2010; Cetorelli and Goldberg, 2011; Kapan and Minoiu, 2012; Dagher and Kazimov, 2012; Ivashina, Scharfstein and Stein, 2012; Ajyar, 2012; Bonaccorsi di Patti and Sette, 2012; De Haas and Van Horen, 2012, 2013; Kapan and Minoiu, 2013) and a *second generation of papers* looking at the impact of the more recent European sovereign debt crisis on lending (Bofondi, Carpinelli and Sette, 2012; Popov and van Horen, 2012; Correa, Sapriya and Zlate, 2012). Most of empirical findings in the literature support standard propositions regarding the influence of bank specific characteristics on this form of bank lending channel – reliance on market funding is negatively associated with the supply of bank credit (Aiyar, 2012; Cornett, McNutt, Strhan and Tehranian, 2011; Ivashina and Scharstein, 2010; Raddatz, 2010); banks with higher structural liquidity are better able to maintain lending when exposed to shocks (Vasquez and Federico, 2012); banks that were more exposed to liquidity shocks in the interbank market reduce total lending (Raddatz, 2010; Allen, Hryckiewicz, Kowalewski and Tümer-Alkan, 2010); and well capitalized banks are better able to sustain the supply of credit during crisis (Brei, Gambacorta and von Peter, 2012; Kapan and Minoiu, 2013).

Cetorelli and Goldberg (2011) show that after the onset of a crisis there are three possible forms of banks transmission of liquidity shocks: the cross border loan contraction, the contraction in affiliates lending and the contraction in lending of small stand-alone domestically owned banks. Large banks hit by an adverse liquidity shock generally reduce their direct cross-border lending and activate an internal capital market channel by reducing funding to affiliates abroad or actively transferring foreign funds in support to the head office balance sheet that results in a significant decrease in the affiliate's loan supply in emerging market countries. On the other hand, small domestically owned banks in those countries that rely on external capital markets for funding local activities cut lending supply as well, as a result of funding squeeze in the cross border interbank borrowing market.

3. Stylized facts about Bosnia and Herzegovina's monetary and banking system

The Central bank of Bosnia and Herzegovina (CBBH) implements currency board, a non-discretionary monetary policy strategy that is based on the rules explicitly stipulated in its legislation.[1] The basic purpose of those rules is to establish the credibility of the CBBH and to avoid potential adverse macroeconomic development that may occur due to possible inconsistencies of policymakers' decisions. Those rules are the following:

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[1] The Central Bank of Bosnia and Herzegovina was established in accordance with the Law adopted at the Parliament of Bosnia and Herzegovina on 20 June 1997. The main rules of the currency board are incorporated into the Law on the Central Bank. The Central Bank started its operation on 11 August 1997.

First, the exchange rate of the national currency, the convertible mark, is pegged to the euro.[2] The exchange rate represents a fixed nominal variable which anchors the inflationary expectations of the public, thereby ensuring price stability in the economy. Second, full convertibility of the domestic currency into the reserve currency – the euro – and vice versa is guaranteed and thereby indirectly into other foreign currencies. Money is put into circulation and withdrawn from it by way of the CBBH buying and selling domestic currency in exchange for foreign currencies. The CBBH performs purchasing and selling transactions with commercial banks as well as with government institutions which hold deposits with the CBBH, while other economic agents receive funds in the domestic currency through the commercial banks. Third, net foreign exchange reserves of the CBBH must at all times fully cover its monetary liabilities in domestic currency that include all bills and coins in circulation, the balances on commercial banks' reserve accounts with the CBBH and other demand deposits with the CBBH. The CBBH has no authority to monetize fiscal deficit or to lend to any economic agents, and it does not act as the lender of last resort to assist banks in overcoming liquidity related problems. The policy of non-lending follows from the basic rules of the currency board and is one of the preconditions for its sustainability. Bosnia and Herzegovina's currency board has all the characteristics of an orthodox currency board, with required reserves as its sole instrument of monetary policy.

The lack of standard monetary policy tools found in classical central banks with independent monetary policy does not necessarily mean that an economy that applies the currency board system is missing some important links, or channels through which the effects of monetary shocks are transmitted through the economy. The strength and the structure of the respective links may be different in various monetary systems and it is realistic to expect that implementation of the currency board imparts specific features to the process of transmission of monetary signals through the economy.

The Bosnia and Herzegovina's financial system is bank oriented – the banks are main providers of credit in the economy, especially for small and medium sized enterprises and households, as shown in Table 1. Other financial institutions include leasing companies, microcredit organizations, investment funds and insurance/reinsurance companies, but with comparatively small assets size. There are two stock exchanges in the country – Banja Luka and Sarajevo stock exchange – but only very large, reputable companies finance themselves through the capital market. After reaching its peak before the onset of the crisis, the stock market capitalization has been stagnating ever since. On the other hand, even though government securities market has been gaining its momentum in the last couple of years, it is still fragmented, mainly concentrated on short maturities and with very few transactions in the secondary market.

Table 1: Structure of Bosnia and Herzegovina's financial sector

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[2] The euro plays a role of the reserve, or anchor currency for the domestic currency. The fixed exchange rate of the euro against convertible mark is EUR 1 = KM 1.95583.

Intermediaries & capitalization/year	2008		2009		2010		2011		2012		2013	
	in million KM	% of BDP	in million KM	% of BDP	in million KM	% of BDP	in million KM	% of BDP	in million KM	% of BDP	in million KM	% of BDP
Banks	20,815	83.3	20,608	84.8	20,416	82.1	20,995	81.5	21,186	82.3	22,026	83.8
Leasing companies	1,225	4.9	871	3.6	744	3.0	767	3.0	716	2.8	597	2.3
Microcredit organizations	1,607	6.4	1,416	5.8	853	3.4	742	2.9	676	2.6	667	2.5
Investment funds	890	3.6	1,000	4.1	888	3.6	810	3.1	796	3.1	762	2.9
Insurance & reinsurance companies	1,213	4.9	1,087	4.5	941	3.8	1,077	4.2	1,174	4.6	1,146	4.4
Stock & bond market capitalization	11,798	47.2	11,219	46.2	11,146	44.8	8,297	32.2	8,433	32.8	8,864	33.7

Source: Central Bank of Bosnia and Herzegovina.

The banking sector in Bosnia and Herzegovina underwent a process of privatization and consolidation. Regarding the ownership structure, at the end of 2013, 17 banks were foreign owned and 8 domestically owned, of which 6 private and 2 state owned banks. Banking system maintained its stability, but lately several banks have started showing signs of weaknesses. It is well capitalized at the system level as shown in Table 2. Strong credit growth during the booming period before the crisis came with a high price – a slowdown in the credit growth after the onset of the crisis and a high level of credit risk as the result of a relatively high share of non-performing loans in the overall credit portfolio. Similar to other countries in the region, even though large foreign banking groups maintained their presence in the country, they started to deleverage – reduced the funding of their operations and began withdrawing the capital. The future outlook of the banking sector mainly depends on the pace of the deleveraging process and the ability of banks to change their business model to start financing credit growth by domestic deposit funds, as well as on the way the problem of non-performing loans is going to be resolved.

Table 2: Main indicators of Bosnia and Herzegovina's banking sector

Item/Year	2006	2007	2008	2009	2010	2011	2012	2013
No. of licenced banks	32	32	30	30	29	29	28	27
Assets, in % of GDP	76.3	89.8	85.3	87.4	85.5	85.3	86.2	84.3
Assets, yoy growth in %	23.8	32.9	7.7	-0.5	0.8	3.4	2.0	4.0
Lending, yoy growth in %	23.4	28.8	22.4	-3.2	2.5	6.3	4.1	3.4
Non-performing loans, in % of total loans	4.0	3.0	3.1	5.9	11.4	11.8	13.5	15.1
Forex and indexed loans to total loans, in %	70.8	74.1	73.3	73.9	70.0	66.9	63.1	62.9
Liquid assets to total assets, in %	35.9	37.7	30.0	30.9	29.0	27.2	25.4	26.4
Tier 1 capital, % of total risk weighted assets	13.6	12.6	12.0	12.4	12.6	13.6	14.1	15.2
Capital adequacy ration (CAR)	17.7	17.1	16.2	16.1	16.2	17.1	17.0	17.8
Return on average assets (ROAA)	0.9	0.8	0.4	0.1	-0.6	0.7	0.6	-0.2
Return on average equity (ROAE)	8.4	8.6	4.2	0.8	-5.5	5.8	4.9	-1.4

Source: Central Bank of Bosnia and Herzegovina

Loans to private sector, mainly extended to small and medium sized private enterprises and households, account for the lion's share of the overall loans extended by banks. Other loans extended by banks include loans to public non-financial enterprises, loans to the government and other loans (see Figure 2). Foreign banks are the main providers of credit to the private sector.

Figure 2: Sectoral distribution of total bank loans and loans to private sector
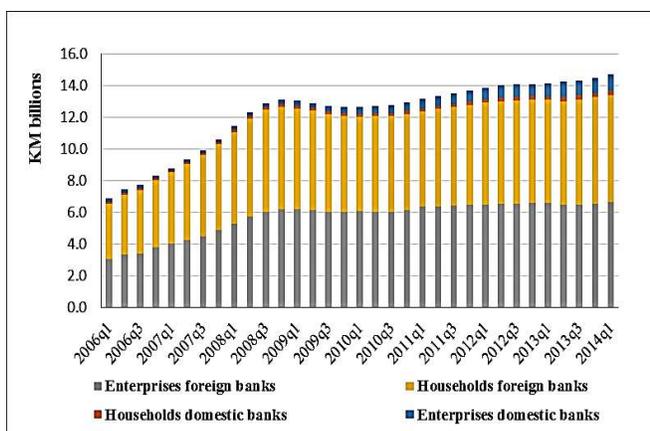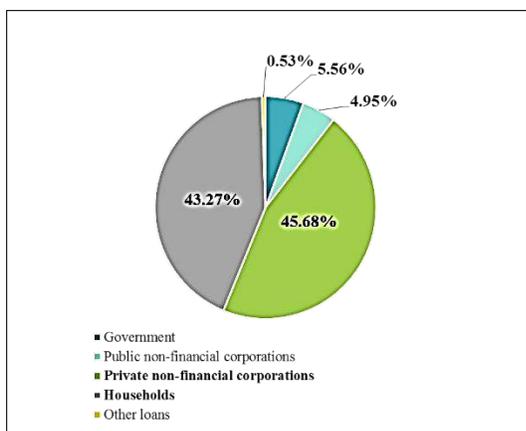
Approximately 80% of loans to the private sector are long term with maturity over one year, while slightly more than 20 % of loans are short term. Most loans are extended in the domestic currency, with very small share of loans extended in foreign currencies. Majority of the loans in domestic currency are indexed to euro (Figure 3).[3]

Figure 3: Term and currency structure of bank loans to private sector
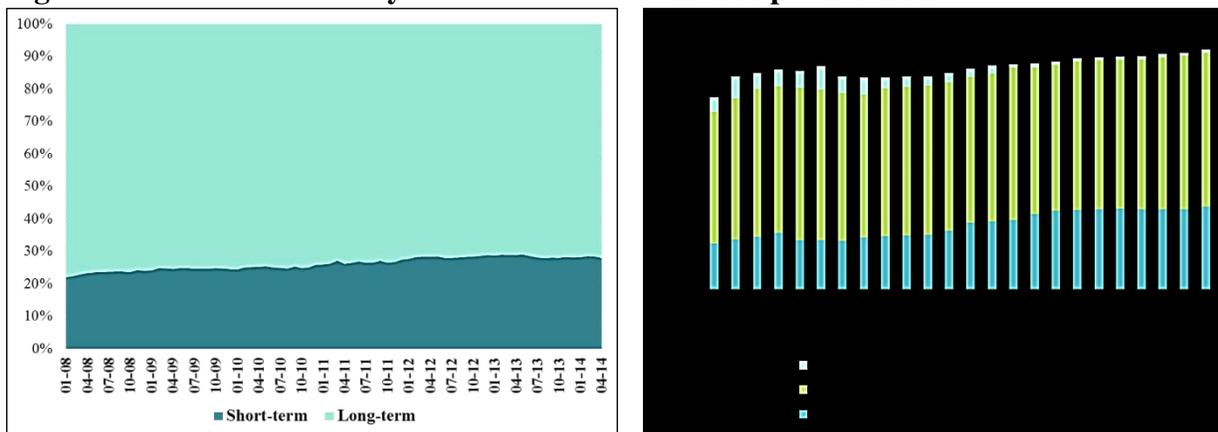
The period before the crisis was marked with a rapid credit expansion, reaching its peak of annual credit growth of round 30% just before the Lehman Brothers collapse. In order to prevent potential dangers of overheating of the economy, CBBH was trying to curb rapid credit expansion by several bouts of increases in the required reserves rate.

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[3] By indexing loans to euros banks protect themselves against potential currency risk, acknowledging the risks to the currency board stability.

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Text Box 1: CBBH required reserves changes

  The monetary strategy of the Central Bank of Bosnia and Herzegovina can be characterized as an orthodox currency board. The only instrument at the CBBH disposal are required reserves (RR). The bank changed RR rate several times with different goals in the expansionary and contractionary phase of the cycle. Changes in the RR rate to curb rapid credit expansion during the pre-crisis period included:

- September 2004 - increase in the RR rate from 5% to 7.5%,
- December 2004 - increase in the RR rate from 7.5% to 10%,
- October 2005 - increase in the RR rate from 10% to 15%,
- January 2008 - increase in the RR rate from 15% to 18%.

On the other hand, changes in the RR rate to stimulate credit growth during the crisis included:

- October 2008 – decrease in the RR rate from 18% to 14%,
- November 2008 – newly borrowed funds (deposits and credit lines) are excluded from the base for the RR calculation,
- January 2009 – introduction of two RR rates according to the maturity of the base: 14% on the short term base with the maturity up to 1 year, 10% on the long term base with the maturity over 1 year.

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  However, after the onset of the crisis, banks significantly decelerated the pace of credit growth, possibly due to both demand and supply factors. Cetorreli and Goldberg (2010) show that the transmission of a liquidity shock through the large banks internal capital markets or through the small banks interbank borrowing market can result in a significant decrease in the loan supply in emerging market countries. Thus, from very high figures, the growth rates even went into the negative territory in the immediate aftermath of the crisis and recovered somewhat in the later period. Contrary to the pre-crisis period, the CBBH now tried to stimulate the credit growth by lowering and differentiating RR rate.

Figure 4: Annual growth rates of loans to private sector and required reserves rate
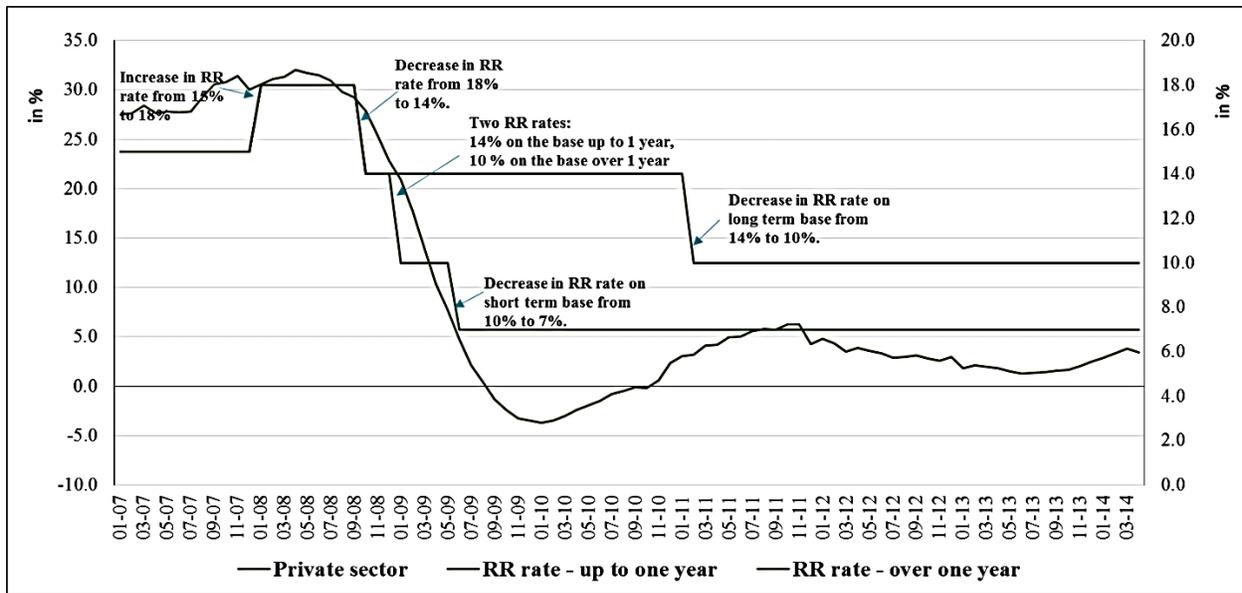
The commercial banks in Bosnia and Herzegovina maintain relatively high level of excess liquidity at their reserve accounts with the central bank. In the process of liquidity management banks have several options: to invest liquid funds into the instruments of the Eurozone money market, to hold them in the form of domestic money market instruments or to keep them at reserves accounts with the Central Bank. The reasons for the high level of liquidity at reserves accounts are mainly twofold. First, with this form of liquidity they were easily able to meet regulatory provisions of banking agencies on term and currency structure of assets and liabilities side of their balance sheets and the other reason was that the CBBH paid remuneration on those funds close to the market rates. By the changes of the required reserves rate, the CBBH intended to control credit potential of commercial banks since those liquidity funds may be used to extend credit – capture those funds with the RR increases and release them by lowering RR rate.

The dominant position of the banks in Bosnia and Herzegovina indicate that the bank lending channel should have an important role in the transmission of monetary shocks in the economy. Contrary to the liquidity shock at the onset of the crisis, the RR change is expected to primarily affect relatively small banks, with limited access to capital markets, because the large foreign owned banks can regulate their funding needs through their internal liquidity markets (Kashyap and Stein, 1994; 2000). Therefore, a negative/positive monetary policy shock is expected to lead to a sharper decrease/increase in lending of the small banks than is the case for the large banks. Since there is a question of endogeneity of RR changes during the deceleration of credit growth in the immediate aftermath of the crisis, the expansionary monetary policy shock in the form of RR reduction at 2011q1 is of special interest for the empirical analysis.

Figure 4: Banks reserves account balance and required reserves changes
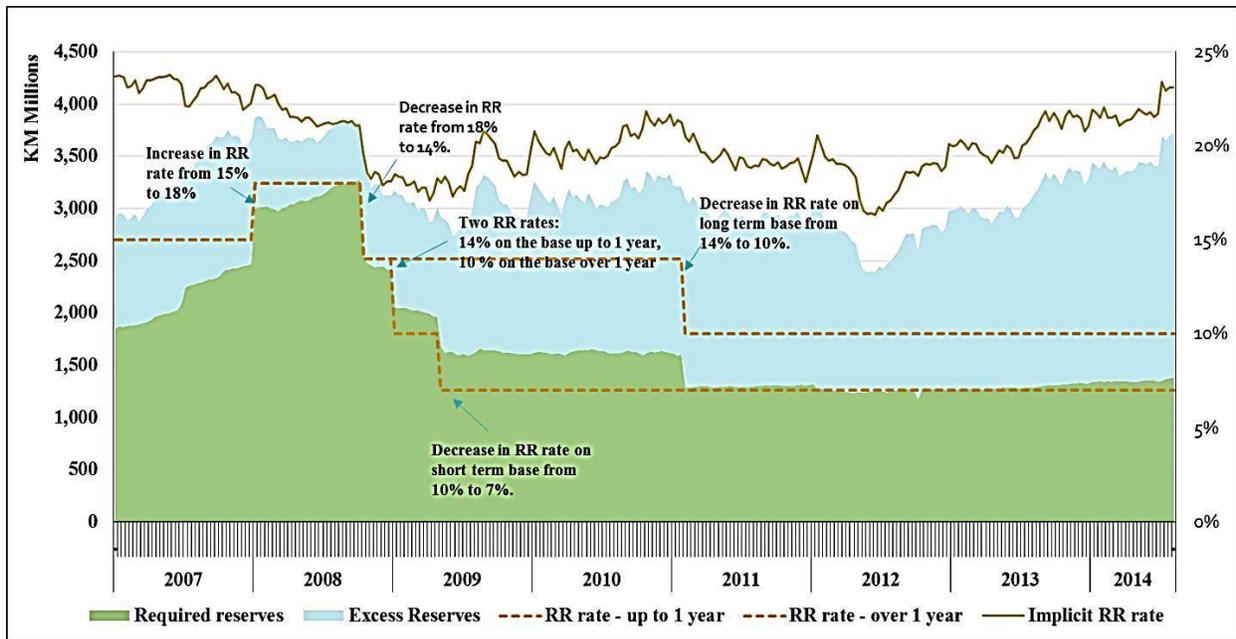
4. Data

The sample comprises quarterly bank specific data on 21 commercial banks operating in Bosnia and Herzegovina and appropriate macroeconomic data that spans the period from 2006Q1 to 2014Q1. Several outlier banks, banks whose operations were subsidized and controlled by the state, as well as banks that changed ownership during the period under analysis, or were bailed out by the government were left out from the sample. Table 1 describes the main variables used in this paper.

The primary variable of interest (dependent variable) is *bank loans to private sector*. Total lending is obtained by summing the stock of loans to households and stock of loans to private non-financial corporates. The variable is disaggregated according to maturity of loans (short term – loans with the maturity up to one year, and long term – the maturity over one year), as well as sectors – loans to private enterprises and households, and their combinations. Overall, the behavior of nine different types of loans is analyzed: loans to private sector, loans to households, loans to private enterprises, long term loans to private sector, long term loans to households, long term loans to private enterprises, short term loans to private sector, short term loans to households and short term loans to private enterprises.

Other variables that are controlled for are bank specific characteristics and corresponding macroeconomic variables. The bank specific characteristics include size, liquidity and capitalization. They are introduced as control variables, because the sensitivity of the individual banks' loans supply on monetary policy should depend on those indicators. The size variable reflects the fact that small banks find it harder to attract non-deposit funding after a monetary contraction, because they face higher informational costs and higher external finance premiums than larger banks. Regarding capitalization, poorly capitalized banks have less access to non-deposit funds forcing them to cut back on loans more than well-capitalized banks facing a

negative monetary chock. Finally, more liquid banks can draw on their excess reserves of cash and securities to protect their loan portfolio than less liquid banks, when monetary conditions tighten. Generally, larger/better capitalized/more liquid banks should reduce their lending less due to a tightening monetary policy shock than smaller/less capitalized/less liquid banks. The reverse is true in the case of monetary loosening.

Table 1: Summary Statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Log of loans to private sector	693	12.49	1.268	9.786	14.88
Log of loans to households	693	11.64	1.424	8.948	14.23
Log of loans to enterprises	693	11.83	1.276	8.751	14.13
Log of long term loans to private sector	693	12.11	1.345	9.054	14.58
Log of long term loans to households	693	11.42	1.499	8.856	14.16
Log of long term loans to enterprises	693	11.25	1.353	6.474	13.67
Log of short term loans to private sector	693	11.20	1.240	8.118	13.53
Log of short term loans to households	693	9.455	1.874	1.609	12.19
Log of short term loans to enterprises	693	10.87	1.320	6.834	13.39
Log of assets	693	13.16	1.142	10.52	15.33
Liquidity	693	21.27	13.39	4.946	62.34
Capitalization	693	26.58	11.97	4.580	59.49
Log of real GDP	693	15.63	0.0381	15.49	15.69
Log of CPI	693	4.593	0.0607	4.489	4.670
Log of REER	693	4.603	0.0140	4.574	4.630
Large banks dummy	693	0.429	0.495	0	1
Crisis dummy	693	0.667	0.472	0	1
Required reserves dummy	693	0.364	0.481	0	1

The *banks size* is measured by the logarithm of banks total assets.

The *liquidity* is measured by the ratio of liquid funds to the total assets. The liquid funds are comprised of cash and deposits and other financial assets with maturity period shorter than three months, excluding interbank deposits.

The *capitalization* is given as the ratio of banks equity capital to the total assets. Equity includes permanent preference shares, ordinary shares, premiums for permanent preference and ordinary shares, unallocated profit, capital reserves and loan loss provisions from the profit in line with the regulatory requirements.

The *macroeconomic control variables* are output, inflation and real effective exchange rate. GDP is included to capture the *aggregate demand* influence on lending activity of the banks, so the influence of analyzed shocks on bank lending should be the result of a change in the *supply of bank loans*. The series is seasonally adjusted applying Census X-12-ARIMA methodology to remove a strong seasonality effect found in it.

The rationale for including Consumer Price Index (CPI) is a possible positive effect of inflation on credit growth (De Haas et al, 2012). The inflation is included as a regressor to ensure

that any inflation-fuelled growth in nominal loans portfolios is controlled for. Additionally, both inflation and output are included as the right hand side variables to control for business cycle effects of domestic economy on credit growth.

The *real effective exchange rate* (REER) is included to capture the potential effects of changes in the price competitiveness of Bosnia and Herzegovina economy on banks' assets and their lending potential. The changes in competitiveness may have an effect on the trade balance and inflow and outflow of funds in the capital and financial account (Schmitz, 2004). Those changes in the flow of funds may directly affect banks' assets and their lending potential. For example, a real appreciation of the REER[4] that leads to a decrease in the external price competitiveness of domestic goods and services normally leads to the deterioration in the trade balance. Resulting increase in net capital inflows will raise banks' assets and their lending potential and vice versa.

The data for loans to private sector and bank specific characteristics are taken from individual banks balance sheets. The source is CBBH statistics database. The GDP and the CPI data are taken from Bosnia and Herzegovina Agency for Statistics database. The data for REER are from CBBH macroeconomic statistics database.

5. Empirical Methodology

For the purpose of empirical analysis of the bank lending channel, the banks in Bosnia and Herzegovina are divided into two groups – large banks that hold dominant share of the overall loan portfolio and de facto are affiliates of Western European banking groups and small banks consisting of domestically owned banks and small foreign owned banks with a comparably small share in the domestic credit market. These two banking groups should have a distinct reaction to various foreign and domestic shocks being analyzed.

The basic assumptions are that foreign shocks are transmitted through the large foreign owned banks that belong to Western European banking groups operating in Bosnia and Herzegovina, as well as that domestic monetary policy shocks (RR changes) are primarily transmitted through the small banks. The cross-border banking literature suggests that the large foreign banks presence helps maintaining lending activity in host country in a case of domestic economy turbulence, but has a drawback of transmitting the home country shocks to host country economy. On the other hand, according to the bank lending channel literature, the domestic monetary policy shocks that influence bank deposits and through them their lending activity should have a greater effect on the small mainly domestically owned banks in comparison to the large foreign owned banks. The large foreign banks can potentially finance themselves through internal liquidity funds that exist within the banking group they belong to.

First, the transmission of various shocks through the bank lending channel is analyzed by investigating the reaction of lending of foreign vs. domestic banks to those shocks applying

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[4] Depreciation of the REER of Bosnia and Herzegovina's Convertible Mark is indicated by a decrease in the index.

nonparametric *difference-in-difference estimator*. The large foreign owned banks are the treated group and the small banks are the control group.

In order to analyze banks' lending behavior reaction to different foreign and domestic shocks, the sample period is divided into five different sub-periods (cut points are four chronologically ordered shocks[5], that could have significant effect on the development of loans to private sector – see Figure 4):

- From 2006Q2 – the beginning of the period determined by the availability of data to 2008Q3 – the Lehman Brothers Collapse in September,
- From 2008Q4 to 2009Q4 – the beginning of the Sovereign Debt Crisis in Europe,
- From 2010Q1 – the period of the Sovereign crisis to 2010Q4,
- From 2011Q1 – the quarter when CBBH lowered required reserves rate at the beginning of February – to 2012Q2 - the Draghi speech at the end of July 2012,
- From 2012Q3 to 2014Q1 – the end of the sample.

Those shocks are not expected to be homogeneously felt across banks, especially between the large foreign owned banks and the small, mainly domestically owned banks. Accordingly, the average of lending activity of those two banking groups is compared in the periods before and after the shocks: log of loans and annualized quarterly growth rates of loans are computed and time averages[6] for individual banks across pre and post shock periods taken in order to conduct this empirical analysis. Comparison of difference in the log of average loans of large vs. small banks in the baseline (pre-shock) period to difference in the log of average loans of those two bank groups in the follow-up (post-shock) period – difference-in-difference – by construction, shows a relative change of lending growth of those banks in the follow-up compared to the baseline period. The difference in the average annualized quarterly lending growth rates of those two bank groups in the pre-shock period compared to the difference in the growth rates in the post-shock period shows how one group accelerated/decelerated their lending growth in comparison to the other.

The analysis is based on relatively restrictive assumptions that the shocks are the outcome of quasi-natural experiments – the simple comparison of the mean of the outcome in the treatment (the large banks) and control (the small banks) groups is justified on the grounds that the randomization guarantees they should not have any systematic differences, apart those that are the result of the given shock. In other words, in the absence of treatment, the unobserved

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[5] Significant shocks that could have impact on lending behavior of banks in Bosnia and Herzegovina. Those shocks are: **Lehman Brothers Collapse** in September that led to the freeze in banks dollar funding markets and marks the beginning of the recent worldwide economic crisis; **the onset of Sovereign Debt Crisis in Europe** – when several European states were not able to repay or refinance large levels of debts or needed to bailout over-indebted banks; **expansionary monetary policy move of the CBBH** in the form of a reduction of the RR rate on bank short term liabilities that enter the base for calculation from 14% to 10% and **the Draghi speech** – when ECB's president Mario Draghi on 26 of July 2012 at the Global Investment Conference in London stated that "ECB is ready to do whatever it takes to preserve the euro", that helped calm down the bond markets in Europe as surging yields of Spanish and Italian bonds threatened the existence of the currency block.

[6] The time averages have the advantage of smoothing out quarter-specific idiosyncratic factors (Cetorelli and Goldber, 2010).

differences between treatment and control groups should be the same over time. The data on treatment and control group before the treatment could be used to estimate the 'normal' difference between the treatment and the control group and then to compare this with the difference after the recipient of the treatment.

The two estimation strategies have been applied:

- *Rolling Difference-in-Difference*, comparing four consecutive baseline and follow-up periods (2006Q2-2008Q3 to 2008Q4-2009Q4 – Pre-Lehman to Post-Lehman, 2008Q4-2009Q4 to 2010Q1-2010Q4 – Post-Lehman to Sovereign Debt Crisis period, 2010Q1-2010Q4 to 2011Q1-2012Q2 – Sovereign crisis period to CBBH post policy move period and 2011Q1-2012Q2 to 2012Q3-2014Q4 post policy move period to after Draghi speech period).The goal here is to analyze reaction of lending of large vs. small banks to different foreign shocks: the outbreak of the Subprime Market Financial Crisis in America, the beginning of the Sovereign Debt Crisis in Europe and ECB's president Mario Draghi speech, as well as domestic monetary policy shock – CBBH RR instrument change.
- *Fixed base period Difference-in-Difference*, comparing four previously defined follow-up periods to the pre-crisis baseline period. Here the longer term difference in behavior of lending of foreign vs. domestic banks after the onset of the Financial Crisis is analyzed, bearing in mind the process of deleveraging of large Western European banking groups that started in the aftermath of the crisis that should have a differential influence on the behavior of the large foreign banks vs. the small banks in the long run.

For an individual bank, i, this estimator performs the following linear regression:

$$Loans_i = \beta_0 + \beta_1 \cdot period + \beta_2 \cdot treated + \cdot \beta_3 \cdot period \cdot treated + control_i + e_i$$
(1)

The estimated coefficients have the following interpretation:

$\widehat{\beta_0}$: is the mean outcome for the control group on the baseline,
$\widehat{\beta_0} + \widehat{\beta_1}$: is the mean outcome for the control group in the follow-up period,
$\widehat{\beta_2}$: is the single difference between treated and control groups on the baseline,
$\widehat{\beta_0} + \widehat{\beta_2}$: is the mean outcome for the treated group on the baseline,
$\widehat{\beta_0} + \widehat{\beta_1} + \widehat{\beta_2} + \widehat{\beta_3}$: is the mean outcome for the treated group in the follow-up,
$\widehat{\beta_3}$: is the Difference-in-Difference or impact.
$period$: dummy variable equal to zero in base period and to one in the follow-up period,
$treated$: dummy variable equal to one for large banks, zero otherwise.
$control$: comprise banks specific factors – size, capitalization and liquidity.

A disadvantage of this empirical investigation is that it suffers from the well-known *identification challenges*. Applying this strategy enables us to pin down the differences in lending behavior of large vs. small banks after different shocks. Bank lending literature explains that banks affected by shocks to their funding sources accommodate that shock with an equivalent adjustment in their loan supply. However, we cannot differentiate to what extent distinct behavior of the two groups of banks is the result of a change in the loan supply or the

loan demand after those shocks. The reduction in the lending supply does not need to occur: banks may be able to substitute away from funding sources affected by the shock into other, more readily available ones. Or even in the case of imperfect substitutability of different sources of funds on the liability side of the balance sheet, banks can potentially insulate their lending activity by absorbing the liquidity shocks with a corresponding change in the available liquid asset buffers. On the other hand, the decrease in lending activity of banks can be the result of a decline in the demand for loans of private sector economic agents: reduced economic activity of private enterprises as a result of a decline in current product market or their future investment opportunities and lower and unstable income and poorer standard of living of households.

Thus, in order to determine to what extent distinct lending activity reaction is the result of banks' loan supply, the loan demand is controlled for in the regressions of bank loans to different macro-economic and bank-specific variables, as well as appropriate time dummy variables denoting pre and post shock periods in a *time series cross section (TSCS) framework*.

Pooled data combines the time series with the cross-sectional data. According to Stimson (1985), when there are more cross-sectional units than temporal units ($N > T$), pooled data are "cross-sectional dominant". Conversely, when temporal units are more numerous than spatial units ($T > N$), the pool is called "temporal dominant". The dataset used here has the characteristics of temporal dominant time series cross sectional dataset (TSCS). The TSCS data are characterized by having repeated observations on fixed units. According to Back and Katz (1995), the number of units analyzed typically ranges from about 10 to 100, with each unit observed over a relatively long time period (often 20 to 50 time units). Both dimensions of TSCS data bring about potential problems to the estimation process. The relevance of the time series dimension in the TSCS dataset may introduce two problems (Joyce and Spaltro, 2014). First, there is the potential problem related to the non-stationarity of variables resulting in a spurious relationships being estimated. Second, the dominant time series dimension introduces the problem of autocorrelation of the error terms. The most typical assumption is that the errors show first-order serial correlation.[7] Additionally, cross-sectional dimension of the data may create two additional problems. First, the errors tend to be correlated across units, or contemporaneously correlated, such that errors in unit i at time t are correlated with errors in unit j at time t. And second, the errors tend to be heteroscedastic – they may have different variances across units, or ranges or subsets of units.

All these problems are going to be investigated and appropriately treated by applying specific estimation procedures. First, to avoid potential problems related to non-stationarity of the data, all variables included in regressions are going to be specified in first differences, so this is less likely to be a problem. Furthermore, three different estimators are applied suitable for the TSCS structure of the data.

The first estimation technique applied is *least squares dummy variables* (LSDV), or one way fixed effects (within) estimator. Such models assist in controlling for unobserved

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[7] Two assumptions are possible, that the degree of seral correlation differs from unit to unit or that it is constant across units. But, simulations show that it is better to assume constant serial correlation across units (Beck, 2006).

heterogeneity (individual effects) when this heterogeneity is constant over time and correlated with independent variables. Because serial correlation in linear panel-data models biases the standard errors and causes the results to be less efficient, Wooldridge (2002) test for serial correlation in fixed-effects one-way models is conducted. In the cases where serial correlation is found, the fixed effect estimator that allows for first order serial correlation in the residuals is used (Bhargava, Franzini and Narendranathan, 1982). [8]

Second, Parks-Kmenta *feasible generalized least squares* (FGLS) estimator is applied (Parks, 1967 and Kmenta, 1971; 1976). This estimator deals with serial correlation, contemporaneous correlation and panel heteroscedasticity of errors that often characterize TSCS data by performing two sequential FGLS transformations: first eliminating serial correlation, and the other to take into account contemporaneous correlation of the errors to get spherical errors. [9] The potential problem with this estimator is that it may result in underestimated values of standard errors of the coefficients (Beck and Katz, 1995).

The third estimation method used is a panel-corrected standard error estimator (PCSE) proposed by Beck and Katz (1995). It uses OLS estimator but replaces standard errors with panel-corrected standard errors that take into account the contemporaneous correlation and hence the heteroscedasticity. Any serial correlation of the errors must be eliminated before the application of this procedure. The authors suggest that it overcomes the stated shortcomings of the previous estimator.

The bank lending channel is investigated by regressing quarterly bank lending growth on first differences (quarterly growth rates) of macroeconomic factors and first differences of individual bank variables:

$$\Delta l_{it} = \alpha + \beta \Delta x_{it} + \gamma \Delta y_{it} + \delta D + \varepsilon_{it} \qquad (2)$$

$$i = 1, \dots, N; t = 1, \dots T$$

where Δl_{it} is quarterly lending growth for bank i in period t, ΔX_{it} is a vector of quarterly growth rates of a set of macroeconomic control variables and ΔY_{it} is a vector of the first differenced individual bank specific variables, D is a vector of group and time dummy variables and their interactions, α is a constant term, and β, γ and δ are appropriate vectors of slope coefficients. Equation (1) can be thought of as a reduced-form relationship intended to pick up the influence on lending of both demand and supply factors, proxied by macroeconomic and microeconomic variables (i.e. individual bank characteristics). The macroeconomic control variables include GDP quarterly growth, the quarterly (CPI) inflation rate and the quarterly growth of real effective exchange rate (REER). Among bank characteristics, size of the banks, capitalization ratio and liquidity ratio are included, all as first differences. Large banks group dummy variable

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[8] Some studies deal with the problem of autocorrelation by introducing lagged dependent variable and use GMM estimator. However, the asymptotic properties of GMM estimator are derived for large N small T data set and may not be applicable for this particular case.

[9] The correction for the contemporaneous correlation of the errors automatically corrects for any panel heteroscedasticity (Back and Katz, 1995). Consequently, only contemporaneous correlation and serial correlation of errors needs to be considered.

that equals one for the large banks and zero for the small banks allows for the investigation of differential behavior of those two bank groups. Time dummy variables control for two shocks being analyzed: the onset of the economic crisis and the CBBH's monetary policy change. The first is crisis dummy that equals to one for the crisis period (2008q4 onwards), and zero otherwise. The second is required reserves dummy that has a value of one for the period after required reserves change (2011q2 onwards) and zero otherwise. The interaction terms between those two time dummies and the large bank dummy are introduced in the regression in order to analyze potential differential reaction of large vs. small banks to those shocks.

6. Empirical results

In order to show the impact of the shocks on loan development of large vs. small banks, different loans are represented in the form of growth rates normalized to 2008q3 (see Appendix, Figure 1). This graphical analysis leads as to the conclusion that two the most important chocks being analyzed are the Lehman Brothers collapse in 2008q3, denoting the onset of the great economic crisis and the CBBH monetary policy change in 2011q1, the points in time when we can observe a significant change in the behavior of those two groups of banks.

Regarding the *total loans to private sector*, we see that both groups of banks slowed down credit growth at the onset of the crisis and while the large banks continued to stagnate, the small banks started picking up credit growth, especially after the change in the RR rate at the beginning of 2011. Both groups of banks considerably slowed down growth in *loans to households* and as the large banks' household credit growth remained subdued throughout the remaining period, the reaction of the small banks was initially to cut down credit growth even further, but they started picking up the pace after the policy move in 2011q1. On the other hand, small banks maintained the pace of growth of *loans to enterprises*, while the growth of large banks significantly slowed down after the crisis and remained flat.

Further term disaggregation shows that the *long term loans to private sector* exhibited more or less the same behavior as the total loans: while the reaction of both groups of banks after the crisis was the same, the small banks increased the pace of growth, especially after the RR change. The *short term loans to private sector* development of both bank groups was similar after the crisis until the CBBH monetary policy change, when the small banks started to grow at a higher pace. The reaction with respect to the *long term loans to households* of both banking groups was similar to the one pertaining to the total loans to households. But as far as the *short term loans to households* are concerned, the large foreign banks maintained the same pace of growth throughout the whole period, while the small banks significantly reduced the pace after the crisis, and started accelerating after the policy move. The *long and short term loans to enterprises* development shows that the small banks maintained the pace of growth throughout the period (even though the initial growth of short term loans of the small banks was a bit subdued), while the large banks exhibit stagnation throughout the crisis period.

Overall, the distinct behavior of large vs. small banks with respect to the total loans to private sector (and with respect to further term disaggregation of that loan category) is mainly the result of differential behavior of those two groups of banks with respect to all categories of

loans to enterprises – the small banks kept on growing even after the crisis started, while the large banks decelerated the pace of growth. On the other hand, both groups of banks decreased the pace of growth of loans to households (with the exception of the short term loans to households) – small banks even more intensively than the large ones. But, the small banks started catching up after the RR decrease. This behavior is in accord with findings in the empirical analysis of the bank lending channel literature and the cross-border banking literature that foreign liquidity shocks are primarily transmitted through large banking groups, while expansionary monetary policy shocks that increase banks loanable funds are mainly transmitted through small banks. Let's now turn to more formal empirical analysis.

6.1. Difference-in-difference analysis

The results of various difference-in-difference regressions are provided in the Appendix in the form of graphical representation (Figures 2 to 5). The graphs show the size of impact coefficients, with the numerical value of the coefficients, their standard errors and statistical significance indicated at the top of each bar. The *rolling difference-in-difference regressions results pertaining to log of average loans* (see Figure 2) show that large banks recorded a statistically significant lower growth of average lending to private sector in the last period, as compared to the previous one, in the overall loans and long term loans category (by 15 and 32 percentage points, respectively). This was the result of a statistically significant differential behavior with respect to loans to enterprises – overall and long term (the growth of average long term loans to enterprises was statistically significantly lower even in the fourth period in comparison to third). On the other hand, loans to households recorded the opposite development. The growth rates of average overall, long term and short term loans to households of the large banks were statistically significantly larger in the third period, in comparison to the second one, while regarding the short term loans to households it was the case even in the second period, when compared to the first.

The results of the *rolling window difference-in-difference regressions on average annualized quarterly growth rates of loans* (see Figure 4) are very indicative, pointing to the importance of CBBH's monetary policy shock. A statistically significant lower growth rates of the total loans and loans to households of the large banks (in fact, an acceleration of growth rates of the small banks) was recorded in all term categories round policy move, i.e. in the fourth period, compared to the third one.

The d*ifference-in-difference regressions that compare the initial period to the following ones pertaining to the log of average loans* (see Figure 3) generally portray the same story as the previous graphical representation. The large banks exhibit lower growth rates of the average total loans and loans to enterprises and larger growth rates of loans to households in the post-crisis periods in comparison to the pre-crisis period.

The *fixed initial period regressions related to average growth rates of loans* (see Figure 5) show how the average growth of different loan categories of the large foreign banks, compared to the small banks, changed in the consecutive post-crisis periods in comparison to the pre-crisis one. We can observe that the large banks had a statistically significant lower average

pace of growth in the last period, compared to the first one, in the total loans, loans to households, long term loans to private sector and long term loans to enterprises categories. Additionally, similar behavior is recorded in the fourth period regarding loans to households.

These regressions enabled us to quantify and explain distinct behavior of large vs. small banks round different shocks. On the basis of the results of this analysis in combination with previous graphical representation of different loan categories development, we can safely conclude that the two most important shocks that significantly influence development of (large vs. small) bank loans are the beginning of the crisis and the CBBH's required reserves change. The statistically significant differential behavior of lending activity of those two bank groups in the periods round other shocks most probably are the result of the impact of the crisis or the monetary policy shock.

The differential lending behavior of the two bank groups identified so far, as explained earlier, could be the result of both, the loan supply and the loan demand factors. In order to analyze the transmission of shocks through the bank lending channel, we need to isolate the loan supply reaction, simultaneously controlling for the demand for loans.

6.2. TSCS Data Analysis

Tables 1 to 9 in the Appendix present the estimation results for the nine different loan variables. Two specifications are used – one more parsimonious with regressors accounting for the *crisis shock* – the crisis dummy and its interaction with large banks dummy, and the other with regressors additionally controlling for the *monetary policy shock* – the required reserves change dummy and its interaction with the large banks dummy. Since the *loan demand* is explicitly controlled for by GDP variable, the remaining development of different bank loans should be the result of changes in the *loan supply* of banks as a reaction to those shocks. Each table contains results for three different estimators: least squares dummy variable (LSDV), feasible generalized least squares (FGLS) and panel corrected standard errors (PCSE).

The regression results for the *total loans to private sector* (Table 1 in the Appendix) show that all banks decreased lending in the crisis period. The results also show that the growth of loans to private sector increased after the decrease in RR rate and that the increase was mainly driven by the small banks, i.e. small banks used additional liquidity to increase the lending supply. However, the loan supply of the large banks was largely unaffected by the loosening of the monetary policy.

Analyzing the structure of the loans to private sector, the results of the second set of regressions (Table 2 in the Appendix) show that the lending supply of banks in terms of *loans to households* decreased after the crisis as well. The lending activity of the small banks started picking up after the first quarter of 2011, when the CBBH's monetary policy measure was implemented. There is a strong evidence that the domestic monetary policy shock was primarily transmitted through the small banks in this category of loans, but not enough evidence of a discernible reaction of those two bank groups to the crisis shock.

On the other hand, there is more evidence of differential lending behavior of banks in terms of *loans to enterprises* (Table 3 in the Appendix) in the observed period. The large banks dummy is statistically significant in both, FGLS and PCSE regressions[10], pointing to the conclusion that the large banks recorded lower pace of lending growth in comparison to the small banks in the overall period being analyzed. However, there is no distinguishable reaction of those two groups after the crisis. This may be the result of the fact that the negative reaction of the large banks to the crisis shock was similar to that of the small banks at the beginning of the crisis, and was more prominent in later periods, so it was picked up by the interaction term between the large banks dummy and the monetary policy shock dummy. The sign and the statistical significance of the RR dummy and its interaction with the large banks dummy point to the similar conclusions as those regarding the previous category of loans – the small banks increased lending supply after more liquidity become available when the RR rate was decreased, while the large banks' loan supply was mainly unchanged.

The regression analysis of the *long term loans to private sector* (Table 4 in the Appendix) lends more support for the differential behavior of the two groups of banks with respect to both shocks. As with the above loan categories, there is a strong evidence of significance of the monetary policy shock. However, as there is evidence that overall banks reaction to the beginning of crisis was to reduce the pace of the growth of long term loans to private sector, there is now much stronger evidence that the large foreign banks, with the dominant position in the market decreased the lending activity to larger extent than the small banks. Again, the evidence with respect to the monetary policy shock shows that the small banks used additional funds released after lowering of the RR rate to increase their lending supply.

Furthermore, the regression results show that banks decreased the pace of growth of *long term loans to households* (Table 5 in the Appendix) after the onset of the crisis in 2008q3. There is some evidence that the small banks increased the lending activity in this loan category after more loanable funds become available when the RR rate was decreased in 2011q1. However, the large banks were unaffected by the policy move. But, statistical evidence for the differential behavior of large vs. small banks after the crisis is weak, leading us to the conclusion that the loan supply of both bank groups was more or less equally affected by the crisis shock.

On the other hand, the evidence for the significance of the crisis shock is much stronger in the case of the *long term loans to enterprises* (Table 6 in the Appendix). The lending activity of banks in this loan category was depressed after the crisis, and more so for the large banks. However, when the RR dummy is introduced, the interaction of the large banks dummy with the crisis dummy loses its significance. But, since the RR dummy in isolation is not statistically significant in all the cases, one possible explanation could be that its interaction with the crisis dummy picks up lagged differential behavior of large vs. small banks after the crisis shock, and to a lesser extent the reaction to the monetary policy shock.[11]

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[10] It is dropped from the fixed effects regression, because within transformation takes out regressors that do not change over time.

[11] Even though there might be other explanations for these results.

There is ample evidence that the short term lending activity of banks recorded differential behavior between the large and the small banks with respect to the total loans to private sector and especially the loans to enterprises. The large banks had a slower pace of growth of the *short term loans to private sector* in the overall period (Table 7 in the Appendix). The banks decelerated the growth of those loans after the crisis and there is a relatively strong evidence that reaction was distinct between the two bank groups – contrary to previous cases, the small banks slowed down credit supply more than the large banks. The fact that the interaction term between the large banks dummy and the crisis dummy becomes significant[12] only after covariates for the monetary policy shock are introduced can possibly be explained by the two effects cancelling each other out when observed together, since the large banks somewhat unexpectedly decreased lending in this loan category much less after the crisis than the small banks. Conversely, the monetary policy shock had a positive impact on lending growth of the small banks in this loan category, while the large banks maintained the pace of their lending activity. It appears that both shocks, the negative crisis shock and the positive monetary policy shock, are primarily transmitted through small banks. One explanation could be that the crisis shock was primarily transmitted through informal interbank liquidity markets of small banks, while large banking groups' liquidity was unaffected in this segment[13] – the deleveraging process of large Western European banking groups had a bearing on the long term loans segment of their affiliates in Bosnia and Herzegovina.

This development of the total short term loans to private sector mainly reflects the behavior of banks with respect to the *short term loans to enterprises* (Table 9 in the Appendix). All variables have the same signs and significance in regressions for this loan category as in the regressions for the total short term loans. But, the regressions for the *short term loans to households* (Table 8 in the Appendix) do not give enough evidence for the significance of the crisis shock, or the differential behavior of large vs. small banks after both shocks. The positive and statistically significant coefficient for the required reserves dummy in LSDV and FGLS regressions give some evidence that the lowering of required reserves had a significant positive impact on lending behavior of the small banks in this loan category.

7. Conclusion

The empirical analysis here shows that the bank lending channel is important in the transmission of monetary signals in Bosnia and Herzegovina, mainly as the result of a dominant role the banks play in its financial system. Two shocks, the onset of the global economic crisis and the reduction in required reserves rate were important for the developments in the domestic credit market, i.e. they had a significant influence on the lending activity of banks. Both, the graphical analysis and the difference-in-difference analysis showed that the large and the small banks had a distinct reaction to those two shocks regarding different loan categories. While the large banks recorded a decrease in the pace of lending in terms of total loans to private sector and

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[12] In the FGLS and PCSE regressions.
[13] Especially, the liquidity at reserves accounts with the central bank.

loans to enterprises in comparison to the small banks, the reaction with respect to loans to households was mainly the opposite.

The formal regression analysis in the time series cross sectional data framework shows that all banks generally decreased loan supply to private sector after the beginning of the crisis. There is evidence that the transmission of the negative crisis shock was mainly realized through the large foreign banks, since those banks recorded lower growth rates of the loans in comparison to the small banks, especially in the long term loans category. This behavior in the overall loans was mainly the reflection of similar developments in the loans to enterprises. On the other hand, there is not enough evidence of differential behavior of those two groups of banks with respect to the loans to households as a reaction to this shock. It appears that large foreign banking groups deleveraging process that started after the onset of the crisis was mainly reflected in the development of the loans to enterprises, since domestic private firms are probably recognized as potentially the largest credit risks and more stringent credit standards were applied. But, the small banks' decline in the supply of the short term loans to private sector after the crisis was more prominent than that of the large banks, again mainly as the result of the similar development of the loans to enterprises. One explanation could be that the crisis shock was primarily transmitted through informal interbank liquidity markets of small banks, while large banking groups' liquidity was unaffected in this segment.

However, in accord with the earlier empirical findings in the literature on the bank lending channel, the positive domestic monetary policy impulse was primarily transmitted through the small banks that used additional liquidity funds acquired by the RR rate decrease to increase the pace of their lending activity. This shows that even limited monetary policy in a rigid monetary policy regime such as the currency board can have a significant impact on domestic credit markets and can be used as a countercyclical monetary policy tool. All these banks' reactions are broadly in line with those found in the previous theoretical and empirical literature on the bank lending channel.

Future work could be extended to the sectoral disaggregation of loans to enterprises, to shed more light on whether some particular industries were mostly hit by the reduction in the loan supply.

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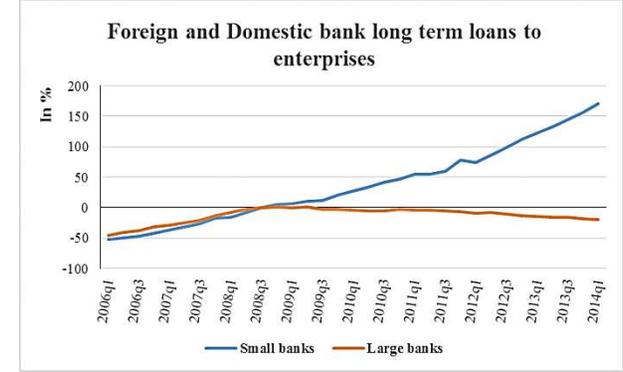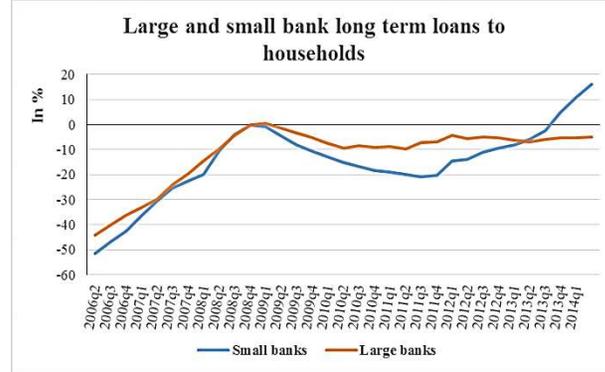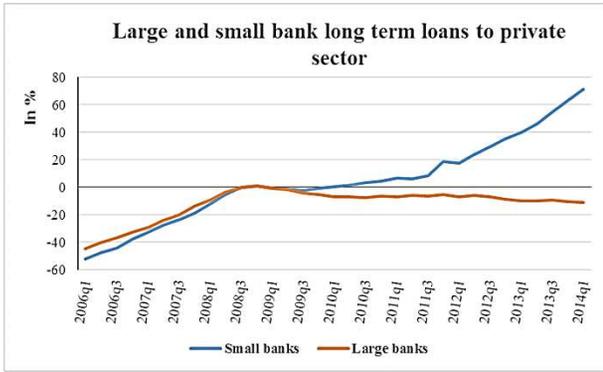
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APPENDIX
Figure 1: Large vs Small Banks Loans (Growth Rates to 2008q3)
Loans to Private Sector

Large and small bank loans to private sector

Large and small bank loans to households

Large and small bank loans to enterprises

Long Term Loans to Private Sector

Large and small bank long term loans to private sector

Large and small bank long term loans to households

Foreign and Domestic bank long term loans to enterprises

Short Term Loans to Private Sector

Foreign and domestic bank short term loans to private sector

Foreign and domestic bank short term loans to households

Foreign and domestic bank short term loans to enterprises

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Figure 2: Rolling Window Diff-in-Diff Regressions (Logarithm of Average Loans)*
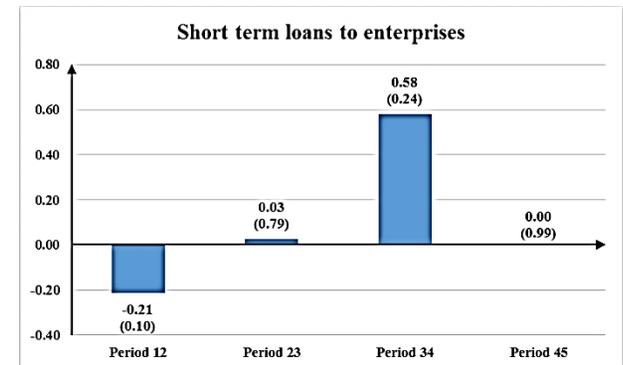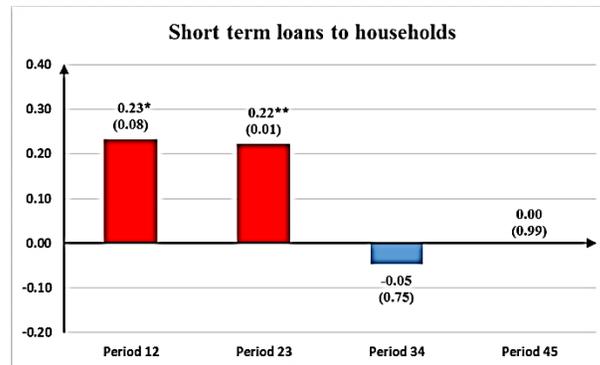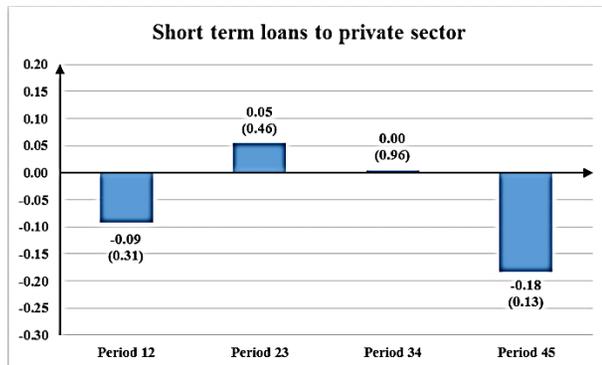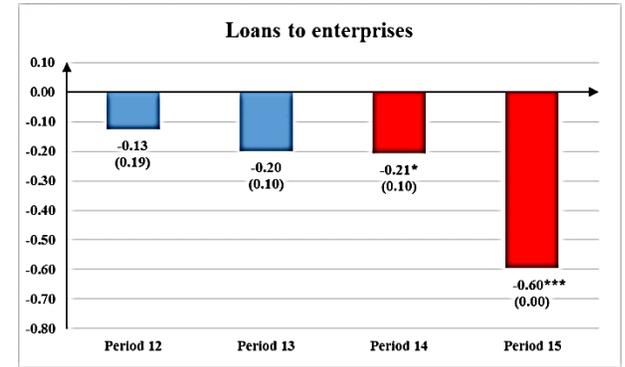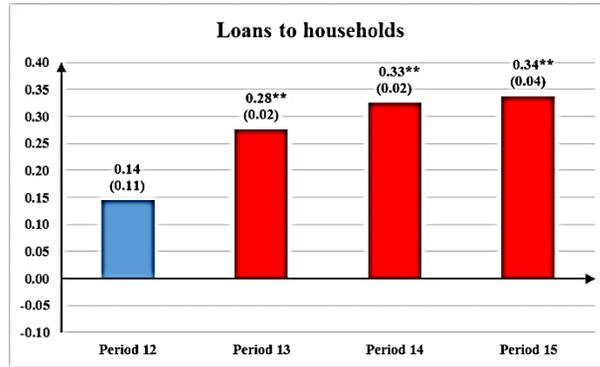
Loans to Private Sector
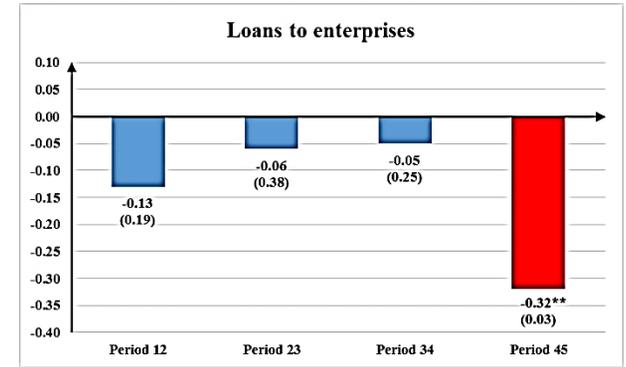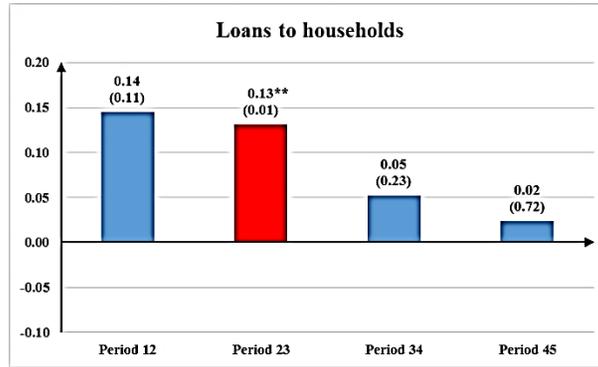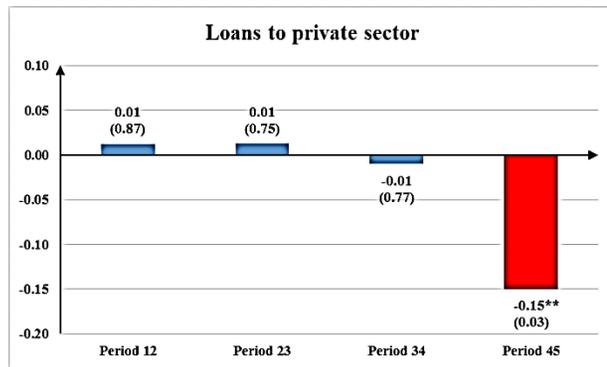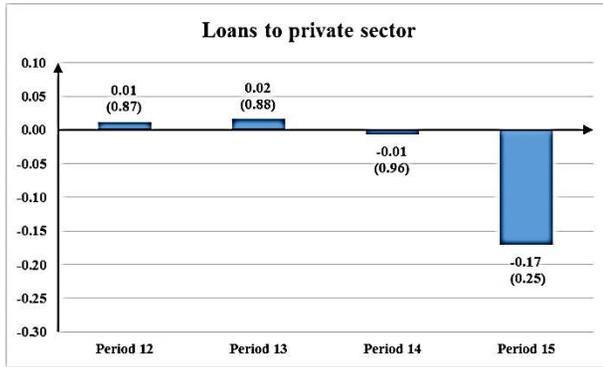

Long Term Loans to Private Sector
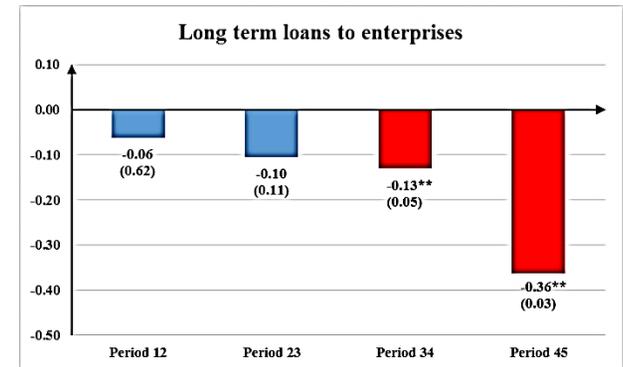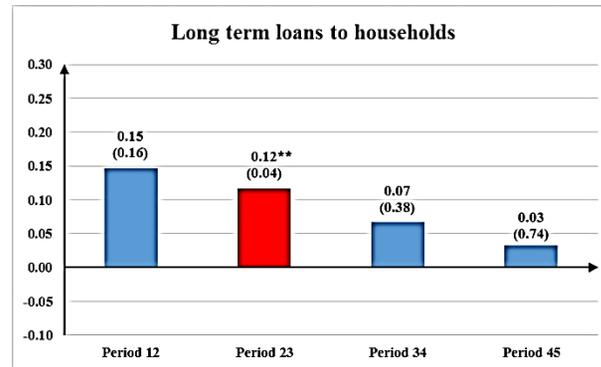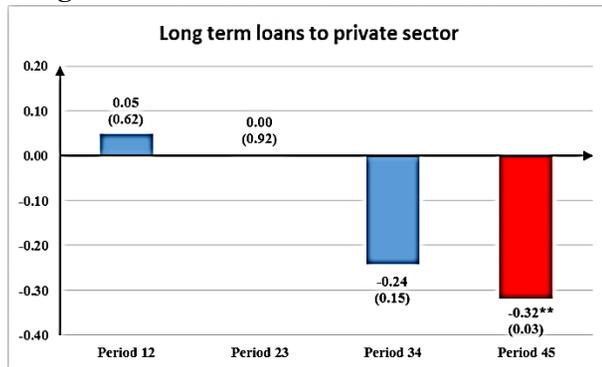
Short Term Loans to Private Sector

*A positive/negative value indicates an increase/decrease in lending growth of large vs small banks in the follow-up compared to the baseline period in percentage points.

Figure 3: Comparison to Pre-Crisis Period Diff-in-Diff Regressions (Logarithm of Average Loans)*

Loans to Private Sector

Long Term Loans to Private Sector
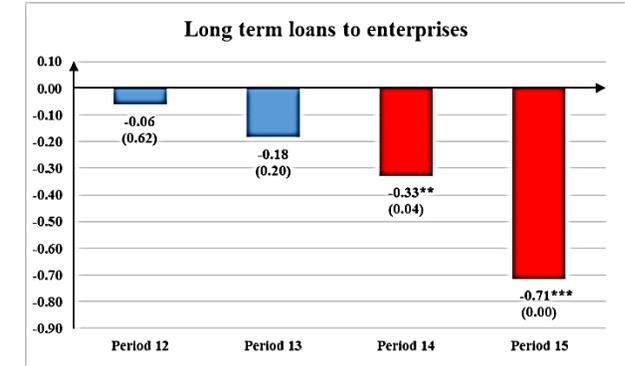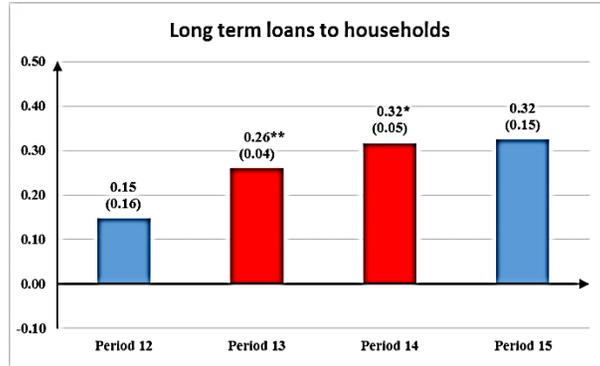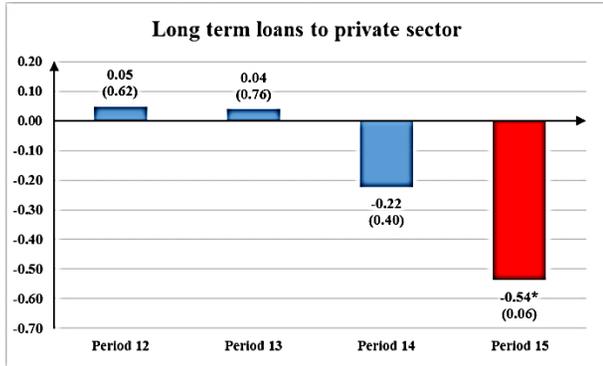

Short Term Loans to Private Sector

*A positive/negative value indicates an increase/decrease in lending growth of large vs small banks in the follow-up compared to the baseline period in percentage points.

Figure 4: Rolling Window Diff-in-Diff Regressions (Quarterly Annualized Growth Rates of Loans)

Loans to Private Sector

Long Term Loans to Private Sector

Short Term Loans to Private Sector

*A positive/negative value indicates an acceleration/deceleration in lending growth of large vs small banks in the follow-up compared to the baseline period in percentage points.

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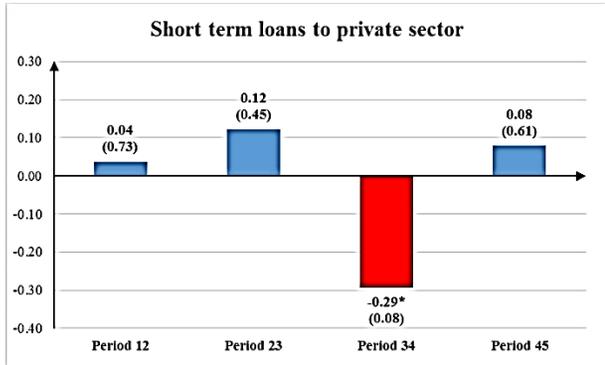
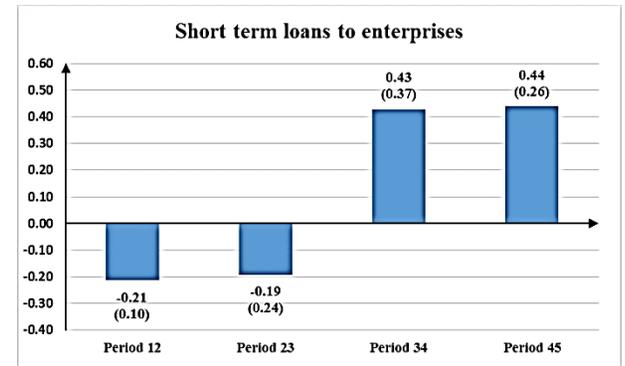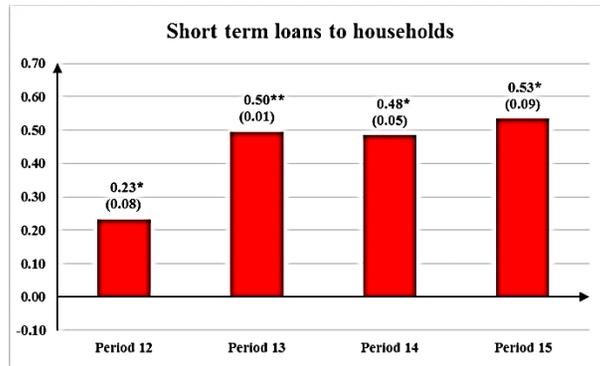**Figure 5: Comparison to Pre-Crisis Period Diff-in-Diff Regressions (Quarterly Annualized Growth Rates of Loans)**
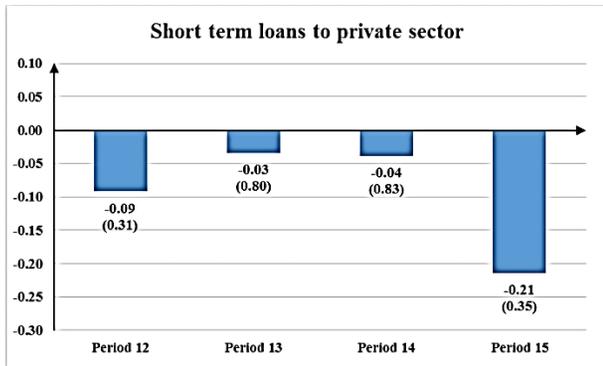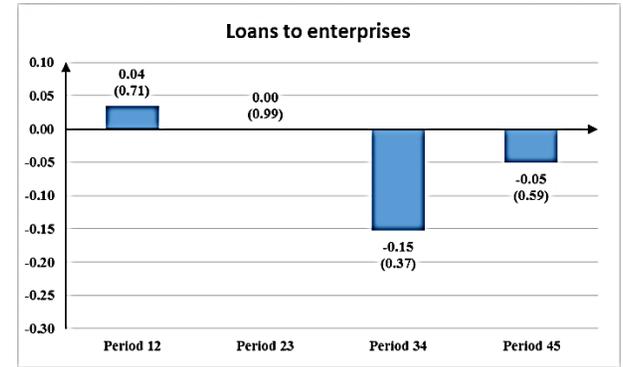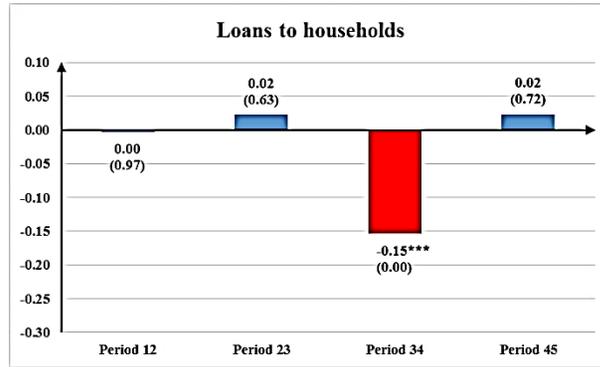
Loans to Private Sector
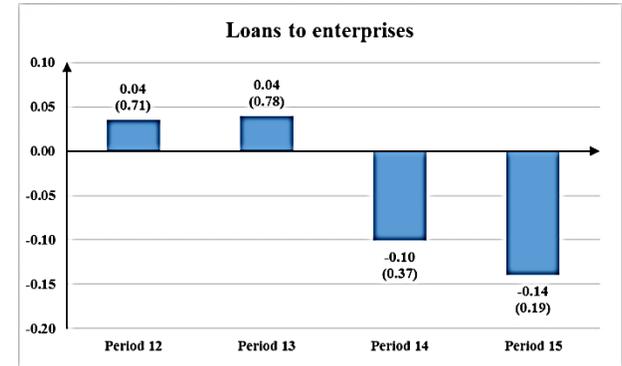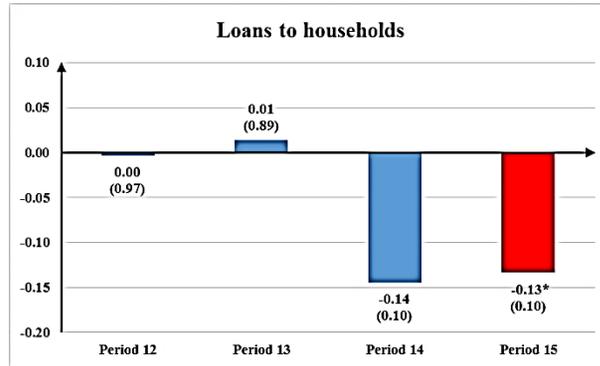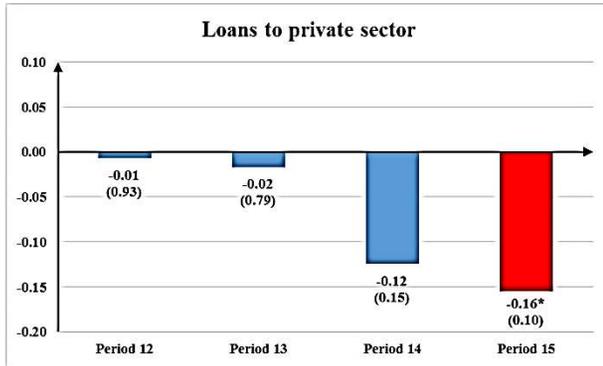
Long Term Loans to Private Sector

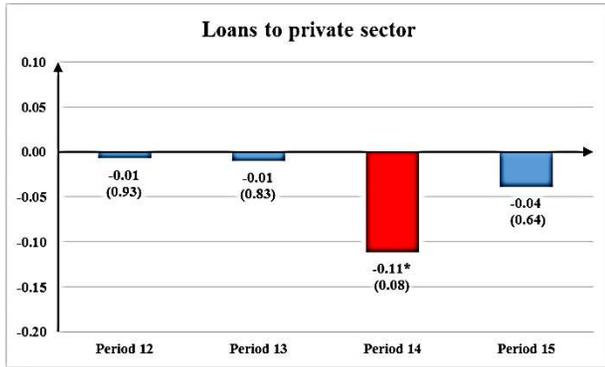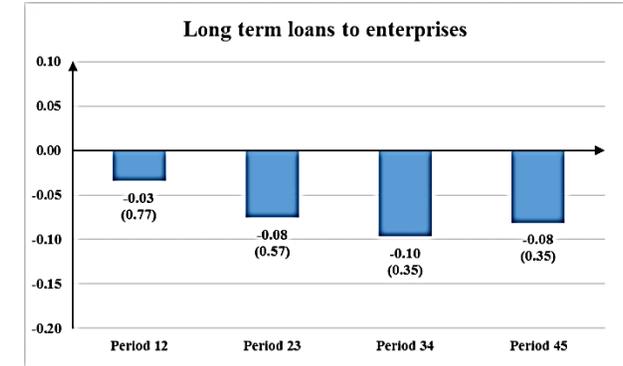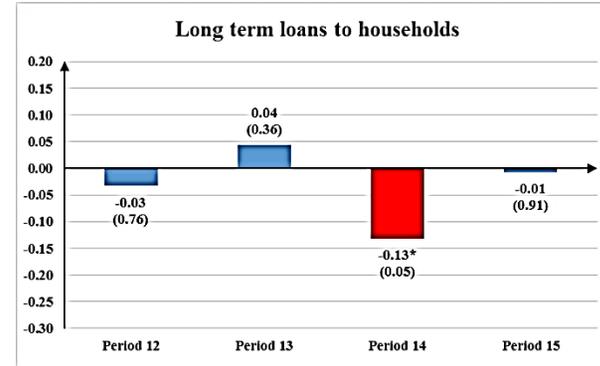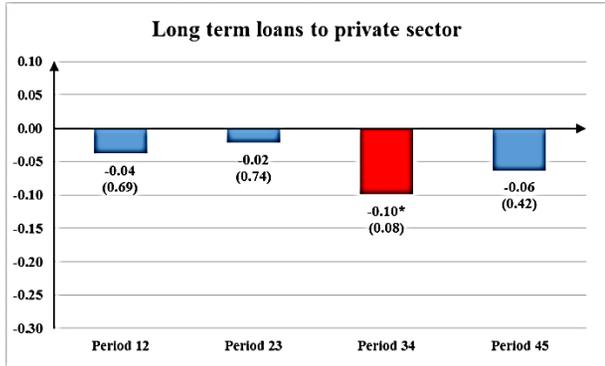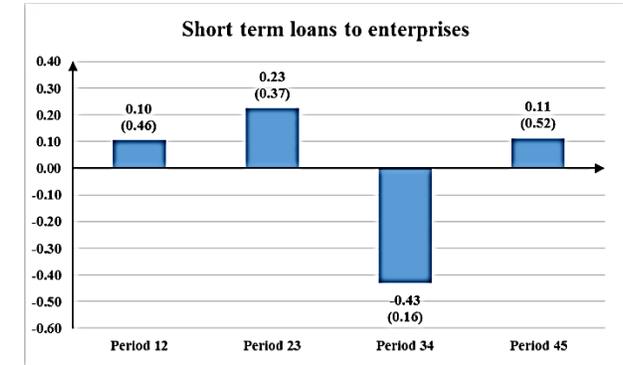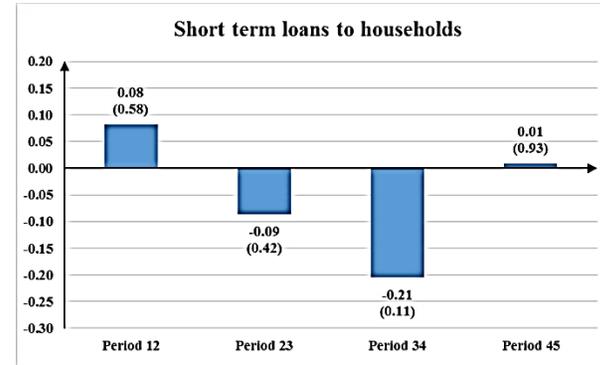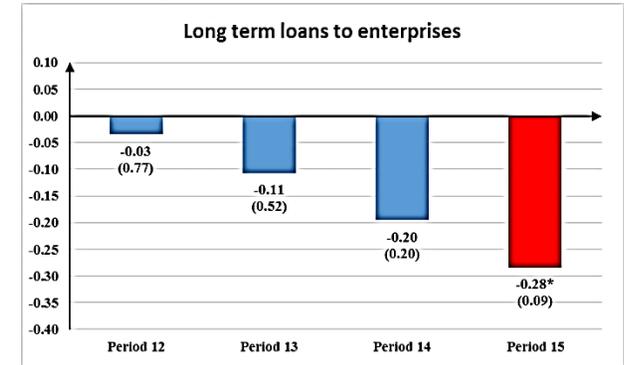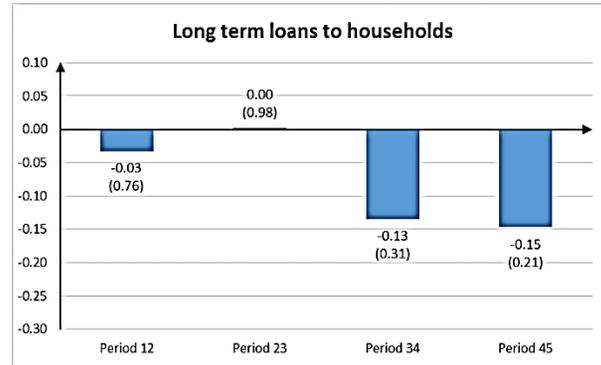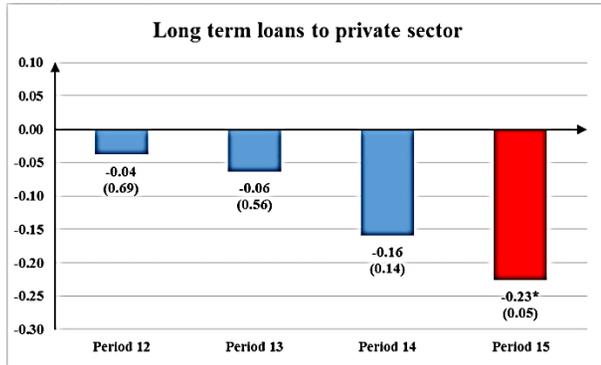**Short Term Loans to Private Sector**
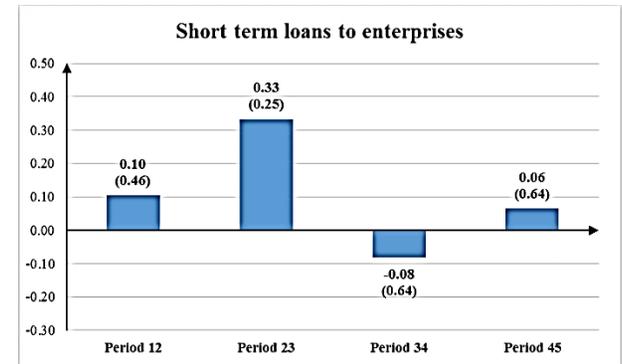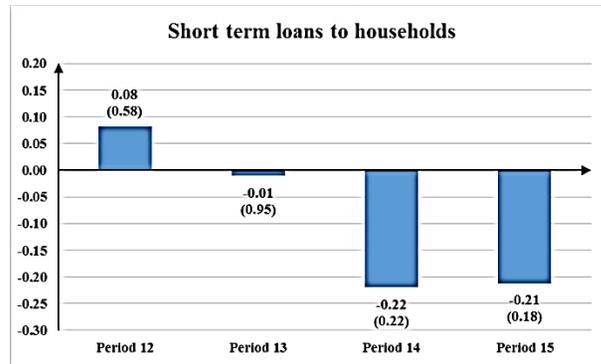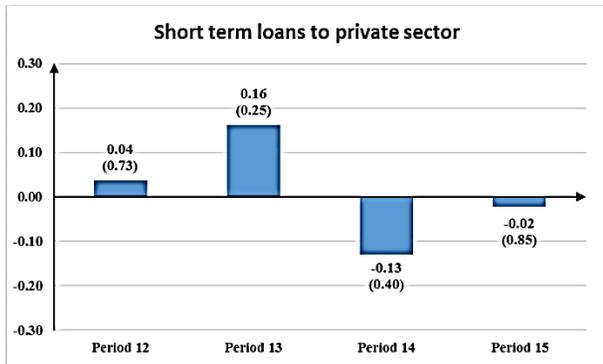
*A positive/negative value indicates an acceleration/deceleration in lending growth of large vs small banks in the follow-up compared to the baseline period in percentage points.

Table 1: Loans to Private Sector

Variables/Estimator	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	0.221 (0.146)	0.197 (0.147)	0.169*** (0.053)	0.167*** (0.049)	0.177 (0.138)	0.148 (0.129)
Log CPI	0.139 (0.228)	0.188 (0.228)	0.229*** (0.078)	0.280*** (0.072)	0.248 (0.200)	0.289 (0.187)
Log REER	0.100 (0.182)	0.106 (0.182)	0.043 (0.067)	0.045 (0.061)	0.049 (0.170)	0.065 (0.158)
LB Dummy	-	-	-0.013** (0.005)	-0.010** (0.005)	-0.010 (0.009)	-0.010 (0.008)
RR Dummy		0.021*** (0.008)		0.023*** (0.004)		0.023*** (0.008)
Crisis Dummy	-0.035*** (0.009)	-0.045*** (0.009)	-0.038*** (0.005)	-0.049*** (0.005)	-0.033*** (0.009)	-0.045*** (0.009)
LB Dummy # Crisis Dummy	-0.017 (0.012)	-0.003 (0.013)	-0.010 (0.006)	0.003 (0.007)	-0.015 (0.011)	0.000 (0.011)
LB Dummy # RR Dummy		-0.028** (0.012)		-0.026*** (0.007)		-0.029*** (0.010)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Banks Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.061*** (0.004)	0.060*** (0.004)	0.064*** (0.004)	0.062*** (0.004)	0.061*** (0.008)	0.061*** (0.007)
Observations	630	630	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares Estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 2: Loans to Households

Variables/Estimator	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	0.259**	0.218*	0.116*	0.080	0.251	0.228
	(0.122)	(0.122)	(0.068)	(0.055)	(0.156)	(0.142)
Log CPI	-0.408**	-0.296	-0.208**	-0.164*	-0.393	-0.311
	(0.195)	(0.195)	(0.106)	(0.086)	(0.245)	(0.221)
Log REER	0.114	0.123	0.052	0.123*	0.108	0.130
	(0.154)	(0.153)	(0.085)	(0.069)	(0.197)	(0.178)
LB Dummy	-	-	0.007*	0.007	0.003	0.005
			(0.004)	(0.005)	(0.011)	(0.010)
Crisis Dummy	-0.051***	-0.065***	-0.050***	-0.061***	-0.052***	-0.065***
	(0.008)	(0.009)	(0.004)	(0.004)	(0.012)	(0.011)
RR Dummy		0.032***		0.025***		0.030***
		(0.007)		(0.004)		(0.011)
LB Dummy # Crisis Dummy	-0.012	-0.000	-0.014***	-0.008	-0.007	0.003
	(0.012)	(0.012)	(0.005)	(0.006)	(0.012)	(0.013)
LB Dummy # RR Dummy		-0.027**		-0.014***		-0.024**
		(0.011)		(0.006)		(0.012)
FE	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.064***	0.062***	0.058***	0.059***	0.061***	0.059***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.011)	(0.009)
Observations	630	630	651	651	651	651
Number of banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares Estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3: Loans to Enterprises

Variables/Estimator	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	-0.174	-0.227	0.086	0.050	-0.181	-0.233
	(0.300)	(0.302)	(0.145)	(0.150)	(0.247)	(0.241)
Log CPI	0.846**	0.882**	0.837***	0.853***	0.857***	0.892***
	(0.396)	(0.396)	(0.192)	(0.196)	(0.326)	(0.316)
Log REER	-0.008	0.015	-0.085	-0.084	-0.015	0.008
	(0.360)	(0.358)	(0.174)	(0.178)	(0.296)	(0.286)
LB Dummy	-	-	-0.026***	-0.030***	-0.032**	-0.032***
			(0.005)	(0.006)	(0.013)	(0.011)
RR Dummy		0.028**		0.018***		0.028**
		(0.011)		(0.006)		(0.011)
Crisis Dummy	-0.034***	-0.050***	-0.025***	-0.039***	-0.034***	-0.049***
	(0.012)	(0.013)	(0.006)	(0.007)	(0.012)	(0.013)
LB Dummy # Crisis Dummy	-0.007	0.016	-0.012**	0.009	-0.006	0.016
	(0.016)	(0.018)	(0.005)	(0.008)	(0.015)	(0.015)
LB Dummy # RR Dummy		-0.043**		-0.028***		-0.042***
		(0.017)		(0.008)		(0.014)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.060***	0.060***	0.062***	0.066***	0.072***	0.073***
	(0.009)	(0.009)	(0.005)	(0.006)	(0.011)	(0.010)
Observations	651	651	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4: Long Term Loans to Private Sector

Variables/Estimator	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	0.339*	0.269	0.293***	0.238***	0.330*	0.262
	(0.191)	(0.191)	(0.075)	(0.078)	(0.194)	(0.177)
Log CPI	0.024	0.072	0.187*	0.215**	0.035	0.083
	(0.252)	(0.250)	(0.099)	(0.102)	(0.256)	(0.232)
Log REER	-0.033	-0.004	-0.159*	-0.162*	-0.041	-0.012
	(0.229)	(0.227)	(0.090)	(0.092)	(0.233)	(0.210)
LB Dummy			0.001	0.000	0.001	0.001
			(0.003)	(0.004)	(0.009)	(0.008)
RR Dummy		0.027***		0.020***		0.026***
		(0.007)		(0.004)		(0.008)
Crisis Dummy	-0.035***	-0.050***	-0.036***	-0.049***	-0.034***	-0.050***
	(0.007)	(0.008)	(0.003)	(0.004)	(0.009)	(0.009)
LB Dummy # Crisis D.	-0.029***	-0.011	-0.025***	-0.010**	-0.028***	-0.011
	(0.010)	(0.011)	(0.004)	(0.005)	(0.010)	(0.010)
LB Dummy # RR D.		-0.032***		-0.024***		-0.031***
		(0.011)		(0.005)		(0.010)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.064***	0.065***	0.062***	0.062***	0.062***	0.063***
	(0.006)	(0.006)	(0.003)	(0.003)	(0.008)	(0.007)
Observations	651	651	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Long Term Loans to Households

VARIABLES	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	0.182	0.157	0.075	0.061	0.192	0.178
	(0.143)	(0.145)	(0.098)	(0.097)	(0.187)	(0.182)
Log CPI	-0.179	-0.105	-0.039	0.022	-0.206	-0.154
	(0.232)	(0.234)	(0.155)	(0.155)	(0.296)	(0.288)
Log REER	-0.071	-0.058	-0.242*	-0.212*	-0.057	-0.039
	(0.182)	(0.183)	(0.124)	(0.124)	(0.238)	(0.231)
LB Dummy	-	-	0.011**	0.012**	0.009	0.010
			(0.005)	(0.005)	(0.012)	(0.012)
RR Dummy		0.022**		0.015**		0.019
		(0.009)		(0.006)		(0.013)
Crisis Dummy	-0.051***	-0.060***	-0.053***	-0.059***	-0.054***	-0.062***
	(0.010)	(0.011)	(0.007)	(0.007)	(0.014)	(0.014)
LB Dummy # Crisis D.	-0.018	-0.011	-0.020***	-0.017***	-0.013	-0.008
	(0.015)	(0.016)	(0.006)	(0.006)	(0.014)	(0.015)
LB Dummy # RR D.		-0.015		-0.007		-0.012
		(0.014)		(0.006)		(0.014)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.066***	0.064***	0.062***	0.061***	0.063***	0.061***
	(0.004)	(0.004)	(0.006)	(0.006)	(0.013)	(0.012)
Observations	630	630	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: Long Term Loans to Enterprises

Variables/Estimator	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	0.357	0.367	0.268**	0.318**	0.346	0.359
	(0.335)	(0.338)	(0.132)	(0.124)	(0.251)	(0.253)
Log CPI	0.201	0.190	0.156	0.125	0.215	0.204
	(0.442)	(0.442)	(0.174)	(0.162)	(0.332)	(0.332)
Log REER	0.059	0.057	0.053	0.065	0.050	0.048
	(0.401)	(0.401)	(0.158)	(0.147)	(0.302)	(0.301)
LB Dummy			-0.021***	-0.018***	-0.014	-0.014
			(0.006)	(0.007)	(0.013)	(0.012)
RR Dummy		0.016		0.006		0.016
		(0.012)		(0.007)		(0.011)
Crisis Dummy	-0.024*	-0.033**	-0.031***	-0.033***	-0.024**	-0.032**
	(0.013)	(0.015)	(0.006)	(0.008)	(0.012)	(0.013)
LB Dummy # Crisis Dummy	-0.036**	-0.013	-0.027***	-0.015	-0.036**	-0.013
	(0.017)	(0.020)	(0.008)	(0.010)	(0.016)	(0.017)
LB Dummy # RR Dummy		-0.042**		-0.027***		-0.041***
		(0.019)		(0.009)		(0.015)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.067***	0.067***	0.078***	0.076***	0.071***	0.072***
	(0.010)	(0.010)	(0.006)	(0.006)	(0.011)	(0.010)
Observations	651	651	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 7: Short Term Loans to Private Sector

VARIABLES	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	0.224	0.153	0.063	0.057	0.218	0.148
	(0.414)	(0.417)	(0.254)	(0.252)	(0.443)	(0.440)
Log CPI	1.262**	1.310**	1.593***	1.538***	1.270**	1.318**
	(0.546)	(0.546)	(0.334)	(0.338)	(0.586)	(0.577)
Log REER	0.586	0.616	-0.006	0.065	0.581	0.610
	(0.496)	(0.495)	(0.303)	(0.301)	(0.531)	(0.522)
LB Dummy	-	-	-0.033***	-0.029***	-0.032**	-0.032**
			(0.007)	(0.008)	(0.016)	(0.015)
RR Dummy		0.032**		0.024**		0.032*
		(0.015)		(0.010)		(0.018)
Crisis Dummy	-0.031**	-0.049***	-0.034***	-0.043***	-0.031*	-0.049**
	(0.016)	(0.018)	(0.010)	(0.012)	(0.019)	(0.021)
LB Dummy # Crisis D.	0.012	0.035	0.012	0.024**	0.012	0.035*
	(0.022)	(0.025)	(0.009)	(0.011)	(0.019)	(0.020)
LB Dummy # RR D.		-0.043*		-0.032***		-0.043**
		(0.023)		(0.011)		(0.019)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.041***	0.042***	0.056***	0.055***	0.054***	0.055***
	(0.013)	(0.013)	(0.009)	(0.010)	(0.017)	(0.016)
Observations	651	651	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 8: Short Term Loans to Households

Variables/Estimator	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	3.934* (2.154)	3.542 (2.176)	3.060*** (0.451)	2.723*** (0.493)	3.923* (2.072)	3.531* (2.048)
Log CPI	-0.871 (2.841)	-0.599 (2.849)	-0.366 (0.595)	0.428 (0.647)	-0.859 (2.731)	-0.586 (2.678)
Log REER	3.797 (2.581)	3.959 (2.582)	2.637*** (0.540)	2.106*** (0.583)	3.787 (2.469)	3.948 (2.416)
LB Dummy	-	-	0.007 (0.004)	0.010 (0.012)	0.006 (0.081)	0.007 (0.078)
Crisis Dummy	0.008 (0.083)	-0.073 (0.095)	0.004 (0.014)	-0.044* (0.025)	0.008 (0.097)	-0.072 (0.109)
RR Dummy		0.141* (0.080)		0.091*** (0.022)		0.141 (0.098)
Crisis Dummy	0.008 (0.083)	-0.073 (0.095)	0.004 (0.014)	-0.044* (0.025)	0.008 (0.097)	-0.072 (0.109)
LB Dummy # Crisis D.	-0.007 (0.113)	0.077 (0.130)	-0.006 (0.005)	0.056*** (0.016)	-0.007 (0.097)	0.076 (0.109)
LB Dummy # RR D.		-0.156 (0.121)		-0.117*** (0.015)		-0.155 (0.101)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.013 (0.066)	0.017 (0.066)	0.015 (0.013)	0.008 (0.020)	0.010 (0.088)	0.014 (0.085)
Observations	651	651	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator. Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 9: Short Term Loans to Enterprises

Variables/Estimator	(1) LSDV	(2) LSDV	(3) FGLS	(4) FGLS	(5) PCSE	(6) PCSE
Log Real GDP	-0.505	-0.622	-0.544*	-0.557*	-0.511	-0.627
	(0.603)	(0.608)	(0.292)	(0.307)	(0.523)	(0.510)
Log CPI	1.946**	2.026**	1.960***	2.047***	1.957***	2.037***
	(0.795)	(0.796)	(0.384)	(0.401)	(0.691)	(0.669)
Log REER	0.149	0.197	0.209	0.090	0.142	0.190
	(0.722)	(0.722)	(0.349)	(0.363)	(0.628)	(0.606)
LB Dummy	-	-	-0.064***	-0.063***	-0.060***	-0.060***
			(0.007)	(0.009)	(0.022)	(0.020)
RR Dummy		0.046**		0.025**		0.045**
		(0.023)		(0.011)		(0.022)
Crisis Dummy	-0.055**	-0.081***	-0.070***	-0.079***	-0.054**	-0.080***
	(0.023)	(0.026)	(0.010)	(0.013)	(0.024)	(0.025)
LB Dummy # Crisis D.	0.031	0.060*	0.035***	0.051***	0.031	0.060**
	(0.032)	(0.036)	(0.009)	(0.012)	(0.026)	(0.028)
LB Dummy # RR D.		-0.055		-0.036***		-0.054**
		(0.034)		(0.011)		(0.026)
Fixed Effects	Yes	Yes	No	No	No	No
Individual Bank Char.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.058***	0.059***	0.094***	0.092***	0.082***	0.084***
	(0.018)	(0.018)	(0.010)	(0.011)	(0.021)	(0.020)
Observations	651	651	651	651	651	651
Number of Banks	21	21	21	21	21	21

LSDV – Least Squares Dummy Variable (Fixed effects or Within) Estimator; FGLS – Parks-Kmenta Feasible Generalized Least Squares estimator; PCSE – Beck-Katz Panel Corrected Standard Errors Estimator.   Standard errors are given in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.